

*Rail Freight Solutions to Roadway Congestion
NCHRP Project 8-42, Task 11 Product*

GUIDEBOOK FOR ASSESSING RAIL FREIGHT SOLUTIONS TO ROADWAY CONGESTION

Prepared by:

*Joseph Bryan, Global Insight, Inc.
Glen Weisbrod, Economic Development Research Group
Carl D. Martland, Senior Research Associate, M.I.T.
Wilbur Smith Associates, Inc.*

Revised, October 2006

Table of Contents

Introduction	1
1.1 Rail Freight as a Solution to Congestion	1
1.2 Objective and Organization of this Guide.....	4
Background: Context for Rail Freight Planning	8
2.1 Rail Freight Planning and Policy Issues.....	8
2.2 Diversion Obstacles	13
2.3 Diversion Levers	16
2.4 Examples of Rail Freight Solutions	19
Guidelines for Preliminary Evaluation of Alternatives.....	24
3.1 The Three Phase Approach.....	24
3.2 The Five Steps for Preliminary Screening	26
• Step 1. Screening for Relevancy	27
• Step 2. Estimating Magnitude of the Problem	33
• Step 3. Characterizing Freight Patterns.....	37
• Step 4. Characterize Available Rail Resources.....	48
• Step 5. Initial Assessment of Benefit and Cost.....	53
3.3 Further Steps for More Detailed Assessment.....	58
Guidelines for Public-Private Dialogue.....	59
4.1 Cooperation First.....	59
4.2 Conflict Resolution	65
4.3 Distribution of Labor	69
4.4 Institutional Development.....	71
4.5 Designing Transactions.....	77
4.6 Winning Support.....	86
Methods for Detailed Analysis	92
5.1 Assess Congestion Levels and Reduction Needs.....	93
5.2 Identify Carrier Cost and Service Levels.....	98
5.3 Analyze Overall Logistics Costs.....	107
5.4 Estimate Truck to Rail Diversion.....	114
5.5 Calculate Traffic & Economic Benefits.....	117
5.6 Representation of Benefit-Cost Findings.....	130
Additional Resources	142

Table of Exhibits

EXHIBIT 1-1: RANGE OF SPECIFIC ACTIONS TO PROMOTE GREATER USE OF RAIL	3
EXHIBIT 1-2: DECISION-MAKING PROCESS FOR RAIL FREIGHT INVESTMENT	5
EXHIBIT 2-1: DIVERSION OBSTACLES	13
EXHIBIT 2-2. EXAMPLES OF PROJECTS AND PLANS TO IMPLEMENT RAIL FREIGHT SOLUTIONS.....	23
EXHIBIT 3-1: MAJOR PHASES OF THE DECISION-MAKING PROCESS	24
EXHIBIT 3-2. FIVE STEPS IN THE INITIAL ASSESSMENT PROCESS.....	26
EXHIBIT 3-3. SITUATIONS WHERE MULTI-MODAL FREIGHT PLANNING IS MOST NEEDED	27
EXHIBIT 3-4. SITUATION SCREENING PROCESS.....	28
EXHIBIT 3-5. RANGE OF ACTIONS TO PROMOTE GREATER USE OF RAIL	30
EXHIBIT 3-6. PUBLIC PROGRAMS AND POLICIES RELATED TO RAIL FREIGHT	32
EXHIBIT 3-7. SUMMARY OF CONGESTION MEASURES	35
EXHIBIT 3-8. FREIGHT FLOW CHARACTERISTICS TO BE MEASURED	38
EXHIBIT 3-9. MACRO ANALYSIS ISSUES	39
EXHIBIT 3-10. EXAMPLE OF TRUCK TO RAIL DIVERSION POTENTIAL BY COMMODITY	43
EXHIBIT 3-11. SAMPLE CALCULATION OF POTENTIAL FREIGHT DIVERSION BY COMMODITY	44
EXHIBIT 3-12 TRUCK FREIGHT FLOWS BY STATE OF ORIGIN	45
EXHIBIT 3-13. EXAMPLE OF AN INTERMODAL MATRIX	47
EXHIBIT 3-14. RAIL FREIGHT TYPOLOGY	50
EXHIBIT 3-15. DEMAND FOR RAIL BY CLASS OF SERVICE	51
EXHIBIT 3-16. HYPOTHETICAL EXAMPLE OF POTENTIAL FREIGHT DIVERSION GIVEN RAIL CAPACITY.....	52
EXHIBIT 3-17. SKETCH PLANNING CALCULATION.....	54
EXHIBIT 3-18A. MARGINAL COST OF HIGHWAY USE BY TRUCKS	55
EXHIBIT 3-18B. MARGINAL COSTS OF HIGHWAY USE BY TRUCKS (CENTS PER TON-MILE).....	55
EXHIBIT 3-18C. AVERAGE PRIVATE AND EXTERNAL COSTS OF TRUCK AND RAIL FREIGHT	55
EXHIBIT 3-19. ESTIMATING MAXIMUM JUSTIFIABLE SPENDING	57
EXHIBIT 4-1: PUBLIC AND PRIVATE PERSPECTIVES	60
EXHIBIT 4-2 UNDERLYING ISSUES AND THEIR RESOLUTION	64
EXHIBIT 4-3 ELEMENTS OF LEADERSHIP AND SUPPORT FOR VARIOUS PROJECT ELEMENTS.....	70
EXHIBIT 4-4: TRANSACTION FACTORS & CONSIDERATIONS.....	78
EXHIBIT 4-5. ILLUSTRATION OF PROJECTED CONGESTION GROWTH ALONG 1-10 CORRIDOR.....	87
EXHIBIT 4-6 ILLUSTRATION OF FUNDING ROLES	89
EXHIBIT 4-7. DISTRIBUTION OF INTERMODAL RAIL COSTS BY MILEAGE.....	91
EXHIBIT 5-1. MEASURES OF TRAFFIC CONGESTION	95

Guidebook for Assessing Rail Freight Solutions to Roadway Congestion

EXHIBIT 5-2. ELEMENTS OF LOGISTICS COST	109
EXHIBIT 5-3. FACTORS INFLUENCING LOGISTICS COSTS	110
EXHIBIT 5-4. MARGINAL COSTS OF HIGHWAY USE BY TRUCKS, 2000 (CENTS PER MILE).....	127
EXHIBIT 5-5. ELEMENTS OF THE CALCULATION OF TOTAL PROJECT BENEFITS	129
EXHIBIT 5-6. CATEGORIES OF POTENTIAL PROJECT BENEFITS AND COSTS.....	131
EXHIBIT 5-7. USING MULTI-CRITERIA ANALYSIS (MCA): AN EXAMPLE.....	135
EXHIBIT 5-8. COST-BENEFIT ACCOUNTING	137
EXHIBIT 5-9. SUMMARY OF BENEFITS AND COSTS AT A SOCIETAL LEVEL	139
EXHIBIT 5-10. BREAKDOWN OF BENEFIT AND COST INCIDENCE AMONG VARIOUS PARTIES	140

ACKNOWLEDGMENT OF SPONSORSHIP

This work was sponsored by one or more of the following as noted:

American Association of State Highway and Transportation Officials, in cooperation with the Federal Highway Administration, and was conducted in the **National Cooperative Highway Research Program**, which is administered by the Transportation Research Board of the National Academies.

DISCLAIMER

This is an uncorrected draft as submitted by the research agency. The opinions and conclusions expressed or implied in the report are those of the research agency. They are not necessarily those of the Transportation Research Board, the National Academies, or the program sponsors.

1

INTRODUCTION

This introduction provides background context on the purpose and use of this report. It summarizes the motivation for considering rail freight options as a solution for addressing traffic congestion, the types of rail freight strategies that can be applied and the types of situations in which they can be most relevant. It then describes the ways in which this report can be used to aid policy development and evaluation of alternatives.

1.1 Rail Freight as a Solution to Congestion

The Congestion Problem. Over the past decade, both urban and intercity highway traffic has continued to grow at rates far in excess of capacity expansion, leading to increasing congestion-related delays and accidents, as well as increasing concerns about congestion implications for air quality, delivery reliability, security and vehicular incursion into residential areas.

Types of Actions to Address Congestion. There are various ways to reduce or minimize the growth of traffic congestion on highways. They fall into three basic categories:

Expand highway system capacity through construction of new or modified lanes, ramps, traffic controls or other traffic management systems;

Institute pricing and regulations to shift highway use by encouraging or requiring some road travelers to shift routes or times of day;

Expand options for alternative modes by enhancing available options for alternative modes of travel, such as use of railroads in place of roadways.

Focus on Rail Freight. All three of these categories of solutions can in theory be aimed at passenger travel or freight travel. Yet while passenger travel accounts for the majority of vehicles on most roads, trucks have a particularly significant impact on highway congestion for several reasons. One reason is that trucks take up more space and require broader separation than cars. Some car drivers are also intimidated by large numbers of trucks mixed with cars on highways, which further adds to traffic congestion. A second reason is that freight movement and truck traffic are growing at a faster rate than passenger movement and car traffic on highways. A third reason is that some policy makers see rail freight as an economically viable and sustainable alternative to intercity truck freight, while the rail option for intercity passenger movement usually requires subsidies.

These statements are clearly over-simplifications of complex situations and there are of course many other factors affecting the viability and benefit of rail freight as an option to reduce highway traffic. However, they indicate the motivation for examining mode alternatives such as rail freight as one path for controlling the growth of traffic congestion.

Situations Where Rail Freight Enhancement May be Relevant. Railroads can offer a viable or potentially viable alternative to trucking in some situations, and that alternative becomes of particular interest when expanded use of rail freight can reduce either existing traffic congestion levels or needs for expanding highway capacity in the future. In general, the situations where rail freight enhancement may be most appropriate are cases where:

Heavy traffic growth calls for expanding highway capacity, yet highway expansion is made impractical by high cost or engineering difficulties;

High levels of truck traffic trucks in a corridor leads to particularly severe local congestion problems;

Problems with the rail network structure restrict the role of rail from offering a viable alternative for freight movement;

The rail network structure has at-grade crossings or other features that restrict the performance of roadways;

Freight users are too small or scattered for efficient rail use, yet consolidation of demand or other strategies could make rail service economically viable; or

The region's economic growth is or will be threatened by an overall lack of goods movement capacity.

Actions to Promote Greater Use of Rail Freight. Public agencies may consider a range of policies, incentive programs or project investments to encourage greater use of rail freight and divert some growth of truck traffic to those rail alternatives. They may also consider public-private cost sharing to encourage such solutions. Generally, the types of solutions that may be considered can be classified into five categories:

- Efforts to better rationalize (reconfigure) the center city rail network;
- Efforts to reduce conflicts among road and rail traffic flows;
- Efforts to increased use of rail/truck intermodal transportation;
- Efforts to improve the level of rail service locally available to industry; and/or
- Efforts to upgrade rail facilities to handle taller or heavier railcars.

Exhibit 1-1: Range of Specific Actions to Promote Greater Use of Rail

A. Rationalize the center city rail network

1. Improve rail access to ports
2. Increase the capacity available for commuter rail
3. Consolidate rail terminal facilities
4. Improve rail and highway access to rail/truck intermodal terminals
5. Upgrade the condition, clearances and capacity of rail mainlines

B. Reduce conflicts among traffic flows

6. Enhance capacity and service with less conflict between freight & commuter rail
7. Reduce delays and risks associated with rail/highway grade crossings

C. Greater use of rail/truck intermodal transportation

8. Add terminal capacity and improve terminal locations
9. Add or upgrade main line capacity
10. Provide more effective equipment
11. Support short-haul shuttle systems (shuttles between ports and inland terminals, or shuttles to move highway freight through or around metropolitan areas)

D. Improve rail service to industry

12. Support construction of rail sidings
13. Support construction of trans-load facilities that can serve multiple customers
14. Include rail infrastructure in economic development planning

E Upgrade facilities to handle taller or heavier rail cars

15. Rail facility upgrade

Private and Public Sector Planning Perspectives. These various types of “rail freight solutions” clearly span an array of different size scales, reaching from individual facilities to region-wide programs and policies. They also affect a wide range of parties from whom information is required. Even the initial screening method described in this guide requires some basic information on the nature of currently (or potentially) available rail facilities and services, in order to ascertain whether rail can even be considered as a viable option for reducing truck traffic.

Freight planning differs from normal urban and regional highway planning. While the field of urban and regional transportation planning has evolved a series of standardized data sources and planning methods over a period of decades, they have in the past focused most heavily on passenger travel. The data sources and methods required for identifying and analyzing freight transportation patterns are less well developed, partly because freight transportation needs are predominantly served by private carriers. Planning and analysis of rail freight solutions needs a dialogue

among planners and representatives of railroads, trucking companies and local shippers to obtain information and appropriately assess opportunities.

To achieve an effective dialogue, railroad officials and transportation planners will have to broaden their perspectives. After all, railroads usually approach planning in terms of markets, lanes, and corridors, which is the “terrain” that terminals can cover and where trains will run. Public agencies, on the other hand, are oriented to the elements of infrastructure at various scales going from individual facilities to urban travel corridors, citywide networks, intercity corridors and state or regional networks. This guide seeks to recognize the different public and private perspectives by presenting several discussions of the issues, opportunities and constraints that they are likely to encounter in seeking rail freight solutions to highway congestion.

1.2 Objective and Organization of this Guide

Target Audiences. This guide provides guidance on both technical analysis and processes for inter-organizational cooperation. It is aimed at transportation planners at both state and regional agencies as well as freight planners at private transportation companies, and decision-makers who control funding and implementation of transportation investments.

Needs for Planning Guidance. As this gap between highway demand and capacity is forecast to accelerate in the future, there has been increasing recognition of the importance of multi-modal planning and specifically the need for more attention to rail freight issues and opportunities in the planning process. This has led both public agency planners and private transportation company officials to recognize a need for tools and methods that they can use to address freight transportation planning issues. These needs fall into three broad subject areas:

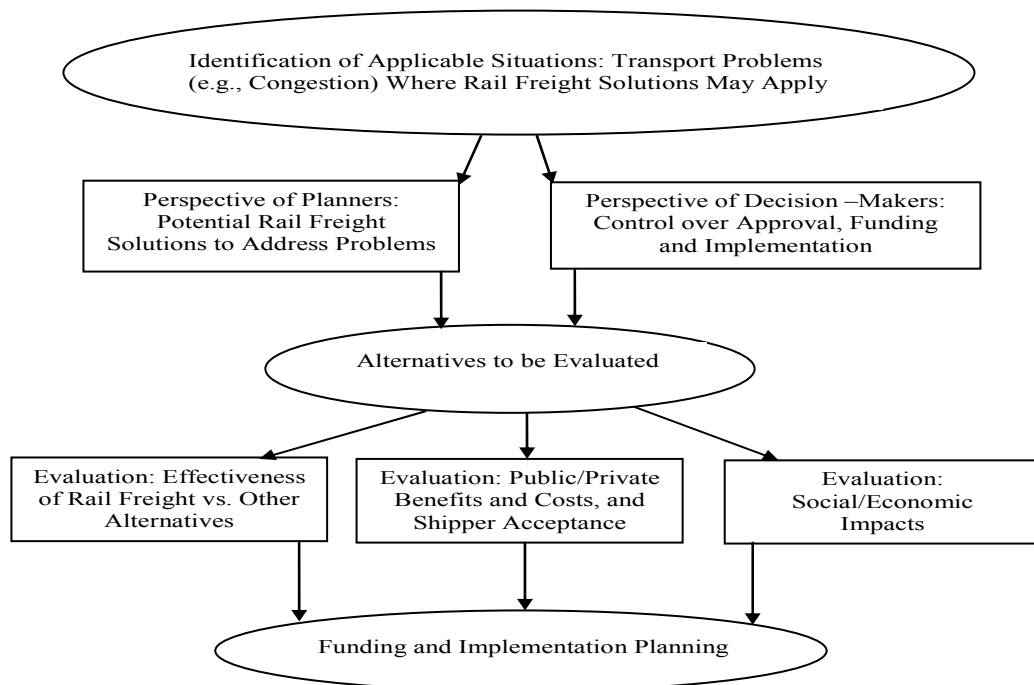
- *Processes for Public Investment Planning* – Traditionally, most state DOTs and MPOs have focused their infrastructure planning largely on highways and given less attention to rail investment, for the fundamental reason that they control investment in highways while they typically do not own or control investment in railroads or rail right of way. However, there is a growing recognition that (a) more multi-modal public planning is needed for freight movement, (b) that such planning should include rail as well as highway options for freight movement, and (c) that rail freight planning, if done well, can help address a wide range of issues relating to security, congestion, safety and air quality.
- *Methods to Identify Transportation Issues and Assess Potential Solutions* – Before expanding multi-modal investment analysis for freight movement, it is necessary for state and regional transportation planning agencies to: (a) clarify

the range of possible transportation issues that should be addressed, (b) define the range of potentially feasible rail and highway solutions to be assessed, and (c) apply appropriate methods to assess their relative benefits and costs. For instance, while there is a current emphasis on addressing problems of growing highway congestion, planners need workable ways of assessing these needs and identifying feasible rail-freight solutions for them.

- *Approaches for Private-Public Cooperation.* Given the private ownership of many railroad and truck-rail intermodal facilities, it is clearly necessary for rail freight planning to involve both private and public sectors. At the same time, key representatives of cargo shipping, trucking and railroad companies also have a strong interest in seeing improved planning and investment, as they are keenly aware of the current shortcomings and needs for improvement in existing road and rail infrastructure systems serving freight movement. Thus, there is clear opportunity for enhancing private-public cooperative relationships in freight infrastructure planning.

The range of analysis and decision issues covered by this guide are shown in Exhibit 1-2. The graphic illustrates how technical analysis of project and policy alternatives must be conducted together with public-private dialogue to consider the perspectives of all parties that need to be involved in implementing rail freight solutions.

Exhibit 1-2: Decision-Making Process for Rail Freight Investment



Topics Covered. This document is designed to provide three types of guidance:

- *Planning Process Guidance* -- Guidelines for planners to identify the types of situations where rail freight is potentially relevant as a consideration for addressing roadway congestion; and the types of organizations and factors that need to be considered;
- *Analysis Guidance* -- Guidelines for assessing the effectiveness of potential rail freight alternatives as solutions to transportation problems, and a description of available analysis methods that can be used to assess the benefits and costs from public and private sector perspectives.
- *Implementation Guidance* -- Guidelines for determining the types of public and private sector involvement that is most appropriate or likely for implementing rail freight alternatives, and approaches for implementing effective public-private cooperation for developing, funding and implementing various forms of rail freight solutions.

Different Levels of Users, Needs and Project Complexity. The guide is intended to provide useful reference material for a wide range of users, who may then tailor its material to meet their needs. The users and their needs can differ in several ways:

- *Levels of Technical Expertise.* The guide can provide planners who are novices to this analysis topic with a straightforward sequence of five steps they can use to identify rail freight options, initiate discussion with relevant parties and conduct screen of them for potential feasibility. At another level, it offers a description of more detailed methods that can be used by experienced professionals to conduct more advanced evaluation applicable for planning and policy analysis.
- *Level of Analysis Detail.* The guide describes a “sketch planning” level of analysis that can be efficiently completed with limited information and spreadsheets to establish a rough estimate of the potential range of costs and impacts associated with rail freight options to reduce road congestion. The guide’s later chapters then describe more comprehensive analysis methods designed to provide detailed estimates on the basis of additional information collection.
- *Level of Project Complexity.* The guide has sections to walks readers through a wide range of public and private sector actors, their concerns and constraints. It is designed to provide a platform for identifying and engaging relevant parties in discussion of proposals for both simple and complex projects.

Because this guide seeks to be useful for different types of users facing different types of situations, it is not presented as a textbook that just teaches readers how to follow a

single set of procedures. Rather, it is designed as a reference tool that provides analysts with the foundation for exploring the many facets of rail freight solutions to traffic congestion. This includes separate sections on screening of opportunities, creating public-private dialogue, and conducting benefit/cost analysis of alternatives.

Organization of this Guide. This guide is designed as a set of sections that readers can consult or ignore as appropriate for their particular situations. The sections can be considered in the following groups:

Initial Grounding - Chapters 1 and 2 provide a basic grounding in freight analysis issues.

- *Chapter 1 (Introduction)* defines the coverage of this guide. It classifies the types of situations, issues and solutions that can be considered in planning and evaluation of rail freight solutions to traffic congestion.
- *Chapter 2 (Background: Context)* provides information for readers who are not already experts on rail freight planning. It discusses the process of rail freight planning and factors affecting rail/truck diversion.

General Guidance – Chapters 3 and 4 provide the basic core guidance on technical analysis and discussions to ascertain the potential for rail freight to help reduce traffic congestion growth.

- *Chapter 3 (Guidance for Evaluation of Alternatives)* outlines a series of five basic analysis steps that can be conducted by planners at relatively low cost, to screen available rail freight options for reducing congestion and identify when further discussion and analysis is warranted.
- *Chapter 4 (Guidance for Public Private Dialogue)* discusses needs, uses and procedures for bringing highway and freight planners in discussion with representatives of institutional players and private sector freight operators, in order to design cooperative strategies that can be acceptable to key parties.

Technical Analysis Methods – The final section provides material for advanced use in analyzing options and presenting results in ways that can potentially gain support among diverse parties.

- *Chapter 5 (Detailed Analysis Methods)* describes the availability and application of various analysis tools, methods and data sources for assessing road and rail options, diversion between them, and the relative benefits and costs involved.
- *Additional Resources* provides a summary of additional resources that readers may consult for further information on evaluation and analysis issues...

2

BACKGROUND: CONTEXT FOR RAIL FREIGHT PLANNING

This chapter provides information for readers seeking an introduction to rail freight planning. It first discusses the process of rail freight planning, and the associated planning and policy issues. It then discusses the various negative factors (constraints) and positive factors (levers) affecting rail/truck diversion. Finally, it provides examples of projects that enabled rail to handle a greater share of freight, including discussion of the different ways in which these projects were justified in terms of their potential public benefits.

2.1 Rail Freight Planning and Policy Issues

Underlying Planning and Policy Themes. A central theme in the public discussion of freight transportation today is the adequacy of capacity. For much of the past half century, this was not a major concern. The US railroad network underwent prolonged rationalization, and public agencies were more concerned with preserving than with expanding rail lines and service. In highway planning, the construction of new roads and lanes could be counted on, and freight largely could be left to look after itself. In recent years, this began to change. Three things occurred in the highway sphere:

- *Emergence of Freight Planning.* The effective ability to build more road capacity was reduced, while congestion mounted steadily. Highway planners started to consider what this meant for the components of stalled traffic, and whether they required a differential response. Since the needs and options for freight stand apart from other traffic and present distinct consequences when mobility declines, it is productive for freight to be treated differently, and this began to happen.
- *Logistics Technology Development.* The movement of American industry to fast cycle systems of logistics over the previous quarter century replaced inventory with information and high performance transportation. This was a beneficial trend for the competitiveness of industry, the globalization of supply chains, and the cost of goods. It was enabled by the digital revolution and advances in mobile communications, and it created great dependency on the reliability and speed of the transportation network. This dependency then came into inexorable conflict with the spread of congestion. While freight operations can manage to work around sluggishness in the network, this is done by accepting a loss of efficiency, and congestion gradually is threatening to compromise the new logistics systems.

- *Concern about Truck Roles in Congestion.* The resounding success of motor carriage as the preferred mode of freight transportation was facilitated by erection of the national highway network, and yet to a large extent this infrastructure was designed for a lesser proportion of truck traffic than it now bears. Higher volumes of truck traffic are a serious concern to the traveling public. Real or perceived, the discomfort produced by unavoidable proximity to large, heavy vehicles engenders animosity toward truck transportation, and limits citizens' support for investments that would increase truck traffic.

Role of Railroads in Freight Planning. Rail transportation, as an alternate form of freight capacity, offers a potential means of mitigating roadway congestion. The rail system already carries a significant part of the nation's goods, especially those heavy loading commodities that travel long distances. To the degree that those goods would otherwise travel by highway, rail transportation limits congestion and highway maintenance, as well as the traffic tie-ups that highway maintenance imposes. Growth in rail can slow the advance of congestion, and in given localities directly relieve it, by diverting freight from the road system. When rail succeeds in winning new traffic, it does so with service that suits the competitive requirements of shipper supply chains, and that boosts the efficiency of motor carriers who can employ it. Truck lines hemmed in by labor shortages, by power utilization dragged down by congestion and by mounting fuel prices may find a reprieve through rail. Rail usage furthermore diminishes the interaction between trucks and automobiles, by moving freight onto the naturally separated rail right of way. Apprehension about the safety of shared roadways thus finds a remedy in rail, and roads that are becoming truck-dominated routes may be helped to avoid or postpone that destiny.

Finally, freight rail promises a series of public benefits beyond its effect on overloaded highways. Maintenance and security costs, for example, are borne by the public for highway freight and are privately provided on rail. The environmental advantage and fuel efficiency of the railroad motive system accrue to the public welfare, and their value may be more acutely felt as the 21st Century progresses. Economic development and competitiveness are a common justification for public rail investments, especially in seaport and hub markets where traffic is dense and service extensive. Benefits of this sort imply that congestion relief does not have to be sufficient grounds for a rail project in order to be an attainable result, because projects justified by other objectives can slim down road volumes as well.

Public Policy Issues. The public interest in transport capacity of course is bigger than freight. Passenger mobility is the need uppermost in the minds of average citizens, which rail can aid by stemming the growth of commercial traffic on roads, removing some of the current truck volume, and preventing the diversion of rail freight. Since the handling characteristics of trucks as well as their size give them an exaggerated footprint on the highway, a reduction in trucks has a magnified influence on passenger traffic flow. Moreover, there is a second magnification at the margins, because incremental traffic is a greater detriment to system performance in already congested

networks. This implies that the diversion or heading off of additional trucks is more productive as congestion worsens, and rail alternatives will be worth more in the future. Even so, the greatest transportation capacity benefits offered by the freight rail network are for the movement of goods. This is important in the public valuation of rail options, because their effect on goods movement capacity can be substantial even while their effect on highway passenger capacity may be less substantial. This means that the more freight is accorded independent importance in public planning, the more useful the rail options will appear.

The rail industry also requires continuing investment in equipment and facilities in order to handle the projected growth in freight traffic. For much of the 20th century, the rail system went through a process of rationalization that resulted in a smaller network with higher density mainlines, fewer branchlines, larger and more efficient classification yards, and new facilities for handling bulk and especially intermodal traffic. For most of this period, advances in rail technology provided tremendous boosts to capacity by allowing heavier cars and longer trains. However, beginning in the mid-1990s the rail system began to experience congestion, to which the industry responded with a combination of demand management and investments within its resources. Additional track and facilities were constructed to handle the extra train traffic, particularly in parts of the network where growth in coal and intermodal was strongest.

As railroads are private companies, they must be able to earn enough to cover their cost of capital if they are to be able to continue to make capacity investments. They also have strong incentives to invest for traffic classes where the return is the greatest, which tends to be bulk, long-distance, or high volume traffic. Since capital is limited, they do not necessarily have the ability, even if they have the desire to provide capacity for shorter-haul traffic that is susceptible to diversion from truck. These limits can be expanded with public contribution, which acts as leverage on the railroads' capital by lowering their blended cost of funds and further improving returns. Better returns then attract more interest in rail from the capital markets, but just as importantly, because it is profitable growth that the markets reward most, public investment helps to stimulate such growth.

These conditions create a convergence of interests between railroads and the public sector. For the public, it is attractive to supply capacity in any productive way, and rail is the most prominent of the multimodal alternatives. For railroads, there is new receptivity to public investment as a way to ease the rationing of capacity, and to open the doors wider to growth. This is a sound basis for public-private partnerships formed in response to common needs. Both railroads and local and state governments are interested in specific changes to local and regional rail systems that will provide more efficient and more profitable operations for the railroads and their customers and achieve better environmental, land use and mobility benefits for the public. Some of these changes can produce network-level effects that elevate railroad performance widely and have national import, and some can be coordinated among local

jurisdictions to produce regional benefits. Capacity alternatives can be pursued jointly for local purposes, or amplified and organized for broader results, even if countrywide investments are not undertaken.

Public-Private Cooperation. Public investment in rail is little different from the public-private partnerships devoted to roadway projects that now are visible around the nation, with the active support of government policy and legislation. Both kinds of partnership – rail and road – are motivated by a desire to lever capital for the expansion of capacity, and by the recognition that conventional sources of funds and capacity are not satisfying traffic demand. There are public goals and legal requirements to be met in both cases, service commitments to be assured, and private returns on investment to be realized. The conditions of infrastructure ownership between road and rail are quite divergent to begin with, and yet this divergence is contracting, because the roadway options today extend to long term leases and agreements with a private responsibility to build, own, and operate. The pressure to find and fund capacity is transforming the way the public sector is willing to do business.

The catalyst for partnership is public capital justified by public benefits. By the public shouldering part of the capital burden, the high capital expense to railroads is reduced, and returns on the carrier portion of investment are rendered more competitive for internal and other private funds. Carriers then are enabled or induced to pursue business that is attractive but below hurdle rates, business development is made possible that rail carriers could not justify on their own, and they can address more projects with public benefits. The policy rationale for doing this is that public benefits normally do not invite private capital, but are a proper use of government revenue, and deserving rail projects may realize certain of these benefits better than other uses of government money. Public advantages - including road relief - in this way can be brought within reach.

Railroads and public agencies will approach joint projects with different objectives in mind, and reasons for conflict will be mingled with reasons for cooperation. The development of relationships among people and institutions in the two spheres will therefore be critical. Traditionally, public agencies have given scant attention to rail freight and carriers have been guarded with the public, resulting in little experience with and limited expectations for cooperative projects. Complicating this picture is the multitude of public agencies with minimal obligation to work together. Moreover, public agencies responsible for rail are unlikely to have much familiarity with options for expanding the capacity of the rail freight system, which involves much different issues than arise in dealing with light density lines, abandonments, and passenger service. Similarly, the customary railway government affairs department was restricted, dealing with such things as line reduction, safety, and taxation; they weren't called upon to work with public agencies to nurture new investment opportunities. Now both groups are changing, and there is ample motivation for relationships to be

woven by a rail industry that needs to grow and a public sector that wants this to happen.

Partnerships in rail are appropriate, realistic, and increasingly valuable for the two parties. Rail will not stop road congestion, but it can blunt it. Rail is not always a remedy for freight capacity, but in fitting conditions it is competitive and effective. Public money is not the whole answer for railroad growth, but it is part of the answer in an era when needs and opportunities are ripe. The questions of when rail partnerships are useful, of evaluating and making the case for them, and of treating barriers to rail effectiveness are some of the matters for which this book is a guide. To the basic questions of whether the public should look to the private rail system for capacity, and whether that can work, the response should be yes. If public investment in private infrastructure produces a public benefit, making the investment ought to be a straightforward proposition. There are institutional obstacles at many levels of government, but there are solutions as well, just as solutions have been found for roadway partnerships. When public funds moderate the capital intensity of railroading, new services become possible at a lower cost. When the new services are competitive with highway transport – as many can be – their cost position creates a persuasive advantage and rail wins traffic. In short, good service at a lower cost wins freight business, public funds used with discrimination can help that to happen on rail, public benefits can result and railroads can grow.

Directions for Incorporating Rail Planning with Highway Planning. What is the place for rail freight in public planning? From the conventional standpoint of highway stewardship, public agencies care about rail for its influence on road conditions. The preservation of rail traffic, the diversion of trucks, and the moderation of their growth all help to combat road congestion and maintain mobility. However, beneath the stress of capacity and fiscal constraints, the conventions are being transformed. The resort to public-private partnerships in the highway sphere is an indication of this, and railways are another, multimodal example. The primary foundation for partnership between the railroads and the public sector is created by intersecting needs, and the catalyst for their partnership is capital: each party gains advantage from the other's contribution, and together they are able to sustain growth. While maturation of their institutional relationships is necessary in order to build on this foundation, the recourse to rail for transportation capacity will be better accepted as freight is valued more in public planning. The crucial place of logistics in the global economy, its vulnerability to network degradation, and emerging concerns about mixed use facilities underscore the independent requirements of the freight system. This system will benefit from local rail projects pursued for conventional motivations. It will benefit more from many such projects, orchestrated by regional strategies of network improvement and public advantages, which are backed by sustained programs of investment - even moderate investment. This makes bigger objectives achievable over time, and marks the transition to more purposeful applications of public-private partnership in the production of freight capacity. Limited investments with parochial justification and

major initiatives both fit into a framework of this sort, because it allows a methodical but variable way of capitalizing on the joint possibilities for rail.

Relevance of this Guide. This guidebook develops these possibilities. It is designed for public and private planners whose interests range from the local, to the coordinated, to the larger scale employment of freight rail partnerships. It supplies basic analytic tools to novices who are uncertain about the role of rail, and systematic techniques and approaches for sophisticated users. Its methods facilitate the utilization of freight rail in answering the nation's need for transportation capacity, and for reining in the progress of congestion.

2.2 Diversion Obstacles

The diversion of freight traffic from highway to rail is a basic objective in congestion relief projects. Diversion is restrained by a series of obstacles that can be overcome, but only if they are recognized and addressed. They can be encapsulated in eleven types of barriers which relate to (a) market viability factors, (b) institutional readiness factors and (c) public issues inhibiting modal shift. These categories of factors are discussed below.

Exhibit 2-1: Diversion Obstacles

Market Viability	Institutional Readiness	Public Barriers
1. Equivalent Service	1. Capacity	1. Public Acceptance
2. Access Limitation	2. Capital	2. Competitive Reckoning
3. Interoperability	3. Institutional Commitment	
4. Density	4. Institutional Structure	
	5. Sustained Performance	

(a) Market Viability Constraints. Market viability factors affect the acceptability, competitiveness, and logistical efficiency of rail service for the customers. The major diversion barriers are four, and reflect on the immediate practicality of projects for planners:

1. *Equivalent Service* is the comparability of the rail product to over-the-road alternatives with respect to the requirements of supply chains. Comparability of service is measured from the shipper's door to the receiver's door and encompasses many factors, including a) trip times and reliability; b) the typical yet not universal perception of rail as an inferior good; and c) the ability of rail to meet the explicit delivery windows required by customers.
2. *Access Limitation* concerns the requirement for rail-truck intermodal operations or for transloading and drayage of carload freight, when direct rail service door-to-door is unavailable. Access limitations relate to the need and specifications for

transfer facilities, the length, efficiency and circuitry of truck pickup and delivery, the time and cost penalties associated with these elements, and the urban problem. The urban problem refers to the fact that metropolitan roadways are especially vexed by congestion, yet if railroad access occurs primarily via truck drayage, then it is precisely the urban areas that railways will find most difficult to relieve.

3. *Interoperability* is the ability of rail to interchange smoothly with marine and motor carriage for either transload or intermodal operations. It embraces particularly the compatibility of equipment, the domestic appeal of service, the breadth of the addressable market, and the integration of rail in the operating networks of ship and truck lines.
4. *Density* is the concentration of traffic volume in specific corridors or lanes; its influence shapes the frequency of service and the productivity of assets. Traffic density is the critical factor in determining if a given traffic flow will support trainload operations, require or avoid intermediate staging, or permit the production of service economies. As a result, it has profound effects on competitive performance and the sustainability of service.

(b) Institutional Readiness Constraints. Institutional readiness describes the capability of railroads in physical, financial, and organizational terms to attract and retain additional volume from highways. There are five prominent barriers to diversion:

1. *Capacity* is the magnitude of line, terminal, and siding infrastructure for the physical and functional accommodation of train operations, including factors like signaling, clearances, and weight limits. It is a tangled consideration in networks, and it has become a significant hindrance to railroad growth. Labor, power, and carrying stock also are components of capacity; shortages of qualified manpower are common in much of the freight industry, and increasingly are a challenge in rail.

An instructive example of the intricate nature of capacity and its interference with diversion comes from a Class I railroad in 2004. A premium intermodal train for a major motor carrier, designed to produce highly competitive three-to-four-day transcontinental service, created system congestion and delays for other trains. Limitations of track, siding, signaling and labor capacity, coupled with the need to create headroom (a clear lane) for the much faster intermodal train, created cascading disruption for other operations, which lasted up to a week.

2. *Capital* is the constraint of funds for investment in capacity and new services, which leaves railroad networks undersized and divertible traffic on the roads. Because rationing of capital pushes internal hurdle rates to high levels, there are important consequences for retention of operations and prioritization of projects: profitable opportunities may not be profitable enough, new business can drive out old, and capacity can be subject to allocation.

3. *Institutional Commitment* is the in-place investment of financial and human resources in a course of action or way of doing business. It causes change to be encumbered, and new ways of operating to face higher asset costs and fewer network benefits than continuance of the old. Partly, it manifests the business franchise that companies build up through the years, with their customer relationships, and interlinked traffic and asset deployments; and partly, it depicts the engrained implications of capacity and capital restraints.
4. *Institutional Structure* acts as a barrier when company and industry organization cause the railroad network to function in balkanized segments, instead of an integrated whole. Due to service and efficiency benefits, railroad market shareⁱ tends to be materially higher in territory where carriers offer single-line service, and this can discourage some interline operations. There are motivational aspects as well: railroads interchanging traffic have shorter hauls than if they handled the traffic themselves, and they must divide profit contributions. This produces the under-served markets of the so-called watershed areas, that straddle the territories of two rail systems,ⁱⁱ and it has an influence on the opportunities and relationships between short line and Class I railroads.

The Alameda Corridor offers another perspective on the motivational component. There, the local authority purchased the right of way to be upgraded, and it bought out all of the competing routes, so as to assure that the user railroads would not favor their own track ahead of the public facility.
5. *Sustained Performance* is a cross over issue between the categories of viability and readiness. If a railroad can introduce but not maintain competitive service, or if it withdraws service in favor of another use for its assets, then traffic diversions are lost. Sustained performance touches on market viability in that the projected demand for a service may not fully materialize, or there may be institutional dynamics and economic incentives at work that depress the volume of business.
 - Start-up risk is a specific and important instance of this barrier at work. Departments of operations frequently are cost centers for railroads and other freight carriers alike. Start-up services impose most of their costs long before they generate most of their revenue. Customer utilization of new services builds and matures through time (following a typical product life cycle curve), and traffic shifts do not reach their peak for a long while after a competitive operation commences. Moreover, traffic activity rarely is consistent day to day, and train starts have a high fixed cost. There is a powerful daily incentive in operating departments to delay or consolidate line haul departures for the sake of more volume, and this normally means a penalty for on-time performance. Unreliable service then undermines the retention of new business, creating more reason to hold departures for volume, and in time the start-up is killed entirely for lack of traffic. This is a vicious cycle that it can be overcome with

discipline and financing, but it is a frequent problem in freight transportation, not just at the lane level, but company wide when there is an organizational movement to raise performance. New ventures consequently may have to run at a loss until they earn customer confidence and attract adequate business, and their operating expenses should be treated essentially as investments.

(c) Public Barriers. While public obstacles to the use and support of freight rail appear elsewhere in this guide, there are two public barriers that will be cited here for emphasis, because they exacerbate the challenges of readiness and viability that this section has discussed.

1. *Public Acceptance* is the first. For almost any kind of freight, the reluctance to accept traffic in populated districts seems to be widespread, and there is a preference for out of sight, out of mind. Citizens want fewer trucks on the road but not more trains, and the construction of new lines as well as new facilities face local in addition to environmental concerns,ⁱⁱⁱ with delays stretching into years. This has caused some railroads to view facility capacity as fixed. The crucial difficulty is that this not only prevents acceptance of substantial new volumes, it also spurs the process by which the railroad traffic mix is culled for only the most profitable traffic. The public and the carrier financial interests are not necessarily aligned in these conditions.
2. *Competitive Reckoning* is the second barrier. Diversion is a two-sided process because it involves competitive interaction, and competition is about *relative* position. While the competitive repercussions of rail projects can be mitigated by the ability of motor carriers to use rail for their own benefit, in the reciprocal case there is little mitigation. The consequences of public road projects for rail are typically subtle, but detrimental and cumulative, and with some exceptions public planning does not take reckoning of these consequences. It seems improbable that this behavior will change, yet the failure to take into account the competitive effects of highway projects is an entrenched barrier to rail diversion.

2.3 Diversion Levers

The countering case against barriers to diversion is found in the levers that aid it. This section introduces a selection of five public levers, some of them commonplace and some not. The selection is more illustrative than comprehensive, and it does not treat the many commercial options available to railroads for attracting traffic.

1. *Two-Sided Character* - In light of the discussion of competitive reckoning, the most obvious lever is the two-sided character of diversion. Actions or inaction that influence the efficiency or service quality of motor carriage have an effect on the competitive balance with rail. It is not in the public interest to interfere with

the performance of truck transportation when it is the way the vast majority of goods travels to market, including a large number that travel part of the distance by air, water, or rail. Conversely, there are initiatives that on balance may be judged to be in the public interest, that nevertheless impose a penalty on truck lines. Tolling of roads is an example of this. Another was the modification of federal hours of service regulations for truck drivers.^{iv} This was designed to improve road safety, but it also reduced labor productivity for some classes of truck shipments, and probably produced a benefit for rail.

2. *Public Financing* is another obvious mechanism, suited to the equally plain purpose of removing capital and capacity constraints. The issues surrounding its use are presented elsewhere in this guide. However, in this section's consideration of barriers and levers, there are two points to underscore:
 - Funds of course can be used to elicit a quid pro quo from the recipient. Therefore, financing agreements can be linked to steps that reduce the barriers of interoperability and institutional commitment, and thus widen the market to which publicly backed rail services may appeal.
 - Start-up risk can be mitigated with limited-duration operating subsidies, protected by performance and marketing covenants. Alternately, to avoid public absorption of operating expense, a combination of project-related equipment financing, and tax credits for fuel and possibly labor, could be applied to accomplish the same objective.
3. *Market Strategy* is a lever not normally associated with the public sector, which nevertheless can be part of comprehensive statewide and regional plans. For instance, DOTs who support the pursuit of bulk traffic by their short line railways are keeping the heaviest trucks off the roads and short lines healthy, but they are also pursuing a vertical market strategy that specializes in the bulk industry. An example of a geographic market strategy favoring intermodal diversion would be the support of enlarged breadth and depth for terminal coverage throughout a geographic region. Its repercussions would fall on the load availability experienced by motor carriers, and could induce their consideration of rail alternatives. A depiction of how this dynamic has worked historically appears in the accompanying box.

Prior to the advent of fast stack train service from the west coast to the interior of the country, those lanes were a long haul truck market. When stack trains arrived, the traffic they captured substantially reduced the number of loads available to motor carriers delivering on the coast, to return their trucks inland. Regional work could be found, but a truck that came from Chicago could not get back to Chicago, nor to anywhere close.

The difficulty was not that the railroad took all of the business, but that it took enough of it for the remaining loads to be fewer and further between. This resulted in trucks laying over longer while they awaited their next load, and traveling a greater distance to find one. The coastal geography – with mountains and rural areas for hundreds of miles eastward – acted like a peninsula to trap truck fleets along the Pacific.

Layovers and empty miles meant declining utilization, and coupled with rates dropping toward the railroad price points, the business was no longer profitable. Many motor carriers withdrew from the west coast market, ceding it to the railroads and to the first truckload lines to seriously adopt rail intermodal as a strategic alternative. Trucks flowed and still flow over the road, especially for time sensitive traffic like California produce, yet the railroads effectively took the market and kept it.

The critical ingredients in the historical example were good quality rail service, its coverage of all the important lanes (which were long, busy, and few), and the peninsular conditions that prevented truck lines from easily finding their loads elsewhere. These conditions can be reproduced in open geography by a terminal network whose coverage areas densely overlap, so long as service levels are competitive and extend to enough of the major lanes. The diversion dynamic is that reduction of a significant portion of available market loads, and elimination of nearby alternatives, disturbs truck utilization to the point that rail options have to be considered.

The effect will be strongest in the most concentrated part of the network, motor carriers actually can be allies in bringing it about, and it isn't necessary to serve all lanes in order to have a noticeable influence on load availability. As a potential public strategy to encourage rail traffic, the key elements are the number, serving radii, and overlap of terminals (which may have to be determined from gate surveys), and the proportion of large lanes these terminals operate with competitive service. The lever is public investment in terminals and other capacity. Since the diversion effect is produced regionally, the strategy works best with multi-state coordination, although geographic barriers can fortify it.

4. *Manipulation of Density* can be undertaken from vectors and points. Inland ports and forward distribution programs transfer the location from which traffic is dispersed, from a gateway or production region to a spot closer to the consuming markets. The lane from that production or gateway region to the new dispersal center consolidates traffic into a dense vector, which may support trainload

operations and non-stop service. Both kinds of program are active in the public (and private) sector; the Port Inland Distribution Network sponsored by the Port Authority of New York and New Jersey is one of many examples.

Point density, which affects pickup and delivery efficiency, is produced overtly by public terminals or land development concepts like the freight village; however, purposeful city planning and zoning can lead with a lighter hand to a comparable result. The operative dynamic is concentration of multiple shippers in a geographic pocket. The pocket then may become served with good access routes, and with rail spurs or facilities, and the proximity of shippers improves the cost and quality of direct or drayage service.^v

5. *Intrinsic Appeal* - Finally, the intrinsic appeal of railroading as a separated right of way can be wielded more aggressively to attract public support to rail projects. On the theory that citizen objections to freight are rooted in the visceral experience of driving alongside heavy trucks, the more segregated and less visible rail mode is an answer. A tactical approach that routinely sought grade separation as a way to reinforce the segregation of rail, and then emphasized the railroad's sequestered character as an additional benefit in projects motivated by factors like congestion relief, could foster a public consensus in regular support of freight rail programs. Such a receptive environment could smooth and simplify the production of diversions by making programs easier to pursue, and faster to accomplish.

2.4 Examples of Rail Freight Solutions

Categories of Examples. There are existing examples of built projects and approved plans that enhance and support the growth of rail freight services as an alternative to reliance on congested roads. Examples found by the preparers of this Guide generally fall into four categories:

1. *Enhancement of rail freight capacity and service for intercity corridors* – e.g., Pennsylvania Double Stack Clearance Project, Virginia I-81 Marketing Project, Netherlands Betuweroute
2. *Enhancement of rail capacity and service along urban corridors* – e.g., California Alameda Corridor Project, Kansas City Sheffield Flyover
3. *Plans to enhance throughput and capacity of regional rail freight system* – Vancouver MCTS Plan, Chicago Rail Futures Plan
4. *Enhancement of rail freight options for service to ports/terminals* – e.g., State rail access programs and Inland Ports.

Examples. A short synopsis of selected examples are shown below. More details are provided in the separate research report document.

- ***Pennsylvania Double Stack Clearance project*** – Pennsylvania DOT coordinated the work of the railroads and contractors, who “cleared” 163 obstacles so that double stack container trains could serve the Port of Philadelphia. This involved a combination of undercutting rail rights-of-way, raising vertical clearances on railroad bridges and tunnels, as well as highway and township road bridges. The project covered Conrail's east-west route from the Ohio border to the port, and Canadian Pacific's north-south route from the New York border to the port. In addition, the project improved horizontal clearances in order to accommodate dimensional movements from Wilkes-Barre to the Port of Philadelphia. The project benefits were: (a) reduced shipping cost and improved service for the region’s shippers, (b) some newly viable competitive rail alternatives where none had previously existed, (c) gain of dimensional traffic for the port and gain of intermodal traffic for the railroads, and (d) a dramatic increase of trucking and warehousing employment in the area.
- ***Virginia Interstate 81 Marketing Study*** - The Virginia Department of Rail and Public Transportation studied the potential for new railroad freight services to attract truck traffic from Commonwealth highways, for the alleviation of roadway congestion and improvement of safety. The project employed market research, competitive and operational analysis, diversion modeling with traffic data, and cooperative planning with railroad officials to establish the product features and attendant costs and investments that would be required to shift varying levels of highway volume to rail. Earlier studies had determined that the direct benefits of freight modal diversion along I-81 were significant, and included improvements in highway user, safety, and pavement maintenance costs, as well as in air quality. The project identified public investment needed to upgrade right of way and expand or develop terminals to allow the introduction of new intermodal trains, raise their performance characteristics, and reduce their cost of operation to the point where it would shift the competitive modal balance.
- ***Betuwerroute Freight Line*** - The Netherlands Ministry of Transport and the NS Railinfrabeheer Railroad partnered to develop a 160 km, US \$5 billion freight-only rail line from the Port of Rotterdam to the German border, linking with the German rail network. It included five tunnels with a total length of 18km and 130 bridges and viaducts with a total length of 12 km, all electrified and built to accommodate double stack trains operating at a speed of 120km/h, with up to ten trains per hour in each direction. The nearly completed project was designed to expand freight rail capacity and protect the competitive trade position of the Netherlands and its major port. It is one of the 14 priority infrastructure projects supported by the European Commission as part of its effort to discourage road haulage in favor of rail freight across Europe. As such, the Betuwerroute is

expected to reduce roadway congestion and yield environmental benefits, which are prominent policy goals of the EC.

- ***Alameda Corridor*** – The State of California and Los Angeles County MTA provided major support for a new freight rail expressway connecting on-dock and terminal rail facilities at the San Pedro Bay (Los Angeles and Long Beach) ports to inland terminals and the continental rail network. The current corridor consists of 20 miles of public, multi-track rail line, half of it grade separated in a sub-street trench. The \$2.4 billion project consolidates access to the country's top international container port by its two serving Class I railroads, with capacity for one hundred trains per day at speeds of 40 miles per hour, in an urban environment. As part of the project, two hundred grade crossings were eliminated by rebuilding the right of way and by redirection of traffic to a consolidated route. This was estimated to remove 15,000 daily hours of vehicle delay from Los Angeles roads. At the same time, the street parallel to the rail corridor was widened and improved as part of the right of way reconstruction, leading to better traffic flow. The corridor is expected to substantially reduce the growth in truck trips associated with port container activity expansion. A planned second phase would extend the route to downtown operations and a huge goods distribution complex at the rim of the metropolitan region. If finished, the second stage would produce a 55-mile trans-urban rail corridor.
- ***Kansas City Sheffield Flyover*** –A public/private partnership of railroads and Missouri DOT funded development of three miles of elevated tracks in Kansas City to increase the capacity and improved the performance of a major bottleneck in the rail network. At-grade crossing of high-density rail routes had not only led to train backups, but also caused extensive delays to highway traffic when trains blocked local streets. The resulting delays were especially difficult for trucks seeking to enter or exit a major industrial area hemmed in between the main lines. By double-tracking the flyover and keeping the existing tracks, it was possible to greatly increase the capacity of the intersection, improving flow of through trains and allowing better service to local rail customers. The project eliminated rail and highway delays associated with train interference at the rail crossovers.
- ***The Major Commercial Transportation System (MCTS)*** for the Vancouver region of British Columbia is a system of key transportation facilities and routes planned to improve both rail and highway connections to the region's to external gateways and major commercial activity centers. The MCTS planning process identified a set of surface transportation projects designed to support a balanced flow of rail and truck movements. They were intended to minimize local traffic congestion, while maximizing the economic health of the region's international gateway function – which is the flow of people and cargo to and from marine port, airport and international border crossing facilities. The "Current and Planned Infrastructure List" makes the case for 17 major new investments, comprising

highway upgrades, rail links, new road and rail river crossings, a new rapid transit line and an additional harbor crossing, with a cost of Can\$ 6 to \$7 billion.

- ***Chicago Freight Rail Futures*** – Chicago’s undeniable stature as the nation’s rail freight hub has immersed that city in the issues of multi-modal policy development. At present, nearly 60% of all US rail intermodal traffic and one-third of all US rail traffic flows through the Chicago region. As overall rail traffic volumes have grown and mergers have concentrated volumes on fewer and fewer traffic corridors, the region has faced a growing rail congestion problem. Although trains can make the trip from the West Coast to Chicago in a truck-competitive two days, once they get to Chicago they can take three more days just to move across town by truck. This adds to urban congestion, especially with 600 at-grade rail crossings in Chicago. The City of Chicago DOT, along with the Chicago Metropolis 2020 organization and the Chicago Coordinating Committee of the railroads have each studied needs for improving freight service and movement through the city. The proposed \$1.5 billion CREATE (Chicago Regional Environmental And Transportation Efficiency) Project, envisioned as a public-private partnership, would maximize the use of five rail corridors, create grade separations at 25 road-rail crossings, and create six rail-to-rail "flyovers" - overpasses separating passenger trains from freight trains. The project has not yet been developed, as public funding is still pending.
- ***State Rail Access Programs*** - Many states have local transportation grant programs designed to help fund local rail and/or highway projects that are needed to help attract and expand industry in the state. Several of these states operate separate rail grant funding programs that are specifically focused on supporting local projects that address these economic development objectives. Among them, Maine’s Industrial Rail Access Program and Ohio’s Rail Economic Development Program offer particularly interesting examples of rail economic development programs, since programs in those states have documented how their projects have explicitly served to reduce highway demand and associated needs for highway-related investment. In both states, most projects are new or rehabilitated rail sidings and spur lines, although the eligible projects can include transload facilities, bridges, rail/roadway crossings, track interchanges and rail yards.
- ***Inland Ports*** - A true “Inland Port” is a remote freight processing facility and connecting infrastructure that provides advanced logistics for ground, rail and marine cargo movements outside of the normal boundaries of marine ports. In effect, it extends a marine port to an off-site, inland location by providing a remote, inland multimodal distribution center for marine/rail and marine/truck transfers, with a direct rail or barge shuttle that moves cargo between ocean-going vessels at the main port and the intermodal transfer site on a frequent basis. By relocating the truck and rail distribution facilities away from the main port site, the inland port facility can reduce congestion from truck traffic in the area of the main port, reduce rail/roadway intersection delays, and remove constraints on port

expansion that are attributable to truck capacity limitations. Examples include the Virginia Inland Port (VIP), the European Container Terminal (ECT) in the Netherlands, Nilai Inland Port (NIP) in Malaysia, and New York’s Port Inland Distribution Network (PIDN).

Motivations. Exhibit 2-2 shows the motivation for each of these examples. It is notable that all of these cases create solutions to roadway congestion, but in most cases this was not the primary stated motivation for the project. The most common impetus claimed for these projects was economic development, or the related matters of port or regional competitiveness. Viewed from the perspective of how projects attract political support and financial backing, these illustrations suggest that the economic card is a strong one to play, and can win relief for roadways where a program based on congestion happens not to suffice. Even so, reduction in road congestion formed an important part of project justification in every instance, and crowded roads are linked to the question of competitiveness. Congestion was a particularly resonant issue where the relief was obvious – as in grade crossing improvements – or was bound up with safety perceptions. Finally, as truck volumes continue to grow and capacity strains increasingly turn acute, congestion may drive more projects, because of the logistical effect on economic performance, and public frustration with deteriorating highway levels of service.

Exhibit 2-2 Examples of Projects and Plans to Implement Rail Freight Solutions

Project Type	Case Illustration	Motivation
1. Intercity Corridor	1) PA Doublestack Clearance	Port/Regional Competition
	2) VA I-81 Marketing	Safety and Congestion
	3) Betuweroute Freight Line	Port/National Competition
2. Urban Corridor	4) Alameda Corridor	Port Capacity & Competition
	5) Sheffield (KC) Flyover	Hub Capacity
3. Metropolitan Citywide	6) Vancouver Gateway	Gateway Competition
	7) Chicago Rail Futures	Economic Development
4. Facility	8) State Rail Access Plan	Economic Development
	9) Inland Port Plans	Port/Regional Competition

3

GUIDELINES FOR PRELIMINARY EVALUATION OF ALTERNATIVES

This chapter outlines a series of three phases involved in moving from a preliminary assessment of potential feasibility to a detailed benefit/cost analysis of rail freight solutions. It then provides details for new analysts on how to complete a five-step initial screening process. This approach also forms a foundation for more complex analysis using other analytic models and tools described later.

3.1 The Three Phase Approach

Evaluating Potential Projects and Programs. While the guide is intended to work for different types of projects, there is an underlying set of three phases that must apply for essentially all analysis and decision-making processes. These phases are shown in Exhibit 3-1 and explained in the text that follows.

Exhibit 3-1: Major Phases of the Decision-Making Process

Phase	Major Activities	Main Question & Desired Outcome	Methodology
1	<u>Preliminary assessment:</u> situations where rail solutions appear feasible	<ul style="list-style-type: none"> - Can rail help relieve highway congestion by handling more freight? - <i>Identification of promising rail projects or programs aimed at specific solutions to congestion problems</i> 	<ul style="list-style-type: none"> - Review information on freight facilities & traffic flows - Use framework to identify problems & potential solutions - Use simple models to estimate costs & benefits of potential solutions
2	<u>Detailed analysis:</u> evaluation of rail options	<ul style="list-style-type: none"> - Do benefits of proposed actions justify their costs? - <i>Analysis of costs & benefits of rail solutions, including economic & environmental factors.</i> 	<ul style="list-style-type: none"> - Estimate project costs and impacts on rail service - Traffic diversion study - Benefits analysis
3	<u>Decision-Making:</u> Multi-criteria & Benefit-cost analysis	<ul style="list-style-type: none"> - Is this project or program as good as or better than other approaches? - <i>Comparative analysis of major alternatives</i> 	<ul style="list-style-type: none"> - Consider alternatives including rail, highway investments and public policy regarding taxation & finance.

Phase 1 – Initial Screening. In general, public agencies are looking for particular rail projects or programs that can help to relieve highway congestion. As such, there is a need for guidance in identifying the types of situations where rail might help; expected benefits associated with congestion relief; and the specific types of projects or programs that might be appropriate given local conditions. These assessments are part of the first phase of the analysis, which focuses on determining whether there is a reasonable chance that the costs of rail projects or programs can be justified in terms of their contribution to congestion relief. This phase involves carrying out five steps to: (1) screen for relevancy of rail freight solutions, (2) gauge magnitude of the road congestion problem, (3) characterize the local pattern of freight shipping, (4) characterize available rail resources, and (5) use “sketch planning” approaches to assess the potential viability (benefit and cost) of available options.

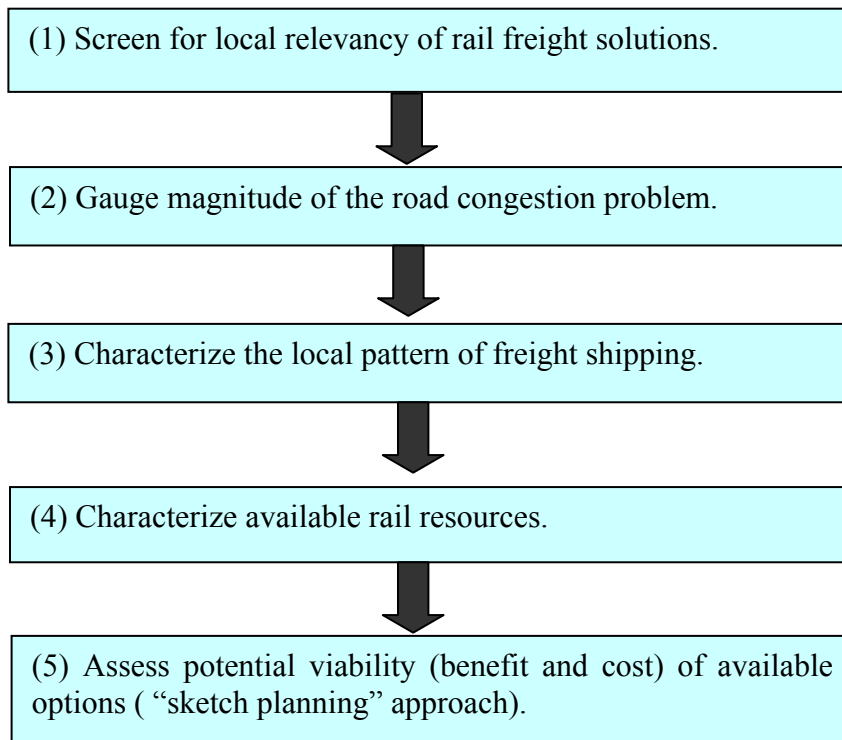
Phase 2 – Detailed Analysis. Only if there does seem to be potential for a particular project or program, then the analysis should proceed to Phase 2 for a more detailed analysis of the proposed options. The logical place to begin is by looking at specific rail investment options and estimating how they could affect cost or any of the service factors that influence total logistics costs. The next step is to use a logistics cost or mode split model to determine whether service improvements, if obtained, would be likely to affect road/rail choices and, if so, to estimate how many trucks might be diverted to rail. Given the potential diversion, it is then possible to estimate the effects on highway performance using various highway models. The changes in highway performance can then be compared to the costs associated with the rail initiatives to see if further consideration is warranted. Thus, Phase 2 makes use of: (1) rail cost or performance analysis, (2) logistics cost or mode split analysis, (3) highway performance analysis, and (4) economic and financial evaluation.

Phase 3 – Decision-making Support. The final phase puts results in the context of decision choices. First, findings must be placed in the context of other options, such as doing nothing and living with congestion, building more highways, expanding the capacity of existing highways, or using tolls, fees or regulations to restrict traffic flows. Second, each option must be considered from the perspective of its economic, political, and practical feasibility for the various participants. This includes consideration of the levels and types of benefits that might accrue to each party, and confirmation of the sufficiency of benefits for shippers to accept a change of mode. It requires direct interaction with the shipping community in any of several ways, and an assortment of steps for the assurance of traffic volumes. Third, for the public evaluation component, additional analysis of social and broader economic impacts might be needed. Thus, Phase 3 makes use of procedures for comparing alternatives in a broader context that may include regional economic models and/or multi-criteria assessment tools.

3.2 The Five Steps for Preliminary Screening

Organization of this Chapter. The remainder of this Chapter guides readers through the five steps involved in carrying out the Phase 1 assessment. These steps are illustrated in Exhibit 3-2. Each of these steps is discussed in terms of (a) types of information and analysis needed, (b) tools that can be used; and (c) ways in which findings can be presented and used. Subsequent chapters 4 and 5 then provide guidance on public-private institutional considerations and available analysis tools for carrying out the second and third phases.

EXHIBIT 3-2. Five Steps in the Initial Assessment Process



• **Step 1. Screening for Relevancy**

The first step is to conduct a three-part screening process to clarify the local situation, available alternatives and public policy levers. The three parts are:

- (1) *Screening the Situation* - whether the local situation matches to prototype of situations where multi-modal freight planning is most appropriate;
- (2) *Screening Available Actions* – whether potentially available local actions match to any of the prototype action categories for promoting rail freight use;
- (3) *Screening Available Policies* – whether public agencies and policies exist to implement relevant actions.

Part 1 - Screening the Situation. The first screening assesses whether the local situation matches any model situations where rail freight can potentially be relevant as a means of reducing highway congestion. The goal is to identify situations where there is a need and opportunity for achieving greater use of rail.

Exhibit 3-3 lists the six categories of situations that are potentially most promising situations for rail freight solutions. In the text that follows, each situation is described in terms of the type of context in which they might be particularly applicable, and examples where rail projects or programs have taken advantage of these opportunities. The user of this guide must determine whether the local situation matches to any of these six categories. In general, judgments concerning the local relevance of these types of situations can be addressed and answered by a group of knowledgeable public officials, railway officials, and customers. Only in promising situations is it reasonable to encourage further analysis of rail solutions for roadway congestion.

EXHIBIT 3-3. Situations Where Multi-Modal Freight Planning Is Most Needed

1. Severe congestion seems to require extensive investment in highways
2. Over-reliance on trucks leads to severe local problems
3. Problems with the network structure restricts role of rail
4. Rail network structure restricts performance of highways
5. Freight users are too small or too scattered for efficient use of rail
6. Regional economic growth is threatened by lack of goods movement capacity

Exhibit 3-4 shows factors to consider in characterizing the local context and type of congestion conditions, and using that information to define the form of congestion and conformity to any of six types of prototype situations.

EXHIBIT 3-4. Situation Screening Process

Factors to Consider

<p>Relevant Questions:</p> <ul style="list-style-type: none"> • Is your area urban or rural? • Are high levels of highway investment planned for the area? • Are you within 50 miles of a port? • Is there a rail terminal within 50 miles? • Are local industries transport-intensive? • If so, are local industries served by rail or truck? • Does the area have commuter rail? • If not, is commuter rail infeasible because rail freight absorbs all capacity? 	<p>Characteristic that describes your area:</p> <ul style="list-style-type: none"> • Congested highways • High truck volumes • Local congestion related to delays at grade crossings • Area is proximate to port/throughway for port traffic • Truck traffic serving local industry is growing • Railroads on periphery/outskirts of metropolitan area create truck traffic • Railroads plan investments on outskirts of metropolitan area
--	--

Classification of the Situation

<p>Form of Congestion:</p> <ul style="list-style-type: none"> • Area-wide (Local Urban) • Inter -City Corridor • Bottleneck • Port/Terminal Access 	<p>Situations Where Rail Freight May be Part of a Multi-modal Solution:</p> <ul style="list-style-type: none"> • Severe congestion seems to require extensive investment in highways • Over-reliance on trucks leads to severe local problems • Problems with network structure currently restrict the roles of rail • Problems with the rail network structure restrict the performance of highways • Freight users are too small/scattered for efficient use of rail network • Regional economic development is threatened by lack of goods movement capacity
---	--

- Situation 1, *where severe congestion seems to require extensive investment in highways*, can be found in two contexts: 1) congested highways with high truck volumes; and 2) local congestion related to delays at grade crossings. Examples of the first include I-5 between Portland, Tacoma, and Seattle, where Northwest Container Services has taken 100,000 trucks off the interstate in order to reduce congestion; and I-95, where the I-95 Coalition is promoting greater use of rail as a way to remove trucks from this heavily traveled highway. Examples of the second include the Alameda Corridor Project (a very large grade separation project, among other things) and numerous smaller efforts around the county to close rail-highway grade crossing or to replace them with bridges.
- Situation 2, *where over-reliance on trucks leads to severe local congestion*, has two primary contexts: 1) truck traffic moving to and from ports causes severe congestion along the major access routes; and 2) truck traffic serving local industry (or agriculture or mines) is growing, causing rapidly escalating maintenance costs for and congestion on local street networks. Examples of the first include the series of projects in New Jersey undertaken by The Port Authority of NY/NJ to promote the use of rail for containers moving to and from the port. Examples of the second abound, especially in locations with recent investments in major industrial facilities that rely on large, frequent deliveries of supplies, such as automotive assembly plants and distribution centers.

- Situation 3, *where the rail network structure restricts role of rail*, can occur when railroad investments in intermodal terminal capacity at the outskirts of metropolitan areas are increasing local truck traffic within the region. In Atlanta and other metropolitan areas, new intermodal terminals have been located on the fringe of the city. In Chicago, conversion of the Joliet Arsenal into an intermodal freight facility, is an attempt to use “brownfield” sites at the fringe of the region for serving metropolitan rail freight operations. Also in Chicago, extensive freight and commuter operations strain network capacity, leading to conflict between commuter and freight operations. CREATE (Chicago Environmental and Transportation Efficiency Project) is a plan developed by railroads and regional agencies in Chicago to reduce rail-rail and rail-highway conflicts.
- Situation 4, *where the rail network structure restricts performance of highways*, occurs when rail facilities block logical development of the metropolitan area or disrupt the flow of local street traffic. For example, Crystal City, a major development project opposite Washington National Airport, was made possible by the closure and redevelopment of Potomac Yard. The Kansas City Flyover eliminated train delays associated with two very busy rail-rail crossings, thereby relieving very extensive congestion in nearby neighborhoods. Another example of rail infrastructure restricting highway performance involves substandard roadway clearances at railroad underpasses, which is not an uncommon problem where such underpasses were constructed as part of grade separation projects undertaken prior to WWII. In Chicago, this is sometimes referred to as the “viaduct problem.” There is little railroad benefit from solving this problem, which would entail significant reconstruction costs as well as disruption to the transportation system.
- Situation 5, *where freight users are too small or too scattered for efficient use of rail*, occurs in many contexts including cases where: 1) local companies lack access to the rail network; or 2) there are untapped opportunities for regional warehouses or distribution centers at locations served by rail. Investments aimed at addressing the first include the many efforts to make intermodal transport cheaper, more reliable, or more accessible, all of which make rail service more convenient to shippers who lack sidings; state programs such as those in Ohio and Maine that help fund construction of rail sidings; and state programs such as those in New York and Pennsylvania that help improve the track structure or increase clearances to allow taller, longer, or heavier cars. Investments aimed at addressing the second include public investments by the state of Maine in a transload facility that eliminated 100,000-150,000 truck trips per year to the port. An example of a private sector investment to promote effective use of rail would be UPS’s development of sorting facilities next to new or renovated intermodal rail yards in Chicago and Jacksonville.
- Situation 6, *where regional economic development is threatened by lack of goods movement capacity*, is most often associated with the following contexts: 1) a region’s economy is based to a significant degree on a city’s role as an

international port or border gateway and growing roadway congestion threatens the continued viability and competitiveness of that economic function; and 2) a region's infrastructure and location make it ideal for locating intermodal interchange facilities or bypass routes and regional officials see this as an opportunity to spur economic growth in their area. Examples of the first include Vancouver, BC, where forecasts of traffic growth indicated congestion barriers to goods movement at ports and border crossings, factors that could significantly reduce regional economic competitiveness and growth; and the I-5 corridor through Portland, OR and Seattle, WA, where congestion threatened the portions of the region's economy that are based on international trade. Examples of the second include efforts by communities in Pennsylvania, New Jersey and Connecticut to develop inland or satellite port facilities that can accept truck shipments and transfer them by rail or barge to the Port of NY and NJ for overseas shipment. These efforts were aimed at helping economically depressed communities take on a new transportation function while also relieving congestion in New York City.

Part 2 – Screening Available Actions. Having characterized the local situation, a user of this guide will have a basis for then identifying the possible types of local actions that might succeed in improving the performance of the rail system. Exhibit 3-5 lists five classes of actions that can increase the role of rail freight in controlling road congestion. In the text that follows, each action category is followed by examples. The user of this guide must determine which (if any) of the five classes of actions appear relevant in the local context and potentially useful as a way to shift freight traffic from highway to railway.

EXHIBIT 3-5. Range of Actions to Promote Greater Use of Rail

1. Rationalize the center city rail network
2. Reduce conflicts among traffic flows
3. Increased use of rail/truck intermodal transportation
4. Improve rail service to industry
5. Upgrade facilities to handle heavier/higher cars

- Action 1 - *Rationalization of the center city rail network* is the most complex and the most costly, but can sometimes be the most valuable. Built for land use patterns and transportation technologies of the 19th century, urban rail networks are seldom well structured for the needs and competitive environment of the 21st century. There are likely to be too many small terminals, too many low capacity track segments, poor integration with other modes, excessive conflicts among transport flows. The public may also be concerned about the risks or environmental impacts associated with the rail system, as reflected in the District of Columbia's attempt to restrict the flow of hazardous material through the city.

- Action 2 - *Reducing conflicts among traffic flows* is another aspect of rationalizing urban rail systems. Conflicts include competition among passenger trains and various kinds of freight trains for space on the major routes, as well as conflicts at rail-highway grade crossings and at locations where rail mainlines cross each other at grade. Possible solutions include adding capacity to the mainlines so they can handle more trains, eliminating grade crossings, and constructing flyovers.
- Action 3 - *Increase use of rail/truck intermodal transportation*, as this is the most rapidly growing rail service, and it is also a form of service where it is often difficult for railroads to add capacity. Railroads have already started to locate major terminals well outside of cities, which means that local shipments will still need to use the metropolitan highway network, even if they are destined to move on an intermodal train. From a public perspective, air quality and congestion benefits could accrue from having multiple intermodal terminals throughout the metropolitan area rather than a single large terminal on the fringe of the region. Another approach would be public support to promote short-haul intermodal service, either through investment in facilities or through operating subsidies. Forms of short-haul service could include shuttles between ports and inland terminals or special services designed to move highway truck traffic through metropolitan areas.
- Action 4 – *Improve rail service to industry* is a strategy aimed at customers rather than railroads, which can be a key way to encourage carload traffic. Several states have provided support for constructing rail sidings as an incentive for industrial development or as an incentive for using rail. Another approach is to support warehouses or distribution centers that could be served by rail, perhaps within a freight village or industrial park development.
- Action 5 - *Upgrade facilities to handle heavier/higher cars* is a strategy that relates to two situations. The first is the rail industry's decision in 1990 to increase axle loads as a means of reducing the total costs of bulk transportation. The standard maximum weight for rail cars rose from 263,000 to 286,000 pounds, allowing some efficiencies in transport costs, but only if the track structure is able to bear the heavier cars. On high-density lines, the costs of upgrading the track and of strengthening the bridges can be justified by operating savings. However, on light density lines, especially lines operated by short line railroads, it is difficult to justify the initial capital expenditures. Since the industry as a whole is moving toward the heavier cars, the location of industrial activity will depend in part upon which locations are able to originate or receive the heavier cars. Public interests in maintaining efficient rail service, in retaining employment, or in industrial development might therefore lead to support for upgrading some of these light density lines. The second situation is where lateral or overhead clearances restrict the movement of doublestack container cars or other large cars. Limited clearances are mainly a problem encountered in the east. Railroads have pursued

clearance projects with public support, for example, to improve intermodal service for the sake of the competitiveness of ports.

It is important to recognize that individual projects fitting any of these five action categories do not necessarily have to be complex, costly or time-consuming efforts that require cooperation among multiple railroads and public agencies. They can be as simple as expanding intermodal facilities, sidings and road/rail crossings, though they can also involve regional efforts to reorganize rail yards or subsidize costs for new services. In any case, the same basic process of analysis steps must be completed.

Part 3 – Screening Potentially Relevant Programs and Policies. Having characterizing potentially relevant actions, a user of this guide will have a basis for identifying specific types of programs or strategies that public agencies can use to maintain, improve or promote the use of rail. Exhibit 3-6 lists six classes of public programs that are most often used for this purpose. These programs and strategies deal with rail finances and industrial development issues, as well as with particular kinds of investments in rail technologies.

EXHIBIT 3-6. Public Programs and Policies Related to Rail Freight

1. Project Finance
2. Public ownership of the right-of-way
3. Redevelopment of rail facilities
4. Taxation
5. Financial reform
6. Land grants and land swaps
7. Light density line programs

- Policy 1 - *Project Finance* programs are an option to put public money into cooperative rail projects that add capacity and divert trucks.
- Policy 2 - *Public ownership of the railway right-of-way* is another option sometimes used to keep a light density route open for rail service. Purchase and lease back of rail lines can also be used as a way to promote the economic health of railroads serving a region.
- Policy 3 – *Redevelopment of Rail Facilities* refers to selective closure and shifts in usage of various parts of the urban rail network as a means of improving rail service. This can also provide an opportunity for better uses of the land occupied by some rail yards. It might be possible to use the development potential of the land to help fund relocation of rail facilities to equivalent or superior sites.

- Policy 4 – *Taxation* is a strategy that can affect general costs of doing business for railroads and their competitors. Tax policies have historically been important aspects of transportation policy. Some, but not all states have granted property tax relief for certain rail properties. The federal government has from time to time offered investment tax credits for railroads and other industries facing financial difficulties. Tax policy provides a way of encouraging investments in particular industries or activities, to further various public interests in the services provided by those industries.
- Policy 5 – *Financial Reform* is another approach that seeks equitable treatment of the various modes. The taxes and fees charged to heavy trucks, fuel taxes, toll charges, and other aspects of highway financing affect the competitive boundary between rail and truck.
- Policy 6 - *Land grants* were a major incentive used in the United States and elsewhere to help finance the construction of early railroads. More recently, there have been specific instances where land grants facilitate the construction of a new rail link or bridge, e.g. the donation of small bits of land to allow construction of a flyover, as in Kansas City. Land grants and land swaps might be needed in order to be able to locate intermodal terminals in locations where they can be most effective in attracting traffic off the highways.
- Policy 7 - *Light density line programs* include public purchase or subsidy of rail lines in order to maintain rail operations, as well as investment in low-volume lines in order to improve the ability to serve customers.

This list of policy directions is not an endorsement of any of them, as this is not the place to judge the extent to which such strategies have been effective in the past. The intent is simply to encourage public agencies to consider the full range of options that are open to them. The success of any project or of any program will depend upon local conditions and the particulars of implementation.

• **Step 2. Estimating Magnitude of the Problem**

Having classified the local situation and identified potentially relevant actions and policies, the second step has two parts. The two parts are:

- (1) develop a *representation of current and projected future traffic conditions*; and
- (2) develop *measures of the level of congestion*, its location and the extent to which truck traffic contributes to its severity that can be used to compare scenarios and assess the magnitude of their congestion reduction benefits.

Part 1 – Representation of Traffic Conditions. The typically requires some representation of regional or corridor highway demand and performance

characteristics in terms of current and future vehicle trips, distances and speeds. By estimating traffic volumes and congestion conditions under alternative scenarios, it is possible to identify the magnitude of the future congestion problem under base case conditions that assume no diversion to rail freight (and later under alternative scenarios that create some diversion to rail freight.)

Most metropolitan areas have some type of road network and traffic model that can be used to represent current conditions and project expected future conditions in terms of the flow of vehicle trips, distances and speeds. Typically, these models start with a forecast of truck and car *trip generation by zone* (including detailed zones internal to the region and larger zones representing areas or directions outside the region that are ultimate origins or destinations). They then provide a forecast of *trip assignment* between origins and destinations based on current traffic levels and expected future changes in employment and population location patterns. Finally, they provide a forecast of *trip distribution* among particular links and nodes, based on a “least time” or “least cost” path for future traffic. This process can forecast shifts in traffic as travel times slow down for those links and nodes that are forecast to have high volume/capacity ratios. The end results are some measures of vehicles, link speeds and trip distances.

Those measures, in turn, are used to calculate the amount of total daily traffic measured as vehicle-miles of travel (VMT) and total time spent traveling measured as vehicle-hours of travel (VHT). Generally, these models are accompanied by some data concerning the portion of vehicle trips that are made by trucks. Many states also have statewide models that are used for major highway corridors, and that data can similarly be applied to calculate current and future VMT, VHT and truck volumes on those routes. This information provides a basis for calculating current and expected future congestion for areas and corridors under base case conditions, which assume no diversion of any freight movements to rail.

Later steps will provide estimates of the potential freight diversion to rail that might be possible or expected in an alternative (future project) scenario. Then, this same process of traffic analysis can be reapplied to calculate the changes in traffic volumes, VMT and VHT expected to occur on under that future scenario. Most road network models will forecast how a reduction in freight-related truck traffic (due to rail diversion) will lead to shifts in the spatial distribution of vehicles on various road links throughout the road network, and then calculate the implications for overall VMT and VHT levels on a regional basis.

Part 2 – Measures of Congestion Problems and Benefits. The traffic modeling analysis, and its findings of changes in traffic conditions, can be used to develop a number of different measures of congestion growth and the additional cost of congestion for freight and passenger travel. The issue of measuring congestion and its costs is addressed in NCHRP Study 2-21 (Report 463),^{vi} which examined the economic impacts of road congestion. It notes that “a great deal of attention has been

devoted to the definition and measurement of congestion in existing research, and is reflected in the development of congestion management systems. Indicators of congestion are available for urban areas and are reported in FHWA's Highway Statistics and BTS's National Transportation Statistics."

Exhibit 3-7 lists the seven most common measures of road traffic congestion. The use of each measure and its advantages and disadvantages is then discussed in the text that follows.

EXHIBIT 3-7. Summary of Congestion Measures

1. Average Time Delay
2. Accessibility or Travel Time Contour
3. Percent of Time that Average Speed is Below Threshold Value
4. Volume to Capacity Ratio
5. Congestion Indices
6. Delay Indices

Summary of congestion measures:^{vii}

- Time Delay (aggregate VHT by vehicle type) – Generally, the measure of travel time delay is most appropriate for this study. This is the most widely used measure of congestion delay. Road network models can be used to forecast differences in total aggregate travel time delay associated with allowing congestion to worsen, compared to taking actions to reduce vehicles on the road (as could occur if rail freight growth replaced some of the future truck volume growth). The values of total delay (increase in VHT) can be used along with business "value of time" factors to calculate the total cost of freight congestion.
- Accessibility or Travel Time Contours – The travel time contours from a single point to/from multiple destinations/origins can be plotted on a map showing times in discrete intervals (e.g., five or ten minutes at a time). These are most useful for studying travel to a major employment center such as the port, airport, border, rail intermodal facilities, Central Business District or industrial zone of a city.
- Percentage of Time Average Speed is Below Threshold Value – This spot-speed measure utilizes information collected from automated speed monitoring equipment. The measure uses data that can be collected in a completely automated fashion, with an increase in the value of this measure corresponding unambiguously to an increase in the degree of congestion. This measure would appear to be practical as long as the threshold speed is set at 20 or 25 mph or higher due to potential equipment inaccuracies at lower speeds.

- Volume-to-Capacity Ratio – The FHWA’s HPMS (Highway Performance Monitoring System) dataset includes peak-period volume-to-capacity ratio (V/C) as a data item. Also, the distribution of total traffic by V/C can be estimated using the HPMS data items, annual average daily traffic volume (AADT) and capacity, together with tables showing the distribution of traffic by V/C for different values of AADT/C. Volume to capacity ratios are used as the basis for estimating network link speeds in traffic assignment models, in a function known as the BPR (Bureau of Public Roads) curve.
- Congestion Indices – Much of the past research on congestion indices has facilitated comparisons of relative levels of congestion among U.S. cities. These are valuable tools for estimating overall levels of congestion but might not be applicable at the regional level and across multiple modes of travel. To expand upon the work done in the past, the Texas Transportation Institute (TTI) developed an index that takes all modes of transport into account and is based on a measure called Volume/Acceptable Flow Rate. The flow rate deemed acceptable by local officials is calculated based on various local roadway classification characteristics.
- Delay Measures – Delays of any type increase travel time and reduce travel speeds. As such, measures of delay are closely tied to time-related measures. By focusing on delay as a performance measure, specific problem locations can be identified. A number of recent studies, focused on non-recurring congestion, have demonstrated the importance of incident-related delays and the benefits that can be derived from their reduction. *Minute Miles of Delay* is the product of the length of a roadway segment and the difference between an acceptable travel rate and the actual travel ratio (where the actual travel ratio is equivalent to 60 minutes divided by the speed on the segment). This measure combines the effects of lower speeds on congested highways and the distance that must be traveled on congested highways. *Level-of-Service (LOS)* classifications are derived from other performance measures and merely represent a qualitative measure describing operational conditions within a traffic stream, and their perception by motorists and/or passengers (TRB, 1985).

Any of these measures can be used to characterize the severity of congestion and qualitatively assess the extent to which it presents a problem for various types of goods movement. For purposes of benefit-cost analysis, the *travel time delay* measures offer the simplest means for quantifying the total business costs of future congestion. This can be done by multiplying total delay hours times various values of time for specific types of vehicles, trips and commodities. Value of time factors are discussed later in this guide.

Other measures can also be useful for evaluating the impact of congestion on goods movement. For instance, the measurement of congestion impacts on *travel time contours* can be particularly important if congestion disproportionately affects throughput and accessibility to ports, borders or particular industrial areas. The

volume/capacity and related *congestion index* can be used to identify conditions in which there will be a disproportionately higher rate of traffic incidents and hence reduction in reliability of travel time. That consideration can be especially important if just-in-time production and logistics scheduling are a major factor for area businesses. For that reason, it can also be important to distinguish “recurring delays” (due to speed slowdown) from “non-recurring delays” (due to traffic incidents). The latter can be particularly significant because traffic incident delays can cause businesses to incur high costs as they pad their schedules (in effect, anticipating incidents) in order to avoid being unduly hurt by them.

Note on Handling of Induced Demand. Often, projects that add to the effective capacity of roads lead to less-than-expected congestion reduction benefits on those routes due to shifts in regional traffic patterns. Some of the changes, such as a tendency for traffic to shift from other congested parallel routes to the now less-congested route, can still lead to overall system-wide savings in both VMT and VHT. However, sometimes the net reduction in congestion and area-wide time savings is less than expected because longer and/or more frequent trips occur when travel times shorten. For instance, delivery services may respond to a reduction in congestion by expanding the frequency of deliveries or the distance of their delivery areas. Individuals may make shopping or recreation trips to more distant destinations. The net result is more vehicle-miles of travel and less vehicle-hours of time savings than would otherwise be expected from the new capacity. This effect is referred to as “induced demand growth.” It may reduce or offset the congestion reduction that would otherwise occur from rail or roadway improvements.

The more sophisticated traffic studies for congested urban areas and highway corridors are now accounting for induced demand in their forecasts of long-term impacts. From the viewpoint of traffic engineering, this consideration is an important step in making more realistic traffic forecasts. However, from the viewpoint of benefit-cost analysis, care must be taken in the treatment of induced demand. After all, no traveler or shipper would change the frequency or length of trips unless there was some benefit in doing so. So it would be wrong to merely assume that the induced demand is a reduction in the economic benefit of congestion reduction.

• **Step 3. Characterizing Freight Patterns**

Having assessed the magnitude of congestion problems in Step 2, the third step is to identify what is being delayed – i.e., the extent of delay for goods movement and the characteristics of the freight flows that are affected—and what might be diverted. This step involves four parts:

- (1) Develop a *representation of local freight shipping patterns* in terms of flow volumes, their spatial patterns and commodity mix;

- (2) Conduct a *macro analysis* of the extent to which truck trips contribute to current and expected future congestion conditions;
- (3) If part 2 establishes that truck trips are a major contributor to congestion, then conduct a *micro analysis* which examines the types of goods being shipped, the potential for truck-to-rail diversion, and the types of investments required to support such diversion; and
- (4) If part 3 determines that some commodities could be shifted to rail freight, then conduct a *geographic analysis* which examines the origins and destinations of truck freight flows in the study area.

The involvement of private sector players during this step of analysis is initially useful and ultimately essential. The following chapter on "Public-Private Dialogue" begins with the importance and methods of engaging them. For the process of preliminary screening, they can assist with data and expert information, provide practical guidance, and offer realistic assessments of whether and why a project aimed at traffic diversion should or should not succeed in the market.

Part 1 – Representation of Local Freight Shipping Patterns. It is necessary to develop a profile of the pattern of freight flows by truck and by rail currently flowing through the region or corridor, in order to identify their spatial pattern and the composition of goods movement. This will allow the analyst to begin to assess the potential for freight diversion from truck to rail. Exhibit 3-8 lists the relevant characteristics of freight flows that should be assessed.

EXHIBIT 3-8. Freight Flow Characteristics to be Measured

1. *Volume of freight* – To what extent is truck freight contributing to local congestion?
2. *Direction of affected freight flows* – What are the specific corridors affected by congestion? Where are the markets currently served by truck freight?
3. *Commodities affected* – Which commodities are currently shipped by truck? For which of these is rail a technically feasible option?
4. *Location of trip ends* – How much of the freight traffic can be characterized as internal trips (within the region), external trips (passing through the region) and internal-external trips (with one trip end at a business within the region and the other trip end outside the region)?

Information on *volume of truck freight* is important for determining whether freight truck traffic is a significant contributor to congestion in the study area. Freight flow *directions* and *commodity information* are important because they directly affect the viability of rail freight as an alternative to trucking: some commodities moving by truck could potentially be shipped by rail, while rail might be impractical for commodities that are more fragile or time sensitive. The internal/external split of *trip end locations* is important as it is an indicator of the contribution of local freight

movements to congestion, and also as it reflects trip length which influences potential demand for local intermodal loading facilities. Information on time of day or day of week, if available, could also be useful in determining the extent to which the truck freight flows affect peak period congestion.

This information on characteristics of freight movements will be needed in Step 4 to assess the potential for freight diversion to rail; and in Step 6 to assess particular types of rail investments that could relieve congestion. In addition, it is important to keep in mind that the economic costs of congestion vary by type of business, so knowing the types of commodities is also important for that reason. These business costs of delay can be substantially greater than the cost of driver time and vehicle operating time alone. For some businesses, there can also be implications for revenues and costs related to the size of the business market and/or service areas; to business inventory and logistics costs; to just-in-time production costs; and to workforce attraction.

Part 2 - Macro Analysis. A macro analysis of shipping patterns answers two general questions, as shown in Exhibit 3-9.

EXHIBIT 3-9. Macro Analysis Issues

1. *Role of Local Origin Traffic* - How much of current congestion is related to (freight) truck trips originating in the study area?
2. *Role of Truck Traffic* - Given existing trends in freight movements, how much congestion will be created in the future by (freight) truck trips originating in the area?

The *first question* is important because it addresses the question of whether rail investments are a feasible way to reduce local congestion. There are three types of truck freight movements: those that begin in the study area (“origin”); those that end in the study area (“destination”); and those that pass through the local area (“overhead traffic”). The greatest potential for diversion to rail within local control are trips with a local origin or destination, because shippers and receivers decide on mode choice options and make the mode choice decisions, so they are strongly influenced by cost and quality of rail service and congestion costs in the areas served. In addition, because the customers are located in and around the study area, it is possible to involve them in planning and public meetings regarding rail investments. Diversions to rail of “destination” movements are likely to be strongly influenced by changes in cost and service in the locations in which the trip originates, although destination conditions certainly affect them, especially if the receiving business has control of the carrier selection (as will happen with auto plants and large retailers, among others). “Overhead” trips are less directly influenced by rail cost or service in the study area, unless the region acts as an interchange point or hub.

The *second question* is substantively the same as the first but is concerned with future levels of truck freight trips. In cases where truck traffic is not currently a major source of congestion, but could be one in the future, or where already heavy traffic promises to become very much heavier, this question is especially pertinent for purposes of long-term infrastructure planning. To assess the proportion of current congestion related to freight truck trips originating in the study area, it is necessary to examine the composition of current traffic. Unfortunately, there is no one public source that decomposes freight traffic by origin, destination, and overhead, and most sources are several years old. However, as noted in Step 2, most metropolitan areas have highway models, which can be used to estimate the contribution of trucks to overall congestion levels. State DOTs will often collect information on the volume of truck traffic in a state or locale; federal sources, including US Bureau of Census's Commodity Freight Survey (CFS) and the Federal Highway Administration's Freight Analysis Framework (FAF), collect information on freight movements by origin and/or destination; and commercial sources offer relevant information for sale. In addition, material from partners and stakeholders is a common and often highly pertinent of traffic information in projects. (Data sources are discussed in more detail in the next section.) Using these data, an analyst can estimate the total portion of truck traffic with an origin and/or destination within the study area.

If the macro analysis reveals that truck freight traffic is composed largely of "overhead" freight movements, it is unlikely that local rail investments by themselves can divert freight traffic. In these cases, a multi-jurisdictional approach with coordinated investment is required, pursued by the public agency either on a regional or corridor basis. Barring that, other solutions to congestion problems should be pursued. Multi-jurisdictional groups, and areas with freight truck traffic that that can be traced to trips with origins or destinations within the study zone, should proceed with micro analysis.

Data for Macro Analysis: CFS data are available on the national, state, and sub-state levels. (Sub-state data include information on each large metropolitan area in a state, as well as the "remainder of state," i.e., non-metropolitan area totals.) Aggregate data include the shipments by mode (expressed in tons, values, or ton-miles) and the percentage of shipments (expressed tons, values, or ton-miles) carried by each mode for each survey year, which include 1997 and 2002. CFS reports also include comparisons of modal breakdown for 1997 and 2002. The availability of 1997 and 2002 data allows for estimation of recent growth in freight shipments by mode, trends that could be extrapolated to determine the extent to which truck freight shipments are likely to be a source of congestion in the future. Many of the data from the 2002 CFS are available on-line in ASCII and spreadsheet formats.^{viii} FAF data can also be used to determine the contribution of current and future role of freight shipments to congestion levels. FAF1 data include state profiles, which include tons and value of originating and terminating shipments by mode for each state for 1998 with projections for 2010 and 2020.^{ix} These profiles can be used to assess whether freight

shipments currently contribute to congestion problems in the study area or will in the future. FAF2 data are expected to offer comparable information for more current time frames. In addition, detailed maps (but not data) of truck freight flows are available from FAF; specific data on truck freight flows can be purchased from private sources, such as Global Insight's former Reebie group. Other tools for more detailed analysis include FHWA's Geofreight^x tool, which can analyze freight flows on particular highway segments, including estimates of origin, destination, and overhead traffic.

Part 3 - Micro Analysis. If part 2 analysis indicates that truck freight movements are currently a major cause of congestion or are likely to be one in the future, then a "micro analysis" is warranted to profile the types of goods and likely trends in the characteristics of goods that are moved within the study area. Micro analysis is important because technical feasibility and cost of diversion from truck to rail will be strongly influenced by characteristics of the goods being shipped. Thus, micro analysis contributes to three analytic needs: 1) estimation of the potential size of truck-rail freight diversions (used in Step 5); 2) assessment of the feasibility of current rail resources to absorb a portion of current or future freight shipping needs (used in Step 4); and 3) determination of the types of rail investments and service offerings that would be required to divert current or anticipated freight from rail to truck given current rail resources.

To get a first-order estimate of the potential for truck-to-rail diversions, it is necessary to assess the composition of commodities that are currently moved by truck or will be in the future. The types of information required for micro analysis can be gathered from metropolitan planning agencies, state DOTs, the CFS and private sources, and by gathering information from surveys or interviews aimed at understanding current and likely future shipping needs. For metropolitan areas, CFS data include information on ton, value, and ton-mile shipments by mode for 10 general commodity classes. Unfortunately, these data are available only for the 50 largest metropolitan areas in the United States and thus, do not provide broad geographic coverage. For states, CFS provides detailed data on shipments by mode for 43 commodity classes.

Both metropolitan and state data are available for 1997 and 2002, as well as for select earlier years, and include information on origin and destination of shipments. With these data, analysts can characterize freight shipments in an area by origin and destination by commodity. These data can also be used to project future shipping needs, either by extrapolating from 1997-2002 CFS trends or by using forecasts of economic activity by industry to estimate future commodity shipments by mode in large metropolitan areas and states. Such calculations would provide a rough estimate of likely future commodity freight demand by type of carriage and can be calculated for any future year, though they are likely to be less accurate in later years. (Basing forecasts on extrapolation of current trends assumes that commodity and modal freight patterns will continue to develop in the future as they have in the recent past. This assumption, of course, will not hold if there are significant changes underway in transportation systems or in local industrial structures.) Analysts also have the option

of using forecasts of freight movements by mode from FHWA. As of this writing, these forecasts are available for all states for the years 2010 and 2020 and can be used as an estimate of future modal demand or as a check against forecasts developed by extrapolating from CFS data.^{xi} However, based on 1998 data and a pre-9/11 outlook, the projections are less useful than previously; updated forecasts will become available from FHWA or can be procured from private sources.

After compiling information on the commodity composition of freight moved by trucks, an estimate of the potential diversion must be made. There are two ways to calculate a first-order estimate of potential diversion of each commodity. The first is to use a “rule-of-thumb” regarding the proportion of freight shipments that is “modally competitive”, i.e., “fall(s) within normal distance and service characteristics of both truck and rail.”^{xii} Forkenbrock (2001) suggests that approximately 40% of long-haul truck freight shipments could potentially be moved by rail. A second method involves examining the types of commodities being shipped locally and inferring potential diversion from commodity composition. This approach requires examining current modal patterns, particularly the proportions of each commodity moved by truck and rail and inferring potential diversion for each commodity based on these proportions.

To illustrate the second method, we can begin by making the following assumptions:

- For commodities for which no freight is currently moved by rail, such as live fish and animals, it is assumed that there is no potential diversion.
- For commodities for which only a very small proportion of freight (less than 5%) is moved by either truck or rail, or the amount moved by truck dwarfs the amount moved by rail, it is assumed that potential diversion is small.
- For commodities for which the proportion freight of moved by rail and by truck is at least 5%, but the proportion moved by rail is still smaller than the proportion moved by truck, it is assumed that potential diversion is significant but not large.
- For commodities for which the proportions moved by rail and truck are large and relatively equal, it can be assumed that potential diversion is large.

Using these assumptions and 2002 CFS data for the US, classifications of potential diversion for each of the 40 commodity classes were developed for this study. These are shown in Exhibit 3-10.

EXHIBIT 3-10. Example of Truck to Rail Diversion Potential by Commodity

SCTG Code	Product	% Rail	% Truck	Potential Diversion
1	Live animals and live fish	--	93%	ZERO
2	Cereal grains	54%	9%	SIGNIFICANT
3	Other agricultural products	23%	43%	LARGE
4	Animal feed and products of animal origin, n.e.c	30%	52%	LARGE
5	Meat, fish, seafood, and their preparations	2%	96%	SMALL
6	Milled grain products and preparations, bakery products	25%	67%	SIGNIFICANT
7	Other prepared foodstuffs and fats and oils	25%	68%	SIGNIFICANT
8	Alcoholic beverages	25%	67%	SIGNIFICANT
9	Tobacco products	--	67%	ZERO
10	Monumental or building stone	--	92%	ZERO
11	Natural sands	23%	70%	SIGNIFICANT
12	Gravel and crushed stone	27%	48%	LARGE
13	Nonmetallic minerals, n.e.c	48%	46%	LARGE
14	Metallic ores and concentrates	21%	5%	SMALL
15	Coal	86%	2%	SMALL
17	Gasoline and aviation turbine fuel	3%	31%	SMALL
18	Fuel oils	6%	35%	SIGNIFICANT
19	Coal and petroleum products, n.e.c	39%	23%	LARGE
20	Basic chemicals	49%	27%	LARGE
21	Pharmaceutical products	--	61%	ZERO
22	Fertilizers	40%	50%	LARGE
23	Chemical products and preparations, n.e.c	13%	80%	SMALL
24	Plastics and rubber	30%	65%	SIGNIFICANT
25	Logs and other wood in the rough	11%	80%	SMALL
26	Wood products	42%	53%	LARGE
27	Pulp, newsprint, paper, and paperboard	40%	56%	LARGE
28	Paper or paperboard articles	4%	88%	SMALL
29	Printed products	--	76%	ZERO
30	Textiles, leather, and articles of textiles or leather	1%	75%	SMALL
31	Nonmetallic mineral products	19%	75%	SMALL
32	Base metal in primary or semifinished forms & in finished	25%	61%	SIGNIFICANT
33	Articles of base metal	13%	79%	SMALL
34	Machinery	5%	83%	SMALL
35	Electronic & other electrical equipment, components, etc.	2%	79%	SMALL
36	Motorized and other vehicles (including parts)	21%	67%	SIGNIFICANT
37	Transportation equipment, n.e.c	--	45%	ZERO
38	Precision instruments and apparatus	--	76%	ZERO
39	Furniture, mattresses and mattress supports, lamps, etc.	1%	93%	SMALL
40	Miscellaneous manufactured products	2%	81%	SMALL
41	Waste and scrap	33%	36%	LARGE
43	Mixed freight	3%	89%	SMALL

These classifications were then translated into estimates of the percentage of freight that can be diverted. Values used in this illustrative analysis are: 0% for “zero or negligible”, 20% for “small”, 40% for “significant”, and 80% for “large”. However, actual values used should be tailored to each analysis based on knowledge of local conditions: actual diversion potential will be strongly influenced by a number of local factors, including local infrastructure and average trip length. In all cases, local knowledge about these factors should be used in lieu of the default classifications and values presented here. After potential diversion values have been finalized, the values can then be multiplied by the current amount of each commodity shipped by truck to

estimate total potential diversion for all commodities. A sample calculation of 2002 CFS data is presented in Exhibit 3-11. Using the default values discussed above, it shows that a large majority of the truck freight (61%) is not divertible, but that also mean that up 39% could potentially be diverted to rail.

EXHIBIT 3-11. Sample Calculation of Potential Freight Diversion by Commodity

SCTG Code	Diversion Classification	Diversion Value	CURRENT		POTENTIALLY DIVERTED	
			Rail Freight ('000 tons)	Rail Freight (M ton-miles)	Rail Freight ('000 tons)	Rail Freight (M ton-miles)
1	ZERO	0%	94.13	25.32	-	-
2	SIGNIFICANT	40%	89.44	23.14	35.78	9.26
3	LARGE	80%	63.27	10.13	50.62	8.11
4	LARGE	80%	29.51	7.74	23.61	6.19
5	SMALL	20%	33.48	2.35	6.70	0.47
6	SIGNIFICANT	40%	15.12	10.18	6.05	4.07
7	SIGNIFICANT	40%	5.50	2.28	2.20	0.91
8	SIGNIFICANT	40%	3.70	1.71	1.48	0.68
9	ZERO	0%	0.31	0.11	-	-
10	ZERO	0%	1.49	0.46	-	-
11	SIGNIFICANT	40%	0.03	0.05	0.01	0.02
12	LARGE	80%	5.53	2.42	4.42	1.94
13	LARGE	80%	1.75	1.82	1.40	1.46
14	SMALL	20%	0.21	0.15	0.04	0.03
15	SMALL	20%	0.35	0.37	0.07	0.07
17	SMALL	20%	0.19	0.26	0.04	0.05
18	SIGNIFICANT	40%	0.85	0.93	0.34	0.37
19	LARGE	80%	0.16	0.11	0.13	0.09
20	LARGE	80%	2.94	0.36	2.35	0.29
21	ZERO	0%	0.05	0.01	-	-
22	LARGE	80%	0.05	0.01	0.04	0.01
23	SMALL	20%	0.05	0.01	0.01	0.00
24	SIGNIFICANT	40%	0.02	0.01	0.01	0.00
25	SMALL	20%	0.03	0.01	0.01	0.00
26	LARGE	80%	4.53	2.13	3.62	1.71
27	LARGE	80%	4.34	2.01	3.47	1.61
28	SMALL	20%	1.69	0.18	0.34	0.04
29	ZERO	0%	1.12	0.14	-	-
30	SMALL	20%	0.57	0.04	0.11	0.01
31	SMALL	20%	1.39	1.14	0.28	0.23
32	SIGNIFICANT	40%	1.26	0.68	0.50	0.27
33	SMALL	20%	0.65	0.66	0.13	0.13
34	SMALL	20%	0.69	0.57	0.14	0.11
35	SMALL	20%	0.59	0.02	0.12	0.00
36	SIGNIFICANT	40%	0.98	0.09	0.39	0.04
37	ZERO	0%	0.02	0.01	-	-
38	ZERO	0%	0.02	0.01	-	-
39	SMALL	20%	0.02	0.01	0.00	0.00
40	SMALL	20%	0.04	0.02	0.01	0.00
41	LARGE	80%	0.03	0.02	0.03	0.02
43	SMALL	20%	1.51	1.07	0.30	0.21
TOTALS			367.6	98.7	144.7	38.4

Part 4 - Geographic Analysis. A geographic analysis can be used to examine the geographic patterns of truck freight flows. This information can be used to estimate amount and direction of truck freight originating in a study area; amount and direction of truck freight destined for a study area; and in some cases, estimation of overhead traffic. At the most general level, analysis will focus on the amount and direction of truck freight originating in or destined for the study area. These data will provide a snapshot of the direction of truck freight flows to and from the study area and will be used in Step 4 to determine whether the broad characteristics of truck freight flows make it possible for large-scale diversion to rail. The geographic analysis might indicate, for example, that truck freight flows are generally north-south while rail infrastructure goes east-west, in which case diversion to rail would be difficult; or that truck freight flows are concentrated in two or three states currently connected to the study area by rail, in which case diversion to rail is technically feasible. An example of analysis using 2002 CFS data for Illinois and Montana is presented in Exhibit 3-12.

EXHIBIT 3-12 Truck Freight Flows by State of Origin

TRUCK FREIGHT BY STATE OF ORIGIN					
	<u>% of All Out-going Truck Freight Tons</u>	<u>% of Non-MT Out-going Truck Freight Tons</u>		<u>% of All Out-going Truck Freight Tons</u>	<u>% of Non-IL Out-going Truck Freight Tons</u>
<u>Montana</u>			<u>Illinois</u>		
Montana	77%	--	Illinois	75%	--
Wyoming	4%	17%	Indiana	5%	18%
Idaho	4%	16%	Wisconsin	4%	16%
Utah	2%	10%	Missouri	2%	8%
California	2%	9%	Ohio	2%	7%
Washington	2%	7%	Michigan	2%	7%
North Dakota	1%	6%	Iowa	2%	6%
South Dakota	1%	5%	Pennsylvania	1%	4%
Colorado	1%	3%	Kentucky	1%	4%
Minnesota	1%	3%	Texas	1%	3%
Illinois	0%	2%	Minnesota	1%	3%
TOP 5	89%	59%	TOP 5	87%	55%
TOP 10 + MT	95%	78%	TOP 10 + IL	94%	76%
TRUCK FREIGHT BY STATE OF DESTINATION					
	<u>% of All Out-going Truck Freight Tons</u>	<u>% of Non-MT Out-going Truck Freight Tons</u>		<u>% of All Out-going Truck Freight Tons</u>	<u>% of Non-IL Out-going Truck Freight Tons</u>
<u>Montana</u>			<u>Illinois</u>		
Montana	73%	--	Illinois	77%	--
Washington	4%	13%	Indiana	4%	17%
Idaho	3%	10%	Wisconsin	3%	14%
Utah	3%	10%	Missouri	3%	12%
Wyoming	2%	8%	Iowa	2%	10%
Texas	2%	6%	Ohio	1%	6%
Oregon	1%	4%	Michigan	1%	5%
North Dakota	1%	3%	Kentucky	1%	4%
Iowa	1%	2%	Pennsylvania	1%	3%
Illinois	0%	2%	Minnesota	1%	3%
Nevada	0%	1%	Texas	0%	2%
TOP 5	84%	47%	TOP 5	89%	59%
TOP 10 + MT	89%	60%	TOP 10 + IL	95%	76%

These data show that about three-quarters of all truck freight flows (origin and destination) stay within each state. For truck freight that leaves Montana, almost 60% goes to one of five states (Wyoming, Idaho, Utah, California, and Washington), a pattern similar to Illinois'. This concentration suggests that in both states, better or cheaper rail service to a handful of states could potentially result in large diversions of truck freight. Truck freight coming into Montana, however, tends to be more dispersed, with the five largest (origin) states accounting for less than half of all truck freight coming into Montana. For Illinois, on the other hand, almost 60% of all incoming truck freight originates in one of five states. It is possible as well to perform state-to-state freight flow analyses by 2-digit commodity, allowing analysts to combine the findings of the micro analysis with a geographic analysis. This would be particularly useful in cases where a small number of commodities account for a large portion of truck freight. This could also be useful for interstate highway corridor projects, where it is important to determine the benefit to participant and non-participant states from infrastructure investment in each of the participant states in order to allocate costs appropriately.

Alternate Method for Intermodal Analysis. For intermodal services, a conventional commodity-based approach to preliminary diversion assessment is limited by the source data. The Commodity Flow Survey does not sample import shipments, which account for about half of the intermodal business, and this depresses the apparent participation of rail in commodity carriage. There also are questions as to the completeness with which the Survey can recognize intermodal activity, since respondents see their pickups made by truck and are not always aware of the line haul mode. The Carload Waybill Sample offers a more inclusive picture on both accounts, but most of its commodity identification for intermodal shipments is with the catch-all category FAK, for "freight all kinds", and specific detail is not available.

An alternate approach begins with the consideration that the great majority of rail intermodal transportation involves "containerizable" goods of the sort hauled in dry van trailers on the road. A commodity list can be screened for containerizable goods; the classification of many (e.g., paper products) will be straight-forward, yet some (e.g., various forms of chemicals) will be divided between dry vans and other equipment types, and an allowance has to be made for the mixture. More readily, the fact that the preponderance of truck traffic moves in dry vans can be employed in a simple estimation. Dry vans account for approximately 66% of the truck traffic over 200 miles and 70% of the traffic at or under 200 miles. Applying these percentages to truck flow data produces a first approximation of the traffic volume compatible with intermodal transport.

An intermodal capture rate can be estimated means of a market share matrix, as shown in Exhibit 3-13. The matrix displays the average penetration rate for rail intermodal service within the market for dry van carriage. It is organized by the distance and density of traffic lanes, based on flows between metropolitan markets. It can be used

in conjunction with traffic flow data from a source such as the CFS, to benchmark intermodal participation and potential diversion. Several points affect the analysis:

EXHIBIT 3-13. Example of an Intermodal Matrix

MODAL MARKET SHARE BY LANE DENSITY & DISTANCE								
RAIL INTERMODAL (IMX) Vs OVER-THE-ROAD (OTR) DRY VAN TRUCK								
Source: TRANSEARCH 2000								
HIGHWAY MILES	LANE DENSITY (Annual Tons [000] by IMX+OTR)							
	< 100		100 - 400		> 400		Total	
	IMX	OTR	IMX	OTR	IMX	OTR	IMX	OTR
1-100	0.1%	99.9%	0.1%	99.9%	0.4%	99.6%	0.4%	99.6%
100 - 299	0.3%	99.7%	1.1%	98.9%	1.4%	98.6%	1.3%	98.7%
300 - 499	0.8%	99.2%	2.3%	97.7%	3.6%	96.4%	3.0%	97.0%
500 - 699	1.3%	98.7%	5.8%	94.2%	11.1%	88.9%	6.6%	93.4%
700 - 999	1.3%	98.7%	8.3%	91.7%	27.2%	72.8%	12.6%	87.4%
1000 - 1499	2.6%	97.4%	8.7%	91.3%	28.1%	71.9%	11.4%	88.6%
>1500	7.3%	92.7%	24.8%	75.2%	62.0%	38.0%	37.1%	62.9%
Total	2.4%	97.6%	6.6%	93.4%	8.2%	91.8%	7.0%	93.0%
Total > 500	3.0%	97.0%	10.8%	89.2%	33.8%	66.2%	16.8%	83.2%
Total < 500	0.6%	99.4%	1.5%	98.5%	1.5%	98.5%	1.4%	98.6%

MARKET SHARE KEY:

OTR TRUCK ≥ 80% BOTH < 80% IMX RAIL ≥ 80%

- If data are no finer than state-to-state lanes, they will be too broad to establish lane density but can offer a general picture of distance. The length of haul totals to the right of the matrix would then be used, although further interpretation could be gleaned from density figures for state lanes with obviously huge or small volumes.
- If traffic is denominated in numbers of trucks, it can be converted to tonnage for correspondence to the matrix by multiplying the number of trucks by 15 tons per load, which is a rule of thumb used by rail and motor carriers for a typical dry van payload on the road. Some commodity groups will have significantly higher or lower tons per load figure, so the actual tons per load by STCC code may be needed if traffic is concentrated in a few commodity groups. Ton-miles can be calculated from tons by factoring in an average lane distance.
- Benchmarking against modal share should take into account the existing intermodal penetration. This can be derived by joining truck data to intermodal information from the Carload Waybill Sample - which is a source all states may tap, and to which MPOs may request access through their state DOT.

- Intermodal traffic gains assume access to rail transfer terminals and the provision of lane service and pricing competitive with over-the-road trucks. These need to be in place or in prospect for any preview of possible diversion to be valid.

Beyond these points, application of the matrix is a clear-cut exercise of multiplying rail percentages against total traffic, with the difference between current and benchmark penetration indicating the diversion potential. For well-developed intermodal lanes, or where new rail services are expected to be especially competitive, the matrix values from adjacent cells can be used to suggest upside traffic gains. The whole procedure produces a preliminary evaluation of possible traffic capture, helpful at a sketch planning level but requiring more rigorous analysis for project assessment, as will be described in later steps.

• **Step 4. Characterize Available Rail Resources**

Having assessed the pattern of truck and rail freight flows in Step 3, the fourth step is to identify the nature of rail lines and supporting facilities available to serve freight movements. The determination of these rail resources will make it possible get a first-order estimate of the portion of current truck flows for which rail freight can potentially be a viable option. In other words, just by screening the direction of railroad lines, location of intermodal facilities and type of services offered, it will be possible to identify the portion of truck freight movements that involve commodities, origins and destinations that can be serviced by existing rail services. This step involves three parts:

- (1) Determination of the *geographic areas and markets served by the existing rail configuration*;
- (2) Assessment of the current *availability of various classes of rail service*; and
- (3) the match of *rail services to types of transport services needed* for diversion of truck freight to rail.

Part 1 – Geographic Areas and Markets Served by Rail. The best source of information on the current rail services offered is the local railroads, who will have the best understanding of: (a) current operational capacity; (b) operational constraints; and (c) the types of demand (i.e., geographic and commodity characteristics) they can readily absorb; as well as (d) any issues related to terminal or service availability. However, it must be noted that issues related to railroad capacity are complex and can involve proprietary data, so obtaining such information would require close contact with carriers.

Material gathered from the railroads can then be compared to information previously collected on the geographic pattern of existing truck freight flows, as assembled for Step 3, part 3 (and also illustrated previously in Exhibit 3-12). This comparison

provides a basis to determine whether existing patterns of demand for freight movements could be filled using existing rail resources.

Part 2 – Availability of Various Classes of Rail Service. The second part of the characterization of rail resources focuses on availability of rail operations by three classes: (a) unit train, (b) carload, and (c) intermodal services. Like any set of generalizations, this typology of rail service into three classes will be objectionable to some observers; it is intended, however, as an overview of the major railroad business groups, and it is functional as such. Key aspects of the economic and market issues that distinguish these three classes are shown in Exhibit 3-14. The most useful aspect of this typology is the linking of commodities with class or type of service. These are as follows:

- The *Unit Train* business handles high volume bulks like coal and grain in trainload quantities. Dedicated operations make time performance fairly good, and the emphasis of service principally is the turnaround time of equipment to keep shippers resupplied. Dense, non-stop, door-to-door transportation in imbalanced lanes conforms to railroad strengths, and this is the traditional baseload of the industry.
- The *Carload group* carries industrial goods, chiefly for further processing, in mixed train consists that require intermediate switches (which is essentially a kind of hubbing). Multi-car shipments are an important component of this category. Shippers who can use carload or multi-carload service typically are focused on equipment supply and low cost transportation for higher lading weights, because performance can be slow and irregular. The time and cost challenges of handling carload traffic cars has caused this historical traffic of the railroads to contract steadily relative to unit trains and intermodal. Another factor contributing to the relative decline in carload traffic is that heavy manufacturing – typically involving major carload customers - has diminished in the American economy and in some cases relocated along interstate highway corridors, with no rail sidings. On the other hand, carload service is much cheaper than truck service, and there is a potential for replacing three to five trucks with a single carload movement. Rail carload service can also involve a service to a transload facility, where the freight is transloaded to trailers or containers for delivery to the customer.
- The *Intermodal business* moves consumer goods and general merchandise, half of it imports and exports, primarily in solid trains with some intermediate hubbing. Service is among the railroad's best, and although it is mostly slower than highway, on premium trains or in well-developed lanes like Los Angeles – Chicago, it is fully the equivalent of over-the-road. Intermodal trains run in a smaller, more concentrated network than carload traffic, but in these markets they are at the front of modal competition between highway and rail. The Intermodal business became the top source of Class I revenue in 2003, surpassing coal and in some ways rendering itself the new baseload of the industry. *Because it is the*

class of service most similar to standard truck service, intermodal is the type most likely to divert highway traffic on a large scale.

Data on class of service offered by railroads can be assembled from sources like the Carload Waybill Sample, public information like the federal Commodity Flow Survey, commercial databases, traffic surveys, or directly from the railroads themselves. Linking class of service and demand by commodity supplies a basis for understanding potential diversion based on existing railroad resources, as well as the types and significance of barriers to diversion, and opportunities to reduce them.

EXHIBIT 3-14. Rail Freight Typology

RAIL FREIGHT TYPOLOGY				
DIMENSION	ELEMENT	UNIT TRAIN	CARLOAD	INTERMODAL
<i>Markets</i>	Commodities	Coal, grain, minerals	Chemicals, forest, bulk food, metals, waste, auto parts	Merchandise, automobiles
	Competitive dynamic	Rail dominion	Eroded dominion Network, access issue	Competitive, divertable
	Intermodality	Water, truck gathering	Truck (bulk transfer, breakbulk)	Marine & truck
	Service requirement Captivity	Equipment turnaround Some	Equipment supply Some	Speed & reliability Little or none
	ASPECT	UNIT TRAIN	CARLOAD	INTERMODAL
<i>Economics</i>	High empty return	<input type="checkbox"/>	<input type="checkbox"/>	No (but imbalance affects)
	Private/sequestered equipment	<input checked="" type="checkbox"/> (not grain)	<input type="checkbox"/>	Box, not car
	Heavy, periodic eqpt. demand	<input type="checkbox"/>	No	International marine
	Long haul	Mixed	Mixed	<input type="checkbox"/>
	High lane density	<input type="checkbox"/>	No	<input type="checkbox"/>
	Heavy axle loads	<input type="checkbox"/>	<input type="checkbox"/>	No
	Serves commodity business	<input type="checkbox"/>	Usually	No (but transport a commodity)
	Operational	Door-to-door Non-stop	Door-to-door Intermediate switch & interchange	Ramp-to-ramp Intermediate mixing & interchange
Capital	Self-funded Traditional Baseload (sine qua non)	Mainly unfunded	Under-funded New Baseoad	
	BENEFIT	UNIT TRAIN	CARLOAD	INTERMODAL
<i>Public Benefits</i>	Bridges & pavements (heavy axle loads)	<input type="checkbox"/>	<input type="checkbox"/>	No
	Congestion & capacity	Avoided traffic	No (but rail is door-to-door)	Avoidable traffic (highway relief)
	Private maintenance & security (pertinent if public investment)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Economic development	Cost of production Viability of plant	Production costs Rural communication	Supply chain efficiency
	Defense	<input type="checkbox"/>	minor	<input type="checkbox"/>
	Emissions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Fuel efficiency (today, a national security benefit)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Safety (truck perception; freight separation)	Avoided trucks	Hazmats: positive record	Avoidable trucks

Part 3 - Match of rail services to demand for transport services. With the information collected in Parts 1 – 2, , the analyst can then develop a spreadsheet to show how the available classes of rail service (collected here) match with the potentials for diversion by commodity class that were previously assembled in Task 3 (and shown in Exhibit 3-11). A sample spreadsheet with hypothetical data is presented in Exhibit 3-15. (For intermodal transportation, the alternative method described in Step 3 can also be used.) This spreadsheet provides an estimate of the demand for (new) freight ton miles for each class of rail service.

EXHIBIT 3-15. Demand for Rail by Class of Service

SCTG Code	Commodity	Potential Diversion (M ton miles)	Class of Service
3	Other agricultural products	8.1	Unit train
2	Cereal grains	9.3	Unit train
4	Animal feed and products of animal origin, n.e.c	6.2	Unit train
6	Milled grain products and preparations, bakery products	4.1	Carload
12	Gravel and crushed stone	1.9	Unit train
5	Meat, fish, seafood, and their preparations	0.5	Intermodal
26	Wood products	1.7	Carload
27	Pulp, newsprint, paper, and paperboard	0.6	Carload
27	Pulp, newsprint, paper, and paperboard	1.0	Intermodal
20	Basic chemicals	0.3	Carload
	TOTAL--UNIT TRAIN	25.5	
	TOTAL--CARLOAD	6.7	
	TOTAL--INTERMODAL	1.5	
	TOTAL--Largest Commodity Classes	33.6	
	Total--Potential Diversion	38.4	
	Largest Commodity Classes as % of Total Potential Diversion	88%	

The results from the above table can then be compared to an estimate of the availability of rail capacity, as illustrated in Exhibit 3-16. This organizes information for determining whether existing rail infrastructure is sufficient to capture freight diverted from truck. It represents a first-order approximation of the amount of potential freight diversion given current demand and supply conditions. If existing rail service is not sufficient for diversion to occur, then this table will provide a starting basis for analysis of the types and level of investments that would have to be made in order to divert rail (used later, in Step 5).

As the Exhibit 3-16 example shows, two pieces of information are needed for this calculation.

- The first is the *current geographic configuration of rail capacity* (from part 1), which is needed to determine the extent of the overlap between the markets served by truck freight and the markets served by the current rail configuration. If, for instance, all of the current or projected future truck freight moves east to west and rail capacity is only available north to south, the potential for diversion would be zero. In general, the exercise is aimed at estimating the portion of truck freight that could be diverted to rail given the geographic characteristics of truck freight movements and the geographic configuration of rail capacity. In the hypothetical example in Exhibit 3-16, this portion is estimated to be 90%.

- The second is the *current availability of various classes of rail services, to which the demand for freight movements can be compared.* For this calculation, it is necessary to obtain indications of available rail capacity. As noted previously, information on terminal and service availability usually must be obtained directly from the railroads, and probably will be expressed in terms of the possible numbers and types of additional trains that might be accommodated. In the example in Exhibit 3-16, it is estimated that 56% of demand can be met with existing rail capacity; and that overall, the current terminal and service availability at the railroads is sufficient to satisfy 50% of potential freight diversion.

**EXHIBIT 3-16.
Hypothetical Example of Potential Freight Diversion Given Rail Capacity**

Factor	% of Potential Diversion	Available Rail Capacity
<i>Demand by State X</i>		
State X	75%	YES
Indiana	5%	YES
Wisconsin	4%	NO
Missouri	2%	YES
Ohio	2%	YES
Michigan	2%	YES
Iowa	2%	YES
Pennsylvania	1%	NO
Kentucky	1%	YES
Texas	1%	YES
Minnesota	1%	NO
% OF STATE DEMAND THAT CAN BE MET (A)	90%	
<i>By Class of Service</i>		
	<i>Demand</i>	<i>Availability</i>
TOTAL--UNIT TRAIN	25.5	13.0
TOTAL--CARLOAD	6.7	4.0
TOTAL--INTERMODAL	1.5	1.8
TOTAL--ALL CLASSES	33.6	18.8
% OF CLASS OF SERVICE DEMAND THAT CAN BE MET (B)	56%	
POTENTIAL FREIGHT DEMAND THAT CAN BE MET (A x B)	50%	
TOTAL POTENTIAL FREIGHT DIVERSION (M ton miles)	38.4	
POTENTIAL FREIGHT DIVERSION (M ton miles) GIVEN RAIL RESOURCES	19.2	

The sample calculation in Exhibit 3-16, of course, greatly simplifies the factors that will shape the capacity of existing rail resources to capture and serve existing freight traffic, so it is imperative to utilize information obtained from the railroads themselves about local conditions in this calculation. For areas in which short rail freight movements are unusual or unlikely, an analyst might assume that available rail resources cannot be used for intra-state movements, in which case assumptions about the percent of state demand that can be met with existing resources would be much lower. If information about local conditions is utilized properly, the general logic in Exhibit 3-15 is sound; the ability of existing supply to meet demand will depend on

the intersection of the characteristics of freight traffic with the characteristics of existing rail resources.

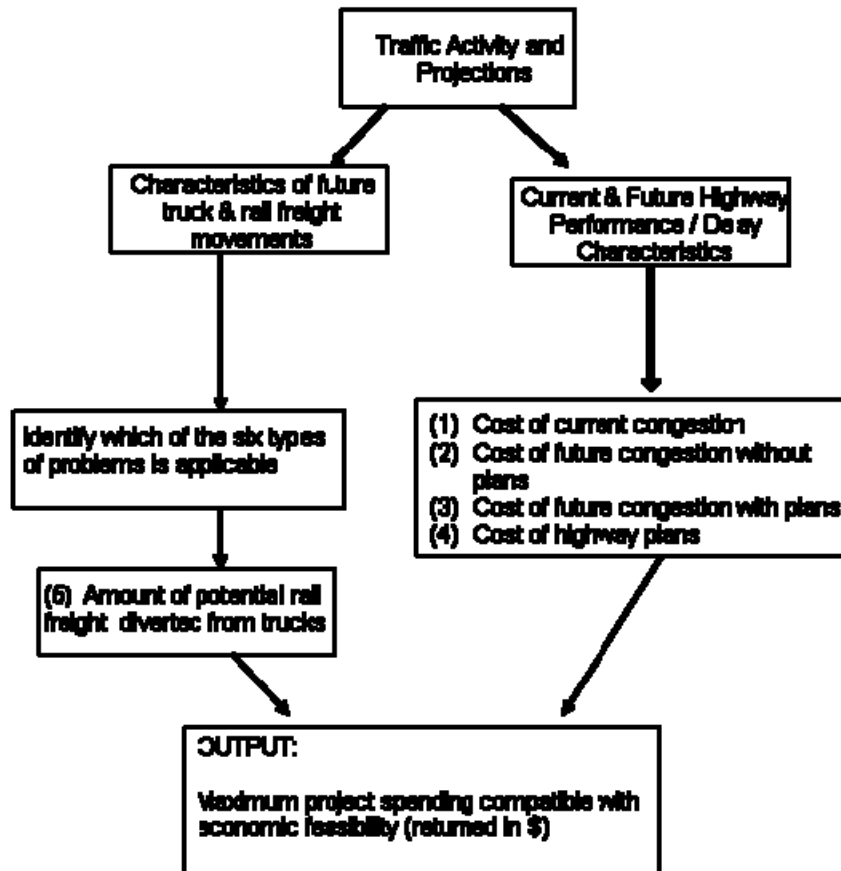
• **Step 5. Initial Assessment of Benefit and Cost**

This step is the culmination of the Preliminary Assessment. It builds on information assembled in Tasks 1-4 to provide an initial assessment of the possible viability of rail freight solutions. This is sometimes referred to as “sketch planning” as it relies on relatively simple models that can be performed to make strategic-level decisions about the value of spending more time and resources on a detailed analysis. Methods for more detailed analysis and application of more sophisticated analysis tools are then described in the final chapter of this guide.

Taken together, prior steps 1-4 provided answers to two questions: (1) How much congestion is related to freight movements by trucks? and (2) How much of the truck freight movements could potentially be diverted to rail? Through use of a spreadsheet model containing rules of thumb for the value of reduced congestion and other factors, Step 5 addresses a third question: (3) What is the maximum investment that could be justified given the external benefits associated with the potential freight diversion?

A sketch planning calculation relies on “rule of thumb” benefit valuations to provide a simple, first-order assessment of the magnitude of the possible benefits from rail diversion. Note that at this juncture, it is not necessary to have specified projects and costs - only the potential magnitude of the congestion problem, possible diversion, and benefits from such diversion are being assessed. However, this preliminary assessment does provide a screening to determine whether or not there is a potential to substantially reduce roadway congestion. Utilizing the first-order estimate of the potential benefits of rail investments, it is straightforward to set a corresponding maximum level of expenditures that could possibly be justified to bring about congestion reduction. The basic logical flow of the sketch planning calculations is shown in the Exhibit 3-17 flowchart.

EXHIBIT 3-17. Sketch Planning Calculation



For instance, Exhibit 3-18a-c show alternative estimates of the marginal external (i.e., non-private) costs associated with reduction of truck usage, and the average private and external costs of truck and rail freight modes. They differ in the following ways:

- Exhibit 3-18a shows the marginal public cost of highway use by trucks in terms of cents per vehicle-mile. A reduction in vehicle-miles of truck travel means a reduction in those public costs;
- Exhibit 3-18b shows the marginal public cost of highway use by trucks in terms of cents per ton-mile. A reduction in ton-miles of trucks similarly translates to a reduction in those public costs;
- Exhibit 3-18c shows the average private and public cost of moving freight (per ton-mile) via trucks and via rail. However, it does not include congestion costs, which account for roughly 30-70% of public costs in urban areas and 10-30% of public costs in rural areas. Taken together, the data in these tables paint a reasonably consistent picture in which public costs of truck freight

movements (in today's dollars) are roughly in the range of 2 - 5 cents per ton-mile in urban areas and 0.5 - 1.5 cents per mile in rural areas.

EXHIBIT 3-18a. Marginal Cost of Highway Use by Trucks

Cents per Mile (2000)						
Vehicle Class/ Highway Class	Pavement	Congestion	Crash	Air Pollution	Noise	Total
Urban						
40 kip 4-axle S.U. Truck/Urban Interstate	3.1	24.48	0.86	4.49	1.5	34.43
60 kip 4-axle S.U. Truck/Urban Interstate	18.1	32.64	0.86	4.49	1.68	57.77
60 kip 5-axle Comb/Urban Interstate	10.5	18.39	1.15	4.49	2.75	37.28
80 kip 5-axle Comb/Urban Interstate	40.9	20.06	1.15	4.49	3.04	69.64
Rural						
40 kip 4-axle S.U. Truck/Rural Interstate	1	2.45	0.47	3.85	0.09	7.86
60 kip 4-axle S.U. Truck/Rural Interstate	5.6	3.27	0.47	3.85	0.11	13.3
60 kip 5-axle Comb/Rural Interstate	3.3	1.88	0.88	3.85	0.17	10.08
80 kip 5-axle Comb/Rural Interstate	12.7	2.23	0.88	3.85	0.19	19.85

NOTE: S.U. = Single Unit, Comb. = Combination; Air pollution costs are averages of costs of travel on all rural and urban highway classes, not just Interstate. Available data do not allow differences in air pollution costs for heavy truck classes to be distinguished.

Source: Reproduced in part from *Addendum to the 1997 Federal Highway Cost Allocation Study Final Report: U.S. Department of Transportation Federal Highway Administration, May 2000, Table 13.*

EXHIBIT 3-18b. Marginal Costs of Highway Use by Trucks (Cents per Ton-Mile)

Cents per Mile (2000)						
Vehicle Class/ Highway Class	Pavement	Congestion	Crash	Air Pollution	Noise	Total
Urban						
40 kip 4-axle S.U. Truck/Urban Interstate	0.21	1.65	0.06	0.30	0.10	2.33
60 kip 4-axle S.U. Truck/Urban Interstate	1.22	2.21	0.06	0.30	0.11	3.90
60 kip 5-axle Comb/Urban Interstate	0.71	1.24	0.08	0.30	0.19	2.52
80 kip 5-axle Comb/Urban Interstate	2.76	1.36	0.08	0.30	0.21	4.71
Rural						
40 kip 4-axle S.U. Truck/Rural Interstate	0.07	0.17	0.03	0.26	0.01	0.53
60 kip 4-axle S.U. Truck/Rural Interstate	0.38	0.22	0.03	0.26	0.01	0.90
60 kip 5-axle Comb/Rural Interstate	0.22	0.13	0.06	0.26	0.01	0.68
80 kip 5-axle Comb/Rural Interstate	0.86	0.15	0.06	0.26	0.01	1.34

NOTE: S.U. = Single Unit, Comb. = Combination; Air pollution costs are averages of costs of travel on all rural and urban highway classes, not just Interstate. Available data do not allow differences in air pollution costs for heavy truck classes to be distinguished.

Source: Calculated by the authors using data from Exhibit 3-16a and assuming average truck load of 14.8 tons

EXHIBIT 3-18c. Average Private and External Costs of Truck and Rail Freight

(Cents per ton-mile, 1994)	Truckload	Mixed Freight	Inter-Modal	Double-Stack
Private Vehicle & Driver Cost	8.42	1.20	2.68	1.06
External Cost	0.86	0.24	0.25	0.24
Accidents	0.59	0.17	0.17	0.17
Air Pollution	0.08	0.01	0.02	0.01
Greenhouse Gases	0.15	0.02	0.02	0.02
Noise	0.04	0.04	0.04	0.04

Source: Forkenbrock, David, 2001.. "Comparison of external costs of rail and truck freight transportation," *Transportation Research Part A*, Vol. 35, p. 334.

Four factors are worth noting.

- First, the derivation in Exhibit 3-18b of cost per ton-mile was calculated assuming an average ton load of 14.8 tons (Forkenbrock, 1999; p.509).^{xiii} This represents the average weight of truckload (TL) general freight. If freight is diverted from less-than-truck-load (LTL) movements or if average weight of truckload is lower, marginal external costs per mile will be higher.
- Second, the value of external costs varies greatly depending on truck characteristics: an 80 kip 5-axle combination truck will generate roughly twice the social costs as a 40 kip 4-axle single unit truck. Thus, characteristics of the local truck fleet will affect average and total external costs.
- Third, the benefits associated with reduction in truck traffic will be partially offset by the increase in external costs associated with increased rail freight. As the data in Exhibit 3-18c suggest, the offset ratio is roughly 4:1, i.e., each \$1.00 in benefits from reduced truck freight is accompanied by an increase in external costs of rail freight of roughly \$0.25.
- Fourth, these benefits represent only public benefits associated with reductions in congestion, noise, pavement costs, and air pollution. They do not include other public benefits such as economic development and security, or other private benefits such as lower prices, better service or larger delivery markets. While they are *not* included in this “sketch planning” phase, they can be addressed in a more detailed evaluation as described in the final chapter.

For sketch planning purposes, the following *gross* numbers can be used as the basis for estimating benefits of truck diversion: 4 cents per ton-mile in urban areas and 1 cent per ton mile in rural areas. These estimates are taken from the high range of the values presented in Exhibits 3-18b and 3-18c. (For the purpose of determining whether rail investments might be an economically feasible way to reduce congestion, high-end estimates should be used. If high-end estimates of benefits from rail investments are not economically feasible, then it is unlikely that any rail investments would be an economically efficient means of reducing congestion costs.) For the actual calculations, *net* benefits (which include the offsetting increase in external costs associated with increased rail freight traffic) should be used: these are roughly 3 cents per ton-mile in urban areas and 0.75 cent per ton mile in rural areas. Chapter 5 provides more detailed discussion on the range of estimates associated with truck diversion.

A sample sketch planning calculation is presented in Exhibit 3-19. The first number entered is the estimate of potential freight diversion given rail resources from Step 4 (Exhibit 3-15), which in this example is 19.2 million ton-miles. Assumptions about the net external benefit of truck diversion for urban and rural areas are then entered. In this example, the default values of 3 cents and 0.75 cents are used. (See above for

derivation of these estimates.) If data are available, information on highway investment plans in the study area — including expected public benefits in the first decade after investment — are then entered. The latter numbers are used to calculate maximum rail project spending that could match the return on investment (ROI) associated with highway investments given the expected change in the factors listed in Exhibit 3-18b (e.g., congestion, noise).

EXHIBIT 3-19. Estimating maximum justifiable spending

Input	Value
Truck freight diverted (M ton-miles)	19.2
Net external benefit of urban diversion (cents/ton mile)	0.03
Net external benefit of rural diversion (cents/ton mile)	0.0075
<i>If known:</i>	
Cost of this year's highway investments	2,500,000
Cost of congestion, noise, etc. without this year's highway investments (over next 10 years)	7,000,000
Cost of congestion, noise, etc. with this year's highway investments (over next 10 years)	4,000,000
Output	
<i>Urban:</i>	
Maximum project spending compatible with positive ROI	5,060,798
Maximum project spending to meet highway ROI	4,800,000
Maximum project spending compatible with 7% ROI	2,572,653
<i>Rural:</i>	
Maximum project spending compatible with positive ROI	1,265,199
Maximum project spending to meet highway ROI	1,200,000
Maximum project spending compatible with 7% ROI	643,163

To complete this table, three sets of calculations must be performed.

- In the first set, the external benefits of freight diversion in rural and urban areas are quantified for the first ten years after investment. These are calculated in terms of net present value (NPV) and summed for the ten-year period.
- In the second set, the first decade of benefits associated with highway investments (if known) are calculated in terms of NPV and compared to the cost of highway investments to determine the ROI of highway spending.
- The third set of calculations compares the benefits of freight diversion to three financial benchmarks to estimate the maximum investment that can be justified on the following grounds: 1) obtaining a positive return on investment (ROI) for the project, which is defined as \$1 more than the break-even point; 2) matching the ROI of existing highway plans; and 3) achieving a 7% ROI, which is widely used as the opportunity cost for public investments. This third set of calculations is the basis for the output section of Exhibit 3-19.

3.3 Further Steps for More Detailed Assessment.

Results of this preliminary assessment make it possible to screen situations and determine whether or not rail freight is an available and potentially feasible option to consider for highway congestion relief in that local context. The preliminary assessment furthermore makes it possible to identify the specific freight market segments that may be applicable, and the types of projects or programs worthy of further consideration. (In the example shown earlier, analysts would consider the potential costs in Exhibit 3-19 and the given rail resources, and then determine whether or not an investment of roughly \$2.5-\$5.0 million in rail investments could be sufficient to support the level of freight diversion implied by Exhibit 3-16.)

This screening is most important, for rail freight options may be unrealistic or have limited applicability in many situations, and the screening can save planners the time and cost of further analysis (as well as the time and cost of further public-private discussion about such options). On the other hand, the screening can serve to identify the particular situations and types of projects where rail freight can be most viable and useful as a means of addressing congestion. For those situations, it can provide a basis for defining:

- (1) project options that are worth discussing further in a public-private dialogue about organizational and institutional feasibility (using the Chapter 4 guide to public-private dialogue that appears next), and
- (2) proposed project options that can be subject to more formal and detailed analysis of project costs and formal and detailed modeling of their freight modal choice impacts (using more detailed analysis methods that appear in the final chapter of this guide).

It is important to note that the project options identified by this screening process can be any of the 15 key types of actions identified back in Chapter 1 (Exhibit 1-1) or they may be any combination of those actions.

4

GUIDELINES FOR PUBLIC-PRIVATE DIALOGUE

This Chapter discusses needs, uses and procedures for bringing highway and freight planners together with private sector freight operators and other institutional players. It lays out the types of actions and cooperative strategies that can be effective in cultivating relationships and forging partnerships between public and private sector players. It first focuses on three types of actions that can aid the development of relationships -- the establishment of cooperation, the positive techniques of conflict resolution, and the distribution of labor. It then prescribes six elements for the development of institutions: stable funding, organizational strategies, professional development, and the promulgation of standards, multi-jurisdictional techniques, and land use actions. The design of transactions is described next in terms of two major categories of initiative: progress improvements, and new market improvements. Topics include expediting projects, taking care of the community, and traffic assurance. The Chapter concludes with methods for winning project support, by addressing program priority and forming multi-party coalitions.

4.1 Cooperation First

Many planners believe that the establishment of mutual cooperation in a public rail program must come first, before any serious investment in technical analysis. This is meant to head off conflict, but it presents practical challenges. Railroads have few resources specially assigned to public interaction, and those they have are dwarfed by the number and variety of agencies. Most rail personnel have other duties, cannot devote time to the nurture of relationships for their own sake, and require specific proposals to win their attention. Similarly, it is common for public organizations to have few resources devoted to freight, and fewer yet to consider railroad options.

Moreover, relationships progress along an evolutionary path. Because public rail partnerships often are new endeavors, most agencies are at the start of the path; they cannot count on a mature rapport or appreciation of rail behavior to guide them in their dealings. Their railroad counterparts frequently are in a comparable position, knowing their own business well and the public process less well, especially in its diversity around the country. While it is easier to form a limited partnership around the particulars of a project and see whether a lasting relationship results, it is better to lay a foundation of understanding and shared purpose. This helps assure that the right projects are proposed - ones that will fit the strategic focus and network priorities for both groups.

Four steps can be taken to create cooperation: a) initiation of advisory discussions; b) provision of leadership and high level contact; c) application of freight advisory councils; and d) situational adjustment.

Advisory Discussions. Advisory discussions are a productive way to clarify the overarching goals and structural requirements of both public and private stakeholders. They should be considered by public agencies whose relationships with their rail carriers are still maturing, by agencies that are further along but want to improve their railroad dealings, and by railroads interested in public partnerships. The purpose of these discussions, preceding evaluation of any specific investment proposals, is to erect a foundation for proposals to succeed. It may be necessary for the parties to have one or more projects in view in order to justify the allocation of time and instill focus to the meetings, but even so, their deeper aim should be to reach an understanding of needs and to instill mutual regard. In order to reduce the ratio of public representatives seeking railroad time to the number of railroad personnel, it can be desirable for states to organize these meetings jointly for their MPOs and themselves. Senior DOT officials reaching out to senior rail executives will be an expeditious way of causing the discussions to happen, and it will give them an aura of importance. Finally, in the treatment of procedures for conflict resolution presented later in this chapter, there are precepts for bilateral decision-making that will be helpful for the management of advisory discussions, and will reduce the likelihood of disagreements.

The objectives for these meetings would include:

- Acknowledgement by both sides that the venture into mixed rail investment may be breaking new ground and should be developed together. Neither public agencies nor freight carriers have the leverage to force change on the other.
- A clear understanding of the priorities and processes that drive public and private investment allocations, and of their assumptions about what will constitute success. The following chart gives examples of how perspectives can differ in each sector’s approach to projects and the factors associated with them.

EXHIBIT 4-1: Public and Private Perspectives

Planning Element	Public Perspective	Private Perspective
Financial Performance	Public rail investment vs. highway cost avoidance and other public benefits	Return on private investment
Access to System	Broadest possible for all freight shippers	Selective access to maximize returns
Public Involvement	Broad education to support political agenda	Minimized; defensive to avoid taxation and liability proposals
Environment	System or corridor focus; net impact on all modes	Adherence to statutory or regulatory limits

Asset Tracking	Public contribution easily identified and tracked	Asset integration to promote efficiency
Capital Planning	Incorporated into formal long-term plans with broad public input	Revised annually to reflect funds availability and ranking with other projects system-wide
Passenger Travel	Impact on passenger rail operations and highway congestion for passenger travel	Impact of passenger rail on freight operations; potential for passenger-driven capacity expansion
Benefit-Cost Analysis	Architecture described by federal funding programs	Proprietary to each carrier, geared to investor expectations

- Understanding and documentation by public agencies of the hot-button issues of the greatest concern to private rail interests. Such issues may include taxation, liability, open access, capacity allocation and management of core assets. Resolution of such issues may, in some cases, be a prerequisite for moving forward on collaborative investment proposals.
- Comprehension and acknowledgement by rail carriers of the public accountability required for use of taxpayer-supported funds. Rail carriers need a good grasp, for example, of how the benefits from public rail investment must be tracked in order to compete with other modes for infrastructure spending.
- Agreement on a shared process to better track and publicize the benefits of rail transportation to key decision makers and the public at large. A specific public information program jointly supported by public agencies and the private freight carriers would provide an additional platform to build confidence and prove the value of public engagement to the carrier community.
- A specific product such as the public information and rail impact-tracking program described above may serve as an inducement for serious, early engagement by the private freight carriers. The overall goal is establish joint ownership of the targeted projects rather than to have either the public agency or carrier in the position of selling the merits of an initiative to the other side.

The budget, level of staff and rail knowledge of public sector players can prove crucial to gaining the degree of carrier engagement that brings success to a public rail program. Carriers will commit resources when given a prospect of real deliverables and a serious, long-term commitment by a state or other agency to fund attractive projects. States whose programs are seen as effective by peers have a history of substantive rail funding and staffs that understand the complexity of railway operations.

Leadership & High Level Contact. Delivery of developmental objectives like those outlined above depends in large measure on having the right kind and level of people in the room. Since new ways of doing business may be devised, those present at such

meetings should have the power to work from organizational needs rather than public policy positions or company protocol. To that end, the following actions will be useful:

- Foster high-level contacts between top railway and public agency executives, if rail initiatives are expected to become a major element in local programs. States that have done this single it out as a key reason for their success in gaining carrier cooperation, and in executing projects on the ground. It also establishes a relief channel to get discussions moving, should parallel (and more frequent) lower-level talks break down. A DOT secretary, top lieutenant or big-city mayor working with a railroad CEO or senior vice president typically is the right kind of contact, provided the parties have a more than superficial commitment to the value of partnership.
- Provide initial leadership by state officials. Many rail projects have significance at the state if not the regional level, even if they may be led by MPO or other local units of government. State leaders also are better positioned to address the broader non-transportation issues (such as liability or taxation) that may surround a carrier's willingness to entertain alternate ways of doing business.
- Consider professional facilitation. Described at greater length under Conflict Resolution, professional facilitation may be required as a means of ensuring that foundational issues remain the focus of the advisory meetings. Planning and carrier officials both can have a tendency to leap to specific scenarios and potential projects before detailing and documenting the full context into which such projects must be launched.
- Limit stakeholder attendance at advisory meetings to a handful of public and railway officials. Private firms are wary of large-scale meetings that may serve as a platform for airing of grievances by interest groups.

Freight Advisory Councils. Support for public rail funding ultimately relies on a broader set of interests than those represented in the rail carrier community. Shipper groups, motor carriers, MPO's, environmental groups, land use planners and economic development interests all have a stake in efficient, balanced transportation investment.

Freight advisory councils (FACs) are employed by many states and urban areas to gather input on stakeholder concerns and to provide policy input to public agencies on transportation priorities. Usually they are not convened expressly to treat rail issues, but railroads and their potential customers commonly are members, and the councils can be well placed to step into this role. Such groups typically are facilitated by public agencies but should include sufficient private sector leadership to be credible in the eyes of citizens and legislators, when it comes to the economic rationale for investment of tax dollars. Councils also can perform the crucial function of delivering an early reality check on the commercial attractiveness of proposals to develop or enhance rail facilities, and their ability to divert highway traffic such as FAC members themselves may manage.

Councils should be called upon critically, but not constantly. The limited time available

Freight Advisory Council: Florida

The **Statewide Intermodal Transportation Advisory Council** (SITAC) was created by the 2003 Florida Legislature to advise and make recommendations to the Legislature and the Florida Department of Transportation on policies, planning, and funding of intermodal transportation projects. Initial responsibilities of the SITAC are to coordinate with the Florida Transportation Commission on the development of a mandated assessment of regional transportation in Florida, and to supply input on the initial draft strategic plan for the Florida Strategic Intermodal System.

The FDOT Office of Policy Planning (OPP) gives administrative support for the SITAC. The OPP also provides project management for development of the SIS strategic plan. The FDOT Seaport Office, part of the Public Transportation Office, is responsible for programs relating to seaports, intermodal development, and planning for freight movement/intermodal connections.

The SITAC meets on a monthly schedule. The members are appointed by the Governor (5), Senate President (3) and Speaker of the House (3). The current members include representatives from each of the modes as well as the Florida Space Authority and various port interests.

to members of advisory groups means that a specific menu of possible rail policies and projects should first be developed by the sponsoring agencies. A draft description of the project assessment principles to be employed should be brought before this group early on, to preempt concerns over the fairness of the capital allocation process.

Agencies in states with active freight advisory councils should draw them into freight rail issues, if they are not already engaged. Others should urge their formation. There are many examples of how to proceed with this; one from the State of Florida appears in the inset box.

Situational Adjustment. Freight carriers always care about operational improvements and cost reductions, and railroad capital programs normally have projects underway of this type. Some railroads also care for network and business expansion, and their interest is particular to their own circumstances and the locality. Public planners should evaluate how the projects they are contemplating match up with the situation and behavior of its carriers. For instance, a railway's financial condition plainly will shape its motivations, so that a company whose position is straitened will be acutely concerned for the near term and not very much for the long. Similarly, its planning horizon may be foreshortened if it is preparing itself for a possible merger, or trying to demonstrate immediate returns to Wall Street. Operational improvements – and there are many examples of operationally oriented projects with significant public benefits - may win the support of these carriers, where new traffic development may not. Carriers intent on expansion will reveal this by their public pronouncements, the programs they support, and the level at which they support them. They may be able to tackle only a few at a time, and fewer than their many public jurisdictions may wish, but they will be a committed partner for both operationally driven and development driven initiatives. In short, public planners should adjust their proposals to railroad motivations, and should

seek to understand those motivations. By doing so, they may be able to reach a project-based consensus with the carrier, regardless of whether they can reach consensus on other issues between them – and this may be sufficient to the purpose.

For the carrier’s part, public proposals should be viewed with flexibility, because there is a range of ways for the railroad to participate. At one extreme, carriers can facilitate corridor access and the development of specialized rail services that would operate with substantial autonomy and little management interaction with the main carrier. This option (which is just short of line sales) may be appropriate for railroads with limited planning horizons. It may allow them to derive revenue when they otherwise would not, particularly at times or in locations where capacity is slack, or where the public sector helps to enlarge it. Use of this option can be seen today in the short-haul intermodal market. At the opposite end of the spectrum is a full service-integration model, where the railroad mingles a new service offering with existing traffic, while accepting public contributions of capital for track capacity, rolling stock or terminals.

Even when projects and participants are in harmony, conflicts will arise. Some of them may derive from the everyday interaction of the railroad with the community, and carriers who keep a clean house with regard to this may find it easier to focus on larger opportunities, and diminish opposition to rail investment schemes. (Similarly, numerous projects that have actively treated community concerns count this among the reasons for their success.) Other disputes may be addressed by broadening the terms of discussion from a narrow point of complaint to the more systematic matter it may manifest. Examples of how this may be done appear in the accompanying Exhibit. Finally, challenging conflicts may be encountered because of entrenched positions, adversarial histories, competitive apprehensions, or the sheer stakes of a project. Organized methods of contending with them, including techniques for improving the general process of public-private decision-making, are presented next.

EXHIBIT 4-2 Underlying Issues and Their Resolution

Initial Issue	Broader Issue	Potential Resolution
Whistle Blowing	Grade crossing safety	Quiet zone improvements or grade separations
Line Abandonment	Job loss, economic development potential	Short line or public rehab assistance; targeted economic development
Disrupted Freight Rail Service	Terminal or line congestion issues	Corridor capacity or terminal configuration assessment and improvements
Commuter Rail Service	Shared Corridor Dispatch Arrangements	New or shared dispatch facility arrangements; interlocking or signal upgrades
Hazmat Transit Concerns	Obsolete urban freight main alignments.	Long-term urban rail relocation planning

4.2 Conflict Resolution

The convergence of interests between the private and public sector is a prime force behind the growing interest in freight rail. Even so, and for a variety of reasons, the achievement of cooperative partnerships between public agencies and rail firms may be impeded or thwarted by conflicts, and methods for resolving them therefore are an important part of practice. Some conflicts stem from divergent motivations and priorities, and others are conflicts within sectors: jurisdictional and funding barriers can divide public agencies, just as competition can divide railroads, so that groups with shared needs may struggle to act in concert.

There are three broad ways by which parties in disagreement can be brought to cooperate:

- *Common Interests* means the uncovering of shared objectives, whose influence brings dissenting parties away from fixed positions and toward areas of accord. The techniques associated with interest-based negotiation are central to the current practice of conflict resolution, and are likely to be the most productive in everyday use. They are treated in greater detail below.
- *Appeal to Higher Order Objectives* means the invocation of deeper purposes that override the specific factors in conflict, and cause the parties to cut their way through to a compromise. Higher order objectives might be a) social values, like the competitiveness of industry during a period of economic stress; b) an ideal, like the pursuit of a world-class transportation system; or c) a political aim, like diminishment of road traffic because of demands from voters. Such appeals normally are initiated by persons in a position of leadership who are able to stand above the fray, are custodians of organizational values, and who present their appeal to counterparts. The nurturing of top-level relationships, such as those between a DOT Commissioner and chief railroad executives (as cited above), maintains a communication link through which higher order appeals may be made. It also is possible for a less well-placed individual to stand forward in a personal exercise of leadership, and to call on others to reach for the common good. Such natural leadership has less organizational force behind it, but it is by no means without precedent or effect.
- *Coercion* is the use of force in some manner or degree. In its baldest form, it employs compulsion – sanctions, fines, takings or threats – yet the compliance this engenders is no basis for partnership and creates hostility instead. While there is a place for raw force when the stakes are high, options few, and adverse consequences less important, it is mainly a last resort and its benefits can be impermanent. The milder forms of coercion are more common and typically

6 Point Framework for Collaborative Dispute Resolution

1. Identify and pursue interests, not solely positions
2. Frame issues for constructive negotiation and management of differences
3. Use objective criteria
4. Generate options
5. Develop a sense of the realities
6. Be cognizant of relationships

Source: Bloustein School, Rutgers

Corridor in fact employed all these methods, purchasing railroad lines so that the local authority held sway, reducing port access to a single rail route, and then charging fees whether rails are used for access or not.) Finally and familiarly is the exercise of hierarchical authority. In this case, an agreement is reached because an officer in charge orders it done, or because disputants face the risk that decisions will be taken out of their hands.

Six Point Framework. Formal structures for conflict resolution have evolved over the last several decades. They are employed by courts around the nation, and have surfaced in the planning arena in connection with interagency disagreements and public involvement.^{xiv} The keystone in these structures is the technique of interest-based negotiation; some classes of conflict may not be susceptible to it, but most are. In this technique, the fixed positions staked out by the parties to an argument are reformulated in terms of their underlying interests. Because multiple positions may be compatible with these interests, this helps the negotiation to become fluid instead of fixed. (To clarify the terms, a position “is something you have decided upon; your interests are what caused you so to decide”.^{xv}) The process of defining interests tends to soften positions, uncover zones of existing agreement, and produce shifts in the conception of the problem. From this, issues can be reframed in different terms; for instance, they might transform a network question from being about who controls a line to being about how to expand capacity. Like product repositioning in the world of business, this approach can open up whole new classes of solution. In fact, one of the benefits asserted for these methods is that they improve the quality of decision-making overall, because of the conceptual change they introduce.

A six-point framework has been put forward by a group of experts in conflict resolution,^{xvi} which is representative of the major elements of technique recommended currently in the field. The framework is summarized in the accompanying box, and offers an overview for practitioners about how to respond to contentious situations. Beginning with the interest-based method and the purposeful reframing of issues in constructive terms, it also emphasizes:

more productive. One is the shutting off of alternatives, so that the choices parties have before them are restricted to certain channels. Another is the buyout of interests, whereby public funds are traded for control, or are used to create incentives toward a desired result. Fines can be replaced with user fees, which ideally have an economic rationale, but also are a method for shaping behavior. (The Alameda

- *Insistence on objective measures*, because a) they are visible to both sides and reduce the opportunity for disagreement; b) they encourage participants to rationally evaluate their own positions for consistency with the facts; c) they afford evidence by which negotiated outcomes can be sold to superiors overseeing each side, as well as to other concerned parties and to the public. Joint fact-finding is a specific procedure for establishing objective information, and simultaneously is an exercise in collaboration for the parties; for example, a railroad and an agency might pool resources for a gate survey to determine lane densities for a port service.
- *Generation of options* is a creative routine that serves at least three purposes. First, it explores the range and combination of ways through which solutions can be reached. Some of these may be new or overlooked, and the upshot is to enlarge the scope for action. Second, the act of probing for solutions in itself is capable of drawing participants out of their corners and into more vigorous give and take. Third, if superior alternatives to those originally under discussion fail to surface, the implication is that the best prospect for settlement is already on the table.
- *Development of a sense for realities* is about recognizing what happens if negotiations collapse. Examining consequences in a clear-eyed fashion may be enough to bring recalcitrant parties back into discussions, or may show that the incentives for settlement are insufficient. A common formulation of this concept is called BATNA: the Best Alternative To a Negotiated Agreement. This holds that the probable outcomes of negotiation should be compared to the best available course of action if no agreement is reached. The relative attractiveness of the BATNA for each party will suggest the power of their position and the strength of their urge to settle, and focusing on it can help bring matters to a head. A corollary is that actions or events that affect the BATNA have a direct bearing on the negotiation.
- *Cognizance of relationships functions at several levels*. Relationships can be essential to the implementation of an agreement, so that when care is taken with them, it aids the ultimate goals. Relationships may be recurrent, implying that the events of one transaction will affect the next. Similarly, they may have a history that assists or impedes their progress, and that should be utilized or addressed. The nature of relationships in addition contributes to the level of trust. Trust will speed the arrival to agreement, and can be especially helpful if discussions shift to higher order objectives. Finally, relationships may be implicit. Buying a gallon of milk, for example, is a cut and dried transaction on the surface. Nevertheless, the commercial branding by the manufacturer creates trust in the integrity of the product, and is a surrogate for a relationship with the buyer. One way this becomes significant is when the reputation of a railroad or a public agency as a reliable or unreliable partner, influences the behavior of parties who have no experience of their own.

Two Step Implementation. Understanding the techniques for conflict resolution does not guarantee an ability to employ them skillfully. Acquisition of this skill calls for a dual course of action. First, the carrier or public agency should import the expertise; second and simultaneously, they should develop it internally, in strategic locations that can support a network of planners.

Step 1: Import – Centers for the study and improvement of conflict resolution have arisen at universities around the United States, with enough dispersion that one or more will exist in most regions of the country.^{xvii} These centers are sources for teams of professionals who may be hired individually or in groups, to assist the solution of a particular dispute. There will be experts in private practice as well, working in service to business or the courts.

Such experts usually are styled as professional mediators, although the title “facilitator” is used, too, as a way to emphasize that their role is not to produce the solution, but to help the disputing parties to produce it themselves. This last point is important in view of the slight transportation industry and planning knowledge that some facilitators will possess today. However, if the disputants are the real source of resolutions, then the critical skill lies in process management and not subject matter – and knowledge can be a cause of perceived bias as well. Familiarity with the industry is going to be preferable, but conflict resolution still can move forward while facilitators accumulate experience. On the other hand, railroads contending with planners and moderators who are both industry neophytes should be expected to feel frustration. Railroads moreover may instinctively resist mediation, comparing it to the arbitration in labor conflicts and guarding their freedom of action. The way to counter their wariness is to show that collaborative dispute resolution is a voluntary procedure, with participants who are independent and act accordingly. The facilitators work to breed cooperation and to improve the joint structuring of decisions; they do not impose settlement on the parties.

The institutional action that needs to be taken is to provide and position expert support where planners can call on it as needed. An indefinite quantities contract, sponsored by the DOT with MPO support and let to one or more consortia, is a logical method (and some states may have services on call now). Its advantages are that a) it establishes an accessible and variable budget; b) the qualification of facilitators takes place in a deliberate fashion away from the time pressures of specific negotiations, and contracting mechanisms are put in place beforehand; and c) the expert resource can be shared among multiple user groups and needs – perhaps improving vendor negotiations or the handling of land use conflicts - and thus the procurement does not have to be justified by rail issues alone. An additional advantage is that the availability of mediation tends to spur parties to reach a settlement, so that they can avoid the more formal process.

Step 2: Develop – Courses of professional instruction for public freight planners, or for railroad officials expected to manage public partnerships, should include conflict resolution in the curriculum. At a minimum, this would provide instruction in basic

techniques, and prepare practitioners to engage in facilitated transactions at a more sophisticated level. Moving beyond basics into a more ambitious program of development, at least two further steps can be taken. First, a series of short training workshops expressly devoted to resolving differences in public-private partnerships, can be launched toward a mixed target audience of planners and industry officials. The series would be designed to kick start the process of partnership improvement, instill elementary expertise more rapidly, fortify relationships, and foster belief in their potential for success. There is no point in such workshops if there is not also an understanding among participants that rail partnerships will be implemented – in other words, there will be no interest in making them better if there is no mechanism to make them happen at all. Given that, the series could be established as an additional scope element in the indefinite quantities contracts for expert support, with attendees defraying some of the cost through fees. Or, a phased approach could begin with an orientation to methods of dispute resolution at a national or large regional gathering, utilizing the associations and conferences of TRB, AASHTO, or AMPO, or as an addition to FHWA programs.

Second, individuals or organizations could be selected by DOTs, acting alone or in groups, to be developed as internal experts in collaborative dispute resolution, and be designated to serve a subsidiary network of planners with guidance and intervention as needed. While outside experts are needed initially, and may be best long term for regions whose partnership opportunities will be infrequent, more active regions could want a high degree of institutional skill. For them, the use of external capacity initiates a process of knowledge transfer that builds into long range, in-house capability through training and experience. By concentrating this development on select recipients who then serve others, the program can avoid creating planners whose skills are insufficient because they handle disputes infrequently. These specialists then may be attached to dedicated institutions like joint powers authorities, whose value in the management of rail partnerships is discussed elsewhere in this guide.

Conflicts between the public and private sector are inherent in their distinct objectives and structures, and may arise whatever the qualities of a project. They do not need to stymie partnership or prevent action, and in some ways conflicts can be welcomed, because they bring into the open forces that need to be reconciled. Collaborative dispute resolution is a productive method for contending with these forces, and it can be developed into a readily available tool for public and private planners.

4.3 Distribution of Labor

Public-private rail partnerships can consume substantial staff time and effort, given their unfamiliarity. All stakeholders must acknowledge the burden of coordination with other groups, but assumption of leadership for certain categories of effort will lessen the staff resources required. This can be done by organizing the distribution of labor.

Labor distribution may be difficult to realize when parties are not well known to each other, yet it reduces the time and complexity associated with partnership planning, needs assessment and funding of capital projects. In the current environment, rail carriers could be better positioned than public agencies to take the wide view on freight transportation corridors that cross dozens of MPOs and states. Railroads conversely have important needs – quite apart from capital funding – that their public partners are better or uniquely able to satisfy. Streamlining of process and acceleration of approvals are one kind of aid; running interference with citizen groups and provision of political assistance are another. These things can have a great effect on the efficiency and diplomacy with which railroads are able to function in the public sphere, and they especially help to answer the challenge of a handful of Class I carriers interacting with hundreds of distinct public entities. Distribution of labor bears with it the seeds of real partnership, because as relationships mature and parties come to rely on one another, they acquire roles and perform like the members of a team.

Freight shippers and receivers, third party logistics firms and motor carriers also have an important stake in the success of freight planning and should likewise be engaged in the public process. Their input could be coordinated through a Freight Advisory Council, as earlier described.

Leadership roles under a shared agenda are illustrated in the following Exhibit. Individual positions should be modified for local circumstances and are not hard and fast; the primary purpose of this chart is to suggest how responsibilities can be distributed, and to show the inter-reliance of parties.

EXHIBIT 4-3 Elements of Leadership and Support for Various Project Elements

Element	Leadership	Support
Rail capacity limits	Rail Carriers	
Rail capacity investment needs	Rail Carriers	Public Agency
Freight market projections	FAC & Public Agency	Rail Carriers
Trans-modal effects of investment scenarios	Public Agency	Rail Carriers
New market assessments	Public Agency	FAC & Rail Carriers
Public education	Public Agency	Freight Advisory Council
Environment	Public Agency	
Multi-jurisdiction coordination	Rail Carriers	Public Agency
Media coordination	Public Agency	FAC & Rail Carriers

Developing relationships means finding the right personalities and leadership to address issues in a broad fashion, and to forge a partnership based on needs, shared resource burdens, and emerging trust. An initial consensus limited to projects, and supported by

the methods of collaborative dispute resolution, can mature into long-term relationships with efficient, inter-reliant roles. The broad perspective also is necessary to cultivate the stakeholder groups required to cement a political coalition favoring local and state contributions to rail projects.

4.4 Institutional Development

A successful project solves an immediate problem. An institutionalized system solves many problems through common channels, and transforms cooperating parties into continuing partnerships. A well-designed and easily understood institutional framework for rail projects also makes the public-private interaction more efficient – organizing priorities for the two sides, normalizing and speeding up the identification and funding of beneficial improvements, and forming rules for the game that encourage the commitment of both parties.

Institutional Development

1. Stable Funding
2. Organizational Strategies
3. Professional Development
4. Standards
5. Multi-jurisdictional Techniques
6. Land Use Actions

Six steps can be taken by or alongside the public sector to foster stronger institutions. They are the introduction of stable funding, use of organizational strategies, provision for professional development, adoption of standards, cooperation across jurisdictions, and land use actions. Some are steps that few users of this guide will have direct power to take, unless they stand in a position of authority or influence.

However, development is something many members of an institution participate in, and each is able to call for appropriate actions from time to time, support their introduction, and capitalize upon them once in place.

(1) Stable Funding. Dedicated, predictable sources of funds add credibility to rail planning efforts and are strong motivations for private sector participants to engage fully in planning discussions. Railroads are used to a very long asset replacement cycle for major investments. A concern for carriers, then, is the reliability of public sector funding as part of any long-term partnership. Many DOTs, if they can use state money directly for rail projects at all, must rely on bonds, appropriations, and their general fund, which are improvised and variable. In several states with well established rail programs, however, there are standing budgets that are modest by highway standards, yet are continuous and can supply a program through time. New Jersey has been able to support rail from its Transportation Trust Fund, and Virginia has created a Rail Enhancement Fund within its Transportation Trust. Where trusts are off limits to rail (as is often the case), there are other approaches. Indiana devotes a sliver of its state sales tax to rail; in Oregon, a portion of lottery proceeds are set aside for non-highway transport, of which freight rail receives a segment and is eligible for more. These designated streams of revenue have the virtue of being sequestered, and this protects them even if they are not

transportation derived. The key point is that states have found a variety of ways to create dependable, annual funding for rail, which strengthens the standing of their rail divisions, enlarges their range for action, and cements their partnership with carriers.

Larger ambitions demand larger budgets. Rail projects with network-level benefits have had price tags from tens of millions to billions of dollars. Apart from infrequent federal earmarks, the bigger projects require funding packages assembled from a combination of federal programs, state and possibly local money, private contributions, and ad hoc sources like project bonds. Qualification under multiple federal programs (and federal flexibility in administering them) is a practical tactic that has led to successful completion of capital packages, even for efforts of moderate size.

Project-driven financing is inevitable for the biggest initiatives, but to move rail investment toward systematic highway relief calls for a steady and growing program at the base. For most users of this guide, fostering a commitment to effectual and sustained funding by states is the right focus, and some form of sequestered revenue is a desirable way to produce this. Two further elements can be very helpful for building up dollar amounts:

- If state money can be safely banked from year to year, then unused or purposefully deferred program dollars can be accumulated toward the provision for major projects.
- If neighboring states each have underwritten substantial rail program budgets, their ability to jointly fund network initiatives that cross jurisdictional borders will rise.

The bottom line for states and other public agencies is that a public commitment to shared-investment rail capacity should be supported with a public funding structure that is robust and stable, in order to gain the full measure of private sector participation.

(2) Organizational Strategies. Many states have statutes or even constitutional prohibitions against use of certain revenue sources for rail improvements. In still other states, a blanket prohibition on investment of public money in private businesses effectively precludes consideration of public investment in rail.

Some obstacles can be dealt with by utilizing the general fund, or better by accessing particular and non-restricted state income, like the lottery revenue mentioned earlier. Beyond this, joint powers authorities have proven to be a pragmatic instrument for bypassing some statutory limitations due to their special taxing and bonding capabilities. Constituted as government corporations or as similar enterprises outside of the normal state structure, the authorities are controlled by two or more public agencies but enjoy independent status. They are endowed with powers like fund raising and tax abatement that enables them to secure, assign, and manage public money in venues that might otherwise be prohibited. Usually they are associated with a single project and not with

management of a portfolio, yet at minimum their organization, systems, and perhaps personnel could be duplicated for successive applications. An entity of this type may be the most sensible way to govern multi-state initiatives, although working instances of this are not fully in evidence and could require legal crafting.

Joint powers authorities offer a way around statutory obstacles to public rail investment. They also may fit into the wider role of a dedicated institution assigned to the management and implementation of a major rail proposal.

Dedicated Institutions - Large projects that take years to bring to fruition can consume staff and resources to a degree that is either disruptive to the typical public agency, or falls short of the needs of the project. Dedicated institutions provide a way to carve out personnel and functions and devote them to a major initiative. This can be a mark of commitment to partners, it gives them a single point of contact, and most importantly it is a practical way to get work done. As fairly independent repositories of professional expertise, authorities also can act as interested intermediaries in the process of collaborative dispute resolution, depicted earlier in this chapter. Dedicated institutions therefore become effective mechanisms to access funds, assess needs and priorities for funds application, treat conflicts, assure project activation, and monitor and manage results.

An organizational approach that is less sharply delineated, but more suited to rail coordination on an ordinary scale, is for the state DOT to assume formal or informal leadership for all public rail planning, analysis and funding in its region. States with dedicated rail groups of any size aim to do this now, and it responds to the freight carriers' manpower limitation for dealing with multiple and overlapping public agencies. Individual cities, counties or MPOs all have specific rail needs or interests, but these can be coordinated through the state group or through a sharing of professional staff and costs - and MPOs seldom can specialize on their own. State leadership in addition ensures that any rail project, even if sponsored by an MPO or city, is developed through an analytical framework with which carriers are familiar.

The quality of the relationship between State DOTs and their MPOs will contribute to the ease or difficulty of reaching agreement on the structure of rail planning efforts. At minimum the states and MPOs should, with the encouragement of carriers, agree on common definitions and measurement tools for evaluating rail investment proposals. Still, this does not mean that the weighting of factors used to evaluate a project must be the same for all locations in a state. Highway congestion and air quality, for example, normally play a more prominent role in the selection process for urban rail corridors than for those that traverse rural areas. Specific timetables and products should be insisted on as well, even if the early products are just policy statements or standards. Carriers are leery of an open-ended time commitment, without some schedule for deliverables.

At least a portion of the state rail section personnel should be knowledgeable about the commercial, operational, and engineering practices that govern rail functions, and ideally

some should have private rail experience. The eventual goal should be to develop specialized in-house planners, able to provide continuity in the evaluation of rail proposals and competence in the eyes of prospective partners. To this end, a program of professional development is a necessary step.

(3) Professional Development. The rail section of the typical DOT isn't prepared to handle a growing public role for rail investment, and MPOs are even less so. They can shore up their capabilities by using contractors, but training and development programs are the best way to equip public officials to deal with the issues. Carriers cannot carry out staff education each time a public sector rail initiative is put forward for discussion. They might, however, be willing to participate in a more broadly based rail education effort, and their own staff may learn from the process. And, professional development makes it easier for public agencies to attract appropriate rail representatives to the table:

- Carriers will come to see public rail staff as knowledgeable and influential allies in raising awareness of rail sector benefits, and building sympathy for rail-friendly policies.
- Carrier time will be spent more efficiently as public staff will be working from a solid understanding of the freight rail environment.
- The level and position of carrier representatives that attend meetings may be elevated, so that officers with decision-making authority become involved.

Development and implementation of a training program should be organized by state DOTs, or more efficiently by a coalition of interested states and like-minded MPOs. Impetus could start from a source like the rail committee of AASHTO (known as SCORT), and proceed with the collaboration of such industry groups as the Association of American Railroads (AAR) or the American Short Line and Regional Railroads Association (ASLRRA). Alternately, the freight professional development program of the FHWA could be adapted to the purpose. Its rail content should be reviewed by a competent body of users (SCORT again is a reasonable choice), and recommended for acceptance or modification. Key considerations for the design of the program are its breadth and duration. There are practical bounds to the time available from course providers and recipients, yet prepared professionals will not emerge from a two-day intensive. A solution would be basic instruction managed nationally, then supplemented by a longer regional course, backed by states and perhaps run through universities.

The program curriculum should feature a general orientation on nuts and bolts issues that influence freight railroad services, including operational, economic, and market factors. This guidebook and its supporting report can serve as a survey of content, or could function as texts. The course should be targeted to state and MPO planners, but it should have features or versions to attract railroad personnel. Certainly railroad officials can benefit from a richer and balanced comprehension of public planning, and the

opportunity for mixed public-private participation in course work would be an understated way to cultivate partnerships.

(4) Standards. Public funding of rail projects can best proceed from a transparent, well reasoned and visibly fair accounting of public costs and benefits. Carriers and states alike have an interest in acquiring standards that organize the assessment process. Carriers in particular have no appetite to learn new evaluation methods for every public partner in the many states of their networks. The procedures presented in this guidebook are intended to form such a core system of standards. By the adoption of common rules for the game, participants can concentrate on their play instead of their adjustments. They can combine efforts across jurisdictions because of shared principles, and can expect generally equal treatment around the country. Moving from a guide to an active system, of course, requires the acceptance of major railroads and public associations, promulgation through professional development programs, and successful use in the field.

(5) Multi-Jurisdictional Techniques. Many proposals simply are not local. Rail networks cross jurisdictions, freight markets ignore boundaries, and trucks move everywhere. A project undertaken in one place frequently has influence in another, even if it can be completed in a single spot. The public sector's institutional difficulty in responding to this is a built-in problem affecting freight initiatives of all sorts, and not just in rail; it derives from barriers based in the system of government and the ways federal money is distributed. A related predicament is benefit-cost imbalance, which arises when the costs of a project fall in one jurisdiction, and the preponderance of its benefits fall elsewhere. Railroads seeking to work with the public sector wrestle with these things, and sometimes prefer locally contained projects for their lack of jurisdictional complexity, even when the strategic needs are larger.

This section has pointed up a number of steps and devices to make multi-jurisdictional programs more feasible. None of them remove the root problem of political and fiscal structure, yet taken together they may reduce the degree of difficulty.

- Common rules for evaluating proposals make it easier for public agencies to collaborate, and may end up fostering common goals. Railroads with their interstate perspective can act as intermediaries to bring these goals into focus.
- The spread of professional development programs in freight rail will support these same purposes by creating more responsive officials with comparable viewpoints in multiple agencies.
- Standing budgets committed to rail, especially those with reliable revenue sources, make rail programs more practical. Budgets committed in adjoining states give neighbors a basis for coordination over an extended period of time.

- Joint powers authorities offer a formal mechanism for the management of cross-jurisdictional projects, provided they can be fashioned to conform to the laws of participating states. They may be able to support cost sharing to offset imbalanced benefits, and they have the additional virtue of dedicating resources to the complicated process of interstate cooperation. Corridor coalitions are a variant on this approach, and are seeing use in freight applications for highway and rail.

Finally, there is the designation of sequential projects in line with an overall strategy. The concept is that multiple improvements in different districts all can be pointed at a general increase in service for a corridor or region. The affected agencies agree to the program, yet the components are executed according to individual budgets and time frames. This is not an ideal approach, because program elements can be interdependent, and strategies with a culminating purpose (like the inauguration of new corridor trains) are made to wait until the necessary pieces are in place. Nevertheless, in the absence of consolidated financing, it is a pragmatic way to create incremental improvements, and for projects particularly with stand-alone components, it is a sensible way to proceed. The maxim "plan regionally, act locally" is a phrase that comes from practitioners in multi-jurisdictional program management, and it expresses the same kind of realism.

(6) Land Use Actions. Land use represents a different kind of institutional issue. Some planners argue that there are ways in which congestion is not a transportation matter at all, and that it results from policies shaping where and how densely the population lives, how industry is encouraged and zoned to locate, the mixture of activities permitted to come about, and other factors often concerned with the use of land. Transportation agencies normally influence but do not determine these policies. However, their use of institutional influence – with economic development commissions, zoning boards, and others – is important to the success of rail investment. Siting decisions and procedures affect rail's integration with other parts of the transportation network, its fit with the community, its popularity with citizens, and the willingness of carriers to accept development time frames. Proactive cooperation, by the railroads with the transport planners and by the planners with land control groups, can make rail ventures more productive in relief of the highway system.

Collaborative steps that can be taken by carriers and public agencies include these:

- States can offer incentives to local communities (such as infrastructure grants or tax incentives) to help carriers overcome the not-in-my-backyard issues that surround development of truck-generating nodes like intermodal terminals.
- The geographic perspective of state agencies (versus MPOs or local communities) permits a more reasoned trade-off between the challenges of freight flow concentration and reduced overall truck-miles on a state's highway network.

- Carriers can (and do) provide incentives to develop client clusters where a large number of carload rail customers can receive regular switching service in proximity to a terminal. Such concentration improves service reliability by supporting more frequent service, and keeps down travel distances to the client sites.
- Public officials can facilitate the organization of client clusters through supportive zoning and roadway planning. Urban brownfield sites situated near rail terminals can be particularly attractive for such use because of alternative decontamination costs associated with retail or residential redevelopment of the land.

The evolution of institutions is one of the primary means by which maturation of public-private partnerships in rail will occur. The six steps outlined in this section are guides for this process that can lead to stronger organizations, and to programs of activity that are more vigorous and better sustained. They extend and reinforce the framework wherein transactions are designed, which move these programs to implementation.

4.5 Designing Transactions

Transactions are the commercial structures for projects. They reflect the project's principles and the agreement between its participants. Ultimately they will be reduced to contracts, but this discussion will focus earlier in the process, and recommend the factors and considerations that should affect the principles and shape the agreement.

It is useful to distinguish two categories of public rail projects, because they establish different areas of emphasis. The first are network improvements that accommodate the current progress of rail operations, including indigenous growth, and the second are improvements that stimulate greater traffic growth by opening new markets. First category projects augment the present service offerings and conform to the regular market focus of carriers. Their familiarity makes them simpler to sell and execute, although their difficulty becomes greater with size, and with jurisdictional and participatory scope. Second category projects have a larger measure of uncertainty. They aim for new business and may require changes in the configuration of service, such as higher train speeds or service frequency. These features make them more challenging to develop, but they are attractive to some carriers in some places, and at times strongly so. The public interest lies with both types, because they both influence capacity and the contribution of truck traffic to congestion.

The two categories are presented separately in this section. More of the common elements for the design of transactions are listed with the first group, but there are shared factors that appear in each. For example, the assurance of traffic volumes is critical for any initiative, yet because there is more uncertainty surrounding it in second category projects, it is discussed under group two. The elements are summarized below.

EXHIBIT 4-4: Transaction Factors & Considerations

1: Progress Improvements	2: New Market Improvements
Identify Potential Beneficiaries	Traffic Assurance
Build a Broad Political Structure	Understand Motivations
Carefully Consider Scale	Engage Buyers
Utilize Network Strategy	Hedge Risk
Adjust for Benefits	
Take Care of the Community	General Steps
Seek Balance	Respect Management Prerogatives
Ensure Role Clarity	Examine Unconventional Solutions
Ensure Equity	Tailor Investment to Diversion
Expedite	Allow for Interoperability
Plan for Tolls	Encourage Carload Freight
Utilize Variable Compensation	Manage Expectations
Employ Performance Measures	

Category 1: Progress Improvements. First category projects support conventional markets by adding capacity or lifting operating constraints. Their significance may be local, or it may be widespread if they treat bottlenecks at the top of the network like hubs, ports, or mainline connections. Investor risk is moderated because the initiatives build on existing traffic, but the growth they accommodate and the roadway volumes they avert can be major. Development of public-private transactions for such projects should incorporate the following practical steps:

- *Identify Potential Beneficiaries* - A broad range of stakeholders in the success of the project should be identified. Benefits accruing to these groups should be quantified and then translated for easy comprehension by lay audiences. Similarly, the parties to the transaction need to understand their effect on one another. For example, the contribution of public capital can reorder a railroad's resource priorities. Identifying the carrier's internal incentives will help to cement their commitment to the public process.
- *Build a Broad Political Structure* to organize stakeholder involvement and to address the embedded limitations of public programs. The support of the local freight interests is essential, and the influence of beneficiaries must be harnessed. For example, special corporations can be formed to overcome prohibitions on public funding of rail, provided there is a mobilized will to do so. Also, once a coalition is formed to identify, finance, and implement projects that fulfill clear needs, then that coalition can quickly move on to additional projects.
- *Carefully Consider Scale* in a project. The scope should be large enough to achieve a critical mass of benefits, supporters, and operating volume, but will grow in complexity as the number of political jurisdictions grows. Participants can favor

single jurisdiction projects until funding and management solutions mature for the wider programs.

- *Network Strategy* may determine the value of a project for rail carriers, and can enlarge its value for the public. In a network business like railroading, the productivity of an improvement can depend on or be enhanced by conditions and parallel actions in other localities, and beneficiaries can be well outside the immediate geographic limits of the project. Railroads will have a strategy for this and states should consider preparing one, because it establishes a context for projects, helps identify initiatives where the benefits and traffic attraction are broader, and supplies a systems approach to development of infrastructure. This implies that public authorities should examine harmonization of their efforts with external jurisdictions. Although they cannot become hostage to an external set of political approvals, coordinated parallel development is another method for agencies to treat project scale.
- *Adjust for Benefits* – Incorporation of public benefits should cause the revision of some private plans for freight investment. Railroads ordinarily will invest in equipment and facilities based upon a financial analysis that includes costs and benefits to themselves and their customers. They do not ordinarily consider the effects (either way) of their decisions on congestion, the environment, communities, or regional economic development. Adding in these public benefits could result in different size and location of terminals, different routings of through traffic across cities, higher capacity mainlines, and further rationalization of the rail network in metropolitan areas. The public contribution to investment should consider the cost of these additions.
- *Take Care of the Community* – Well-designed rail projects give advantages to surrounding communities that do not depend just on freight shipping factors. Commuter rail improvements, grade crossing safety and community re-development opportunities are important additions that help gain acceptance for a freight mobility program. Transit and passenger rail authorities often enjoy deeper or different political support within a metropolitan area than do freight stakeholders, which can strengthen a freight coalition. Segregation of freight traffic from neighborhoods - through grade separation or route arrangement - produces benefits by improving popular perceptions of safety, reducing congestion, and softening community impacts. Minimizing the detrimental effect of construction also is important. One project did this by a) preserving the historical character of improvements; b) smoothly handling problems and concerns as they come up; and c) closely coordinating between agencies so that improvements were accelerated.
- *Seek Balance* - The willingness of various railroads to work together and to negotiate ways to distribute costs is essential in a project with multiple players. Competitive concerns between rail carriers, or between motor carrier and rail interests, can stymie a project and should be addressed in its design. The organizing agency should have the scope to attend to these concerns, and it can tackle them by devising a program of

improvements that benefits multiple groups. For instance, multiple projects or separate phases of a project can be packaged to deliver investment opportunities for different parts of the surface transportation network, and for different stakeholders in turn.

Third party rail operators offer a way to provide balance at joint facilities whose operation is important to more than one carrier. Short line railways and switching roads supply a neutral and often lower cost form of common access to many ports and terminal areas today. They can be a satisfactory solution for the management of infrastructure whose function is vital to the public, and where there is a need to support rival rail networks.

- *Ensure Role Clarity* – For the sake of efficiency and accurate expectations, the roles of public and private sector participants require clarity from the beginning of a project. To that end, full responsibility for certain categories of capital and expense items should be allocated to specific participants, as distinct from cost-sharing schemes that would entail complex reconciliation of public and private financial accounts. As an example, public agencies could take on the financing role for specific net additions to line capacity in a given location, while the railroad bears responsibility for replacement in kind of existing capacity, as well as capital renewals going forward.
- *Ensure Equity* - The contributions from each party to a project should be scaled to its benefits, in order to relate investment to return. This may not be strictly practicable if the parties are operating under resource constraints, and it is reasonable for one to supply funds that another reimburses. However, no party should be expected to pay for advantages it doesn't seek, all should be satisfied that their results are worth their investment, and contributions needn't and won't be all financial.
- *Expedite* – The long ripening time of projects in the public sector, and the sometimes byzantine approval process are recognized obstacles to investment for railroads, whether they proceed alone or in partnership. Fast-track procedures, go-between services, cushioning with citizenry, and political cover for nailing down agreements are ways that public agencies can simplify and expedite requirements for their rail counterparts. These steps raise efficiency, and they also make public collaboration more attractive to railroads as a means of doing business.
- *Plan for Tolls* – Plans for road pricing are intensifying in the US, with a particular emphasis on truck tolling. Truck traffic that seeks to avoid these charges will move to alternate highways or secondary roads, and some may be picked up by rail. In Europe, road pricing is used in conjunction with rail programs to encourage their success. It is improbable that this would develop in the US, but it is appropriate for American agencies to anticipate the effect of road pricing on rail capacity requirements, and build into project designs the recognition that road tolls are a stimulus to rail.

- *Utilize Variable Compensation* schemes with carriers. Financing systems will be attractive to railways that replace up-front capital investment with contributions linked to use, essentially turning fixed costs into variable costs. In some projects arranged this way, rail carriers found their direct operating cost savings *on existing traffic* were sufficient to cover the usage charges, which compensated the public for new or improved facilities. The repayments from this method of financing also can be placed in trust, replenishing the public fund for development of further rail system improvements as volumes grow.
- *Employ Performance Measures* – Freight performance measures are being introduced generally in statewide plans, for the rail and the highway modes. Rail measures can reveal the fitness of carriers to attract new volume and the sections of the network requiring improvement, and thus suggest market and investment opportunities. For project applications, performance tracking is a vital part of sound and sustained investment. Because railroading is a service, investments in plant have to be protected with competitive operations that are sustained through time. Thus, it is important to know not only the volume change across a facility versus the investment plan, but also whether it is being operated according to the service plan and will continue to fulfill its purpose. Public-private initiatives can be judged to have been successful when a) the public investment or support is sufficient for the private carriers and customers to justify greater use of rail and less use of highway transport; b) the public benefits are sufficient to justify the public portion of the investment; and c) there were no clearly superior means of achieving similar results. Performance measures are critical to determine this success and earn the continuance of funds. They should be integrated in the project undertaking, and expressed in covenants between the parties.

Category 2: New Market Improvements. Second category projects pursue the diversion of truck traffic from new lanes and markets. They may offer standard services for new places and customers, but typically they draw on higher performance, expanded capacity, better routes, fresh equipment, or other improvements to attract business. The standards for cost, speed and reliability in these markets are set by motor carriage, and they have to be matched. This will be done most often but not exclusively with intermodal service.

There must be room – available or feasible physically - for the new traffic, it must fit with other operations on the network, and it must be more attractive than alternatives. Then, the key dynamic in traffic diversion is an investment that supports the introduction of new train service with competitive performance characteristics, and costs of operation reduced to the point where the modal balance shifts. Because the performance is unproven and the traffic must be captured, there is significant uncertainty for the railroad and other investors. Railroads accept this risk selectively, with projects small and large. However, it is a normal business risk; it is the way that a business grows and the way that roadway relief will grow. Development of public-private transactions for these projects should begin with traffic assurance, and proceed from there with a series of general steps.

Traffic Assurance. No traffic diverts without a change to stimulate it, and new rail services introduce this change. Adequate utilization of new services by transportation buyers is one of the central concerns for second category project investments. Transactions that create these investments can attack this concern in three ways:

Understand Motivations to begin with. For intermodal products particularly, there are several kinds of buyers with different sets of needs.

- **Shippers** want on-time performance in specified transit windows, competitive costs door-to-door, and shipment visibility. So long as carrier performance reaches a threshold level of service, cost is the primary issue.
- **Ocean container lines** want capacity at an aggressive price point. Service times are important but less crucial; the key factor is that inland transportation typically is embedded in a commoditized international price, and the objective is to get it done very economically in shipload volumes.
- **Motor carriers** with national fleets and a serious interest in intermodal products want two things. First, intermodal linehaul is more profitable than highway, provided service will satisfy shippers and charges remain competitive. In this respect, their specifications are like the shipper's, but what truck lines want is more business and a bigger, high-service rail network to carry it. Second, rail allows more truck shipments to be handled per unit of manned motive power. Since tractors are expensive and drivers perennially in short supply, motor carriers want the higher utilization of scarce resources that intermodal linehaul allows.

Engage Buyers in face-to-face discussion. Preference surveys and similar marketing devices are sensible ways to gauge the general demand for new services. However, the deeper questions – about how the service should be constructed, where the tipping points lie, how long conversion may take, and how to disarm the buyer's reservations – are best answered in a probing, interactive format that is not tightly time-limited. Focus groups and depth interviews, conducted in person, are the best methods for this; public forums are less productive because information is not confidential and the venue attracts posturing. Freight Advisory Councils also are effective in this role, if their discussions are directed in the structured fashion of a focus group. They can be conduits for the recruitment of interview prospects besides, particularly those who are not local, and councils have the additional virtue that their viewpoints can be sought at successive stages of a project. In this sense, they may serve in the manner of an independent Board of Directors to a project.

Hedge Risk from three directions.

- **Appoint a Devil's Advocate** - Recognition of risk is the starting point for treating it. An old and promising method for doing this well is the appointment of a Devil's Advocate. This is meant in the original sense of a kind of lawyer for the opposition,

who is attached to the project staff with the formal charge of uncovering defects. Planners may step into this function informally, and it is an easy precaution to take.

- Secure a Baseload - For volume risk, the usual answer is to secure a baseload. First category projects have one in place; if existing traffic is to be rerouted or upgraded in service, a ready baseload can be available in the second category as well. Without this, volume for the project launch has to be assembled from a group of buyers. Ship lines, large motor carriers, and Fortune 500 companies are possible candidates. Railroads and advisory councils should be responsible for identifying them, although prominent local industries should be obvious to planners. Buyers with a firm interest in new service should be able to quantify the business they would consider tendering, but they should not be expected to offer a definitive commitment unless they are investors in the project, or special beneficiaries of a segment of construction. The strongest response that is reasonable to seek is a non-binding letter of buyer support, akin to the instruments that railways secure to buttress a merger application. Even so, refusal to provide a letter is not proof of negative intention, because buyers can be cautious of public pronouncements, or unwilling to reveal traffic information.
- Establish Covenants - A competitive service that performs as promised, that is offered at a compelling price, and that makes economic sense to begin with, is going to win traffic. Given a good product design and free market pricing, the risk lies in the performance, and covenants associated with financing are a reasonable remedy. In exchange for public dollars, these are binding commitments by the railroad to provide service of some minimum frequency and configuration for a minimum period of time. Service incentives can be incorporated as well. A critical railway concern is the obligation to run trains despite inadequate volume; the public concern should be that compromise of service will prevent volume from growing. This is the common problem of start-up risk. Some solutions to it are: a) a public guarantee of minimum rail revenue, or outright purchase of train starts; b) a public investment in such train assets as locomotives, aimed at reducing the railroad's financial exposure; and c) investment in train starts by independent third parties (discussed below in the section on Winning Support.)

General Steps. Several further steps should be taken in designing transactions for new market improvements:

- *Respect the Management Prerogatives* of railroads to select clients and manage their franchises as they see fit. Carriers will not be convinced to compete for new markets or service low-margin business because of public benefit objectives. What will convince them is public investment that changes their margins.

A related dilemma is the allocation of added capacity, because the expense of successive additions frequently will climb, and this opens the question of which users should be expected to pay for each. For joint facilities, or facilities shared between passenger and freight activity, the prerogatives of individual players can come into

conflict, and the difficulties posed need a clear and collaborative resolution early in the project.

Examine Unconventional Solutions and structures. Rail service applications to certain markets may not fit the business priorities and service design of standard carrier operations. Partnership with carriers can adjust to this by taking a variety of forms:

- In a condominium approach the public purchases an easement to build and operate rail service that is physically and operationally separate from that of the existing carrier. This method, while expensive, can be used to create new services and to control the quality of a corridor-specific operation. Ongoing involvement by the railroad is minimized, but the public becomes a carrier, or contracts with one. (The Alameda Corridor followed this form.)
- In an apartment approach specific units of service capacity are leased or bought from a carrier to serve a given market under specified terms and conditions. The public agency negotiates a slate of capital or expense contributions to support the service. Traditional and new train operations take place under an integrated structure, but the railroad exits certain responsibilities such as supply of rolling stock, terminals or administrative support.
- In an REIT approach the public is an investor in railroad development. It contributes funds or incentives that the railroad uses to build new capacity, or otherwise cover the capital requirements for serving new business. Public money becomes part of the overall capital structure of the carrier. The public interest is in project performance instead of functional management, and the railway retains traditional roles in marketing, service quality and operating control. This approach imposes less disruption on existing carrier practices but requires accountability to the public investor, and the demonstration of benefits the investor expects.

Tailor Investment to Diversion – The dominant components of rail operating costs vary by length of haul. For intermodal freight services, the majority of costs at distances below about 900 miles are taken up by terminal expense and drayage – in other words, by transloading, and the pickup and delivery operation. As mileage climbs, the balance shifts toward the costs for line and for operation of trains. Tailoring of public investment toward the sensitive cost factors, according to the profile of traffic lanes in a project, is a sensible way to support its truck diversion objectives. For example, tax incentives for drayage could make sense at the medium and short haul end, as could investment in transload facilities. Time elements, too, become more sensitive as linehaul distance declines, so that reduction of crossing delays can be an appropriate way to aid diversion in the lower mileage ranges.

- ***Allow for Interoperability*** – The free flow of intermodal shipments between rail and non-rail operations creates efficiency and a larger effective network. Compatible equipment is a necessary component of this interoperability, which is well-developed

between railroads and marine container lines, but much less so with domestic trucking. The rail intermodal business has emphasized stack containers over domestic trailer service for many valid reasons, including better capacity utilization; however, it is domestic trailers that fill the highways. The upshot is that motor carriers using rail are encouraged to do so with a specialized container operation, while the trailer fleets cannot make rail a broad extension of their over-the-road networks. This produces a robust international intermodal system and a smaller effective domestic system. For public planning, the useful step is to allow for interoperability in project design. If the goal is to appeal to international shipping, capacity for container trains will suffice. If the goal includes domestic truck diversion, containers will capture some, but the interoperability of motor carriage with rail will become a consideration, and added capacity for trailer service may be desirable.

- *Encourage Carload Freight* – General merchandise carload freight is not the engine for rail industry growth that the intermodal business may be, but it is a valuable part of the rail portfolio for public planning. Rail retention of carload traffic keeps heavy-loading goods off the highways, and when new traffic is captured, it often is done with direct-to-door service at one or both ends of the journey – in other words, no drayage truck is involved. Diversion effects on local roads can be quite significant when an industrial plant shifts volume to direct rail, and the short line sector tries to specialize in this kind of conversion. Apart from proactive inclusion of carload freight in rail programs and partnerships, many of the key steps for government are in complementary land use and zoning regimes at the city or MPO level. The encouragement and retention of sidings, the provision of rail spurs into new commercial sites, industrial development in proximity to rail lines, and financial mechanisms to support these things are some steps to improve carload access. Joint investment or just local approvals for bulk or breakbulk transload facilities are appropriate when direct service is impractical.
- *Manage Expectations* – The success of any project is shaped by what its constituents expect it to do. Careful forming of those expectations is important in first category projects and more so in the second, where citizens may be hoping to see fewer trucks in their daily travel. The fact may be that even large diversions of truck volume will be overwhelmed by the overall growth in freight. Transit advocates face a similar dilemma in selling their projects. Their argument is that a parallel system like transit guarantees people a certain minimum threshold of mobility in the face of worsening roadway congestion. Freight rail can argue (and has) that it slows the growth of congestion, or retards the rising incidence of trucks, or that it guarantees mobility to supply chains by offering a parallel system in freight. The point is to consider the popular perceptions of a project's objectives, and direct those perceptions toward what the project can finally accomplish.

Transaction design thus solidifies the approach to projects and the roles of participants. It is concerned to assure their success, and the way that success will be determined.

4.6 Winning Support

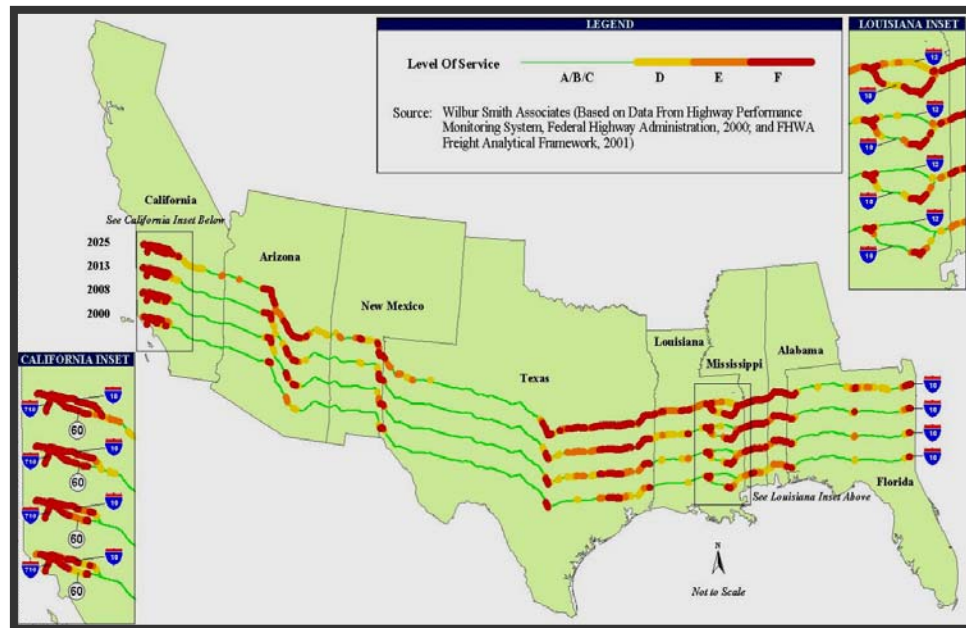
Drawing support to public freight rail projects organizationally, politically, and financially is vital to their likelihood of implementation. Two avenues for doing this are explored in this section: methods of influencing program priority, and utilization of multi-party coalitions.

Program Priority. The program priorities for multimodal projects in the public sphere can be heavily governed by their ability to delay or eliminate the need for new road capacity. Rail projects answer well to this requirement when diversion is concentrated on particular roads due to high volume shippers or confluent traffic, but in other locations the same diversion effect can be diluted across the road network. To contend with this, the value of rail can be asserted for program prioritization in three ways.

- 1) *Reformulation:* First, it should be questioned whether the effects on the passenger-driven highway spending program are the right way to judge freight projects. When the capacity problem is reformulated as congestion specifically affecting the freight system, the rail solutions become more potent because they address it directly. For example, if highway conditions determine the advantage of diversion, then results for the class of traffic which departs the highway are excluded, yet this traffic should experience the greatest benefit from a rail project. Reformulation of conditions in terms of the system for freight, and including all affected commercial traffic because the modes are interactive, is a more relevant method of deciding program priority.
- 2) *Containment:* Second, the utility of rail should be stressed for the management of congestion as a worsening and generalizing condition. For example, intercity lanes represent the new zones of congestion in the decades ahead. One projection of this is reproduced below in a map from the National I-10 Freight Corridor Feasibility Study. It depicts highway level of service deterioration spreading through the years, until the corridors linking major cities degrade to the most congested rank almost end to end. Even if they are focused at greater lengths of haul, rail options help to respond to congestion because of its proliferation.
- 3) *Broader Criteria:* Third, rail benefits that resonate with the voting public should be advanced as additional program criteria, focusing especially on economic competitiveness, and safety in the form of traffic separation. For instance, in the major hub center of Chicago, rail freight has been shown to be worth whole points of gross regional economic product. While the influence of rail in more typical locations will be less, this large-scale example shows the strength of the connection

to economic well being, with its implication of jobs, income, and political interest. Other advantages from rail can act in a comparable role: in Europe, railroad environmental performance wins preference at the policy and program level, and some American communities may choose to act similarly, because of air quality non-attainment, climate concerns, or local opinion.

EXHIBIT 4-5. Illustration of Projected Congestion Growth Along 1-10 Corridor



Multi-Party Coalition. An essential question for a railroad and its public partners is whether their pooled financial resources are large enough to support their desired projects, and given the many demands on their treasuries this question will be perennial. A promising solution in some cases is to expand the two-party partnership, by inviting or recognizing the involvement of other private sector entities in the provision of rail capacity.

Certain railroad customers for decades have been contributors to capacity in narrow but meaningful ways.

- Electric power utilities own coal-bearing hopper cars and purchase dedicated trainload service from carriers. This assures their generating plants a steady supply of fuel by guaranteeing the availability of equipment and service, and it affords them a form of inventory storage. For the railroad, it assures full productivity from the fixed cost of a train start, limits their mobile asset investment to locomotives, and may supply the baseload traffic for a branch line.
- Chemical shippers normally lack the volume to purchase whole trains, but by maintaining large fleets of private tank cars, they protect their supply of specialized

equipment, insure the safety and compatible usage of the tank, and possess a method of product storage. Railroads gain by avoiding ownership of equipment whose utilization often is restricted.

- In the intermodal business, steamship lines provide containers and chassis, and purchase trainload service on some high-density lanes. A number of motor carriers run their private trailers and containers by rail, and while they have lacked the individual volume to take on a train, some are developing the size and density to be capable of it, alone or on a shared basis. Steamship lines cross the threshold of trainload quantity because of the great mass of American containerized imports, funneled through relatively few ports in huge vessels. Motor carriers are beginning to cross the threshold because of the amount of traffic several are coming to control, aided by purposeful marketing to approach the volume level for train lot consolidations.

Thus, there is precedence for additional parties entering the rail capacity picture. The existence of non-rail private direct investment in the intermodal sector is especially significant because of the importance of this class of service for highway traffic diversion. Moreover, while there are many intermodal users who depend on the railway for all equipment and operations, railroads have a preference for those who bring assets to the table, and favor them when capacity is tight. Commitment of assets also produces a vested interest in the rail operation and usually in the quality of service, since service affects the utilization of equipment and therefore its return on capital. When the volume or operational requirements of the asset owner begin to warrant investment in trains or terminals, this interest can become compelling and create an additional full partner for a cooperative relationship.

Railroads can have misgivings when a private partner begins to look like a private operator. When purchasers of trainload intermodal services have resold space on trains, railroads have asked whether they are competing with themselves. The dilemma is like that of ocean lines with Non-Vessel-Operating Common Carriers (NVOCCs), who improve the utilization of ship capacity yet are rivals with the lines for some business. Nevertheless, while railroads prefer to retain full control of trains, they are apt to prefer profits more, and can reach an accommodation with private players who will not severely commoditize rail service.

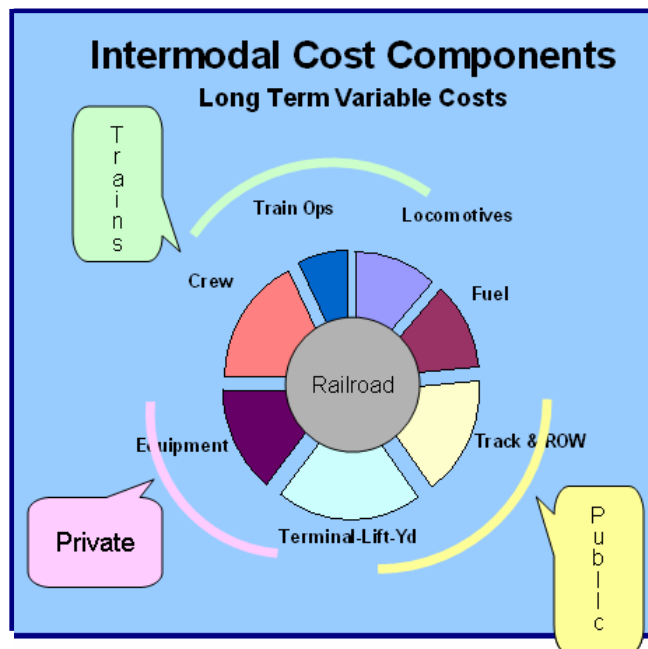
A multi-party approach to public-private partnership brings a clear set of advantages to rail projects.

- *Traffic Assurance* - Truck lines, ship lines, and shippers all command volume they can tender to railroads, and this brings assurance to project traffic levels. Even if quantities fluctuate, their existence reduces project risk and makes railroad and public money safer to invest.

- *Public Relations* - The influence of alliance members on public relations and the courting of public favor is a second advantage. When the pairing of railroad and government expands to take in transportation users, the partnership begins to have evident market support, and if the users are well known to the community or prominent in the industry, it can take on the aspect of a grand coalition. This establishes an impression of solidity and prestige that is beneficial to a project, by helping to sway decisions for it in a political environment.
- *Capital* - The most obvious advantage is the enlargement of sources of capital. The funding minimums required to make new projects operational become easier to reach, more projects reach fruition, and the money available from public and railroad coffers goes further. The new partners will have characteristic inclinations, derived from their own business functions, which tend to slot them into certain roles: for example, a motor carrier will commit fleet equipment but isn't likely to invest in track. While seemingly restrictive, these roles in fact can be complementary to the public interest, so that taken together the parties may fund a rail initiative more completely than any would alone. How this could function is discussed next.

Funding Roles. The funding roles that the parties in a coalition may play are pictured in the accompanying Exhibit. It shows in a general way the rail cost composition of intermodal service, and each partner's area of involvement and potential contribution.

EXHIBIT 4-6 Illustration of Funding Roles



Public sector actors normally will make rail investments in infrastructure, mirroring their function on the highway side. Specifically, they will contribute toward track and right-of-way (ROW), yards, terminals and access, and potentially terminal transloading (lift) equipment.

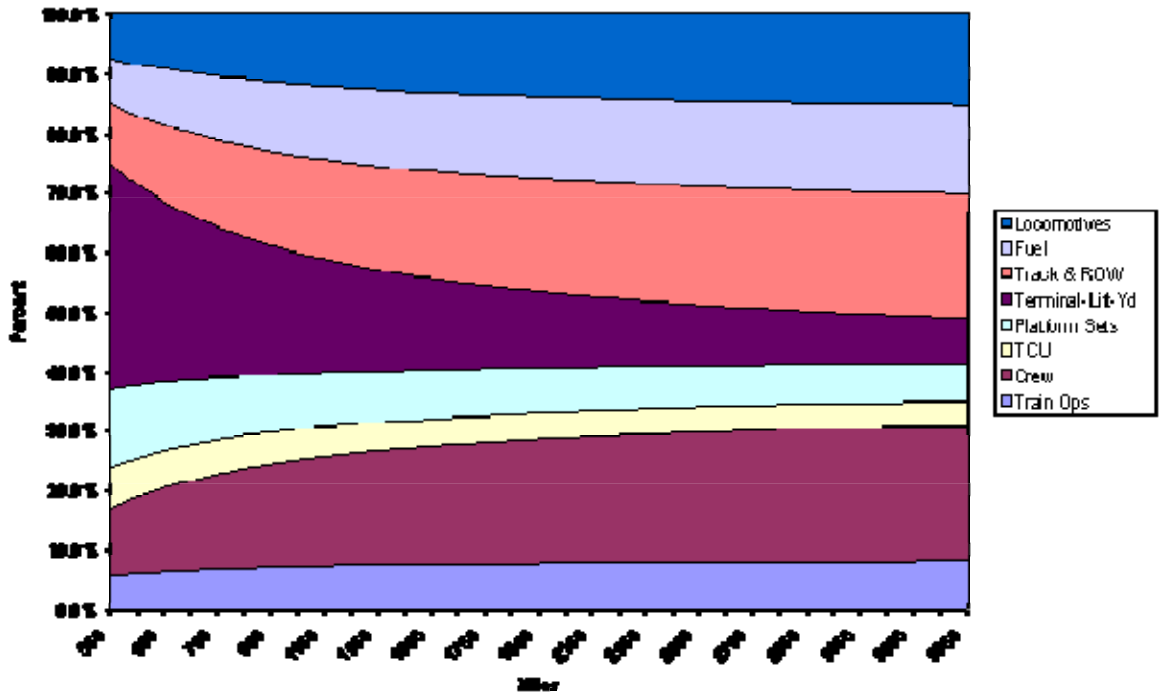
Private sector actors invest principally in payload equipment: trailer/container units or railcars. Some may be brought into terminal investment, perhaps on a shared basis with a railroad or public agency (as shown in the chart). While this is not normally

done today, ship lines with on-dock rail or industries with private spurs are stepping in this direction, and motor carrier-owned terminals outside of the rail sphere are commonplace.

- Train starts are possible targets of investment for both public and private players, individually or on a shared footing. A train start is a commitment of crew, locomotives, and operating resources on a set schedule. Although it is not a capital commitment per se, it imposes a material fixed cost that railroads approach with care, and a purchaser of trainload services can defray it. Shippers, container lines, independent operators, and public agencies all have undertaken this to varying degrees, and motor carriers have now begun to do so. The party that is best able to accept the train start risk is the one who controls enough traffic to support the train. The public agency function can be to bring several private entities together to reach a volume threshold, or to guarantee against a volume shortfall as an inducement to the cooperation of others, especially during the ramp-up phase of a project.
- Railroads invest everywhere, sustaining the system – the network, fleet, personnel, controls, transactions, and organization – that makes contributions by others effective. A public investment in track, for instance, represents a subset of the hundreds of miles of track that trains may travel in providing service to that investment. Similarly, a train start draws on a pool of qualified labor and a string of locomotives maintained and positioned in the right district by the carrier.

The relative significance of roles in the cost composition of intermodal rail service is illustrated somewhat better by the graph in the following Exhibit.^{xviii} The previous pie chart displays the distribution of expenses for a mixture of longer and shorter haul traffic, with a weighted average around 1,000 miles. The graph depicts how this distribution changes with distance. A consequential point for public planning is how important the terminal and equipment components are at the lesser lengths of haul, encompassing half the costs under 500 miles. Since terminals and equipment also are the nexus where private non-rail and public roles meet (as shown in the pie), it stresses how helpful and even critical a multi-party alliance can be, at the distance ranges where railroads traditionally have not competed. In addition, the chart reinforces the notion advanced earlier that investment can be targeted to sensitive components, in order to divert a given traffic mix.

EXHIBIT 4-7. Distribution of Intermodal Rail Costs by Mileage



As the Exhibits suggest, the roles that the parties tend to fall into are complementary and mutually supportive. They are not limiting roles, so that a public agency could act differently – perhaps by purchasing locomotives to assure a project’s power supply. However, they are essentially natural parts for each actor to play, delineating a partnership structure that can be followed, and diluting the capital demands of railroading by spreading them according to segmented interests.

Winning support for projects concludes the process of public-private dialogue, in the development of rail responses to road congestion. There are detailed steps of analysis that should be conducted in parallel with this process, in order to demonstrate the viability and value of rail initiatives and their preferability as a use of public resources. Those steps form the subject of the next chapter.

5

METHODS FOR DETAILED ANALYSIS

This section describes methods that can be used for more detailed analysis of project cost, benefits and feasibility, beyond the sketch planning approach for preliminary screening that was described in Chapter 3. The methods described here encompass six major steps that can be part of a more detailed analysis:

- **Assess Congestion Levels and Reduction Needs** - Section 5.1 describes methods for determining the severity of traffic congestion and the relative contribution of truck traffic to that problem.
- **Analyze Shipping Cost and Service Features** - Section 5.2 describes methods for assessing differences in freight carrier cost and service levels associated with truck and rail freight options.
- **Analyze Overall Logistics Costs** - Section 5.3 describes methods for assessing the overall logistics cost factors considered by freight shippers (users of freight transportation) when making decisions between truck and rail freight options.
- **Calculate Truck to Rail Modal Diversion** - Section 5.4 describes methods for estimating the impact of proposed project alternatives on diversion of freight from truck to rail along congested corridors.
- **Calculate Traffic and Economic Impacts** - Section 5.5 describes methods for calculating impacts on transportation system efficiency (cost to carriers), benefit for freight system users (shippers), and broader impacts for other businesses (regional and national economy).
- **Present and Summarize Benefit - Cost Findings** - Section 5.6 then describes methods for portraying project benefits and costs from various perspectives that may be useful for public discussion and decision-making.

For each element, this guide describes: (a) overview of the analysis step, (b) components of the analysis, (c) background considerations, (d) factors to be considered, (e) alternative methods for analysis and (f) resources required.

5.1 Assess Congestion Levels and Reduction Needs

(5.1a) Overview of the Analysis Step.

The first step is to estimate levels of current and projected future traffic congestion within the study area or along the highway corridor, and the extent to which truck traffic contributes to that congestion. This is necessary to establish the potential benefit that could potentially be achieved if some portion of the truck traffic could be shifted to rail freight alternatives.

(5.1b) Components of the Analysis.

There are three factors to be considered in evaluating current congestion and forecasting future congestion levels. They are:

- The *measurement* used for monitoring congestion levels and estimating future levels;
- The process of *modeling of traffic growth* in target areas and corridors; and
- The handling of *reliability effects* resulting from sporadic delays that are known to increase in incidence as traffic volumes approach the design capacity of highways.

(5.1c) Background.

Traffic congestion refers to the slowdown in travel speeds and increase in incidence of traffic backups that grow exponentially as the volume of traffic approaches the design capacity of a road, bridge or intersection. Traffic congestion increases the travel time, operating expense and safety costs of travel. With limited capability to further expand many highways in the future, it becomes particularly important to forecast the expected future growth of congestion so that actions can be taken to mitigate its negative effects.

However, the costs of congestion are often under-estimated because state and regional travel demand and road network models typically focus on average daily traffic conditions and report them for large areas. Unless the analyst requests special reports for small areas, the extent of severe localized congestion will also be missed. Yet even if the analyst requests a report for a specific area or corridor, the measurement of daily average traffic volumes over a 24-hour period will tend to show moderate average volume/capacity ratios and travel speeds, while failing to identify the extent of peak period over-capacity conditions and delays in that area. This makes it particularly important to apply methods that can assess the extent of time-specific and location-specific congestion conditions.

In addition, many state and regional travel network models count only total vehicles and do not track differences in car/bus/truck vehicle mix for specific areas and corridors. That can also leads to an under-estimation of the costs of congestion for two reasons: (1) trucks contribute more to congestion because they take up more road space and require broader separation than cars and (2) the business costs associated with truck delay can be

substantially greater than the economic value of passenger car delay. In addition, options for shifting truck traffic to other modes (such as rail) can be quite different from the options available for shifting car traffic. This makes it particularly important to assess the vehicle mix in congested areas and identify the extent to which trucks contribute to that congestion.

(5.1d) Factors to be Considered.

The analysis of congestion levels considers four dimensions:

- The *spatial pattern* of traffic congestion; delays can be area-wide or location-specific;
- The *temporal pattern* of traffic congestion; delays can occur during morning or afternoon peak periods or during off-peak periods;
- The *stochastic element* of congestion; delays can be on a predictable basis or occur sporadically at random times as a result of traffic incidents (that rise exponentially as volume/capacity ratios increase); and
- The *mix* of vehicles and traffic classes affected; vehicles include cars, buses, and various categories of trucks, while traffic classes include local and through traffic.

(5.1e) Methods for Analysis.

Element #1 - Measurement of Congestion Levels

Congestion measurement can be grouped into four broad classes, which portray congestion levels on the basis of:

- a “congestion index” related to the rate of travel delay (reflecting average speed);
- an “excess delay” measure for urban areas that is tied to total vehicles and minutes spent on facilities operating below a certain level-of-service; or
- the percentage of time at a given point on a highway system that average speed drops below some threshold value.

Exhibit 5-1 provides a more detailed list of the various measures used to assess severity of congestion in a given area. These various congestion measures can be derived from direct observation (discussed here) or application of a travel demand and network models (discussed in the subsection that follows).

A growing number of agencies are monitoring congestion levels via direct observation. Examples of alternative data collection approaches for direct observation are Houston’s Real-Time Traffic Information System (which uses cellular telephone reporting and automatic vehicle identification techniques to record travel times); the TRANSCOMM Electric Toll and Traffic Management Project in New Jersey (which monitors the travel times of specially tagged vehicles); and the ADVANTAGE project in Chicago (which uses satellite global positioning systems and probe vehicles to record travel times).

EXHIBIT 5-1. Measures of Traffic Congestion

Time-Related Measures
Average Travel Speed
Average Travel Time
Average Travel Rate
Travel Time Contours
Origin-Destination Travel Time
Percent Travel Time Under Delay Conditions
Percent of Time Average Speed is Below Threshold Value
Volume Measures
VMT/Lane Mile
Traffic Volume
Congestion Indices
Congestion Index
Roadway Congestion Index
TTI's Suggested Congestion Index
Excess Delay
Delay Measures
Delay/Trip
Delay/VMT
Minute-miles of delay
Delay due to construction/incidents
Level-of-Service Measures
Lane-miles at/of Level of Service Rating "D" or "F"
VHT/VMT at/of Level of Service Rating "D" or "F"
Predominant Intersection Level of Service Rating
Number of Congested Intersection

FHWA; Analytical Procedures to Support a Congestion Management System; Technical Memorandum 1; prepared by Cambridge Systematics; February 1994.

NCHRP Report 463 (NCHRP Project 2-21) is entitled *Economic Implications of Congestion*. That report provided a full discussion of the elements of traffic congestion and alternative ways of measuring it. It can be accessed in two volumes at:

http://gulliver.trb.org/publications/nchrp/nchrp_rpt_463-a.pdf

http://gulliver.trb.org/publications/nchrp/nchrp_rpt_463-b.pdf

To avoid redundancy, readers of this guide are referred to that document for a more complete discussion of congestion measurement.

Element #2 - Modeling of Traffic Growth

The availability of data on actual congestion levels varies from one metropolitan area to another. Data may or may not be available at the level of detail desired, and data may or may not be updated on a regular basis. Highway travel demand models are therefore frequently used to estimate traffic flows and congestion for specific facilities or for metropolitan road networks. Such models also provide a way to forecast future growth in traffic volumes and associated congestion levels. The traditional form of travel demand modeling is the four-step model process of trip generation, trip distribution, mode choice, and trip assignment via computer simulation models. There are also simpler sketch-

planning spreadsheet-based models, sometimes using an approach known as “pivot-point analysis,” to estimate future changes based on the application of growth rates to existing conditions. In general, these modeling methods yield estimates of highway system travel performance metrics in terms of highway volumes, speeds, travel time saved, operating cost changes, and safety effects.

Travel demand models can be used to forecast the implications of alternative future conditions, by changing the assumptions about traffic growth. Thus, they can forecast how a reduction in truck traffic will lead to reduced congestion delays compared to what would otherwise be expected. They also provide a measure of the delay reduction benefit to remaining auto travelers and truck carriers on the affected highways. However, the usefulness of travel demand models for truck reduction scenarios depends on two factors that are not always considered in statewide or regional travel demand modeling systems:

- (1) *The ability of the modeling system to distinguish truck and car traffic changes* – This is important since many regional and statewide highway network models assume a fixed truck/car ratio for all road segments and cannot distinguish the greater congestion reduction benefit that comes from reducing truck traffic.
- (2) *The ability of the modeling system to distinguish concentrations of congestion at particular times and places* – This is important since the severity of congestion delays rises more than linearly as traffic volumes rise, so a system that can hone in on particular locations and peak periods will find greater overall regional congestion than one that only considers daily average region-wide levels.

Since the truck percentage of vehicles on a highway can vary widely (from 2% to 10% or more), it can be particularly useful to observe the current truck share for specific congested areas and corridors, and then be sure that the travel demand forecasts can be used to generate car/truck shares of forecast future traffic. In addition, since congestion can vary by time of day, it can also be useful to observe the current ratio of peak traffic to daily average, and then be sure that the travel demand model can be used to generate peak period forecasts for the specific areas and corridors of interest.

Additional Resources. The Federal Highway Administration’s Office of Operations has produced a web-based report called the *Traffic Analysis Toolbox*, which discusses and describes all the different types of travel demand, traffic forecasting and sketch planning models. It can be accessed at <http://ops.fhwa.dot.gov/trafficanalysistools/index.htm> . To avoid redundancy, readers of this guide are referred to that document for a more complete discussion of the available options for traffic analysis tools.

Regional travel demand models can also be supplemented with corridor-specific peak congestion measurements and truck congestion measurements in order to address the previously cited concerns about limitations of region-wide models. An example of that additional modeling is provided in the 2005 study, *The Cost of Congestion to the Portland Region* available at http://www.portlandalliance.com/pdf/Congestion_Report.pdf .

Element #3 – Handling of Reliability Effects

As the volume of traffic rises beyond 80% and towards 100% of the facility design capacity, there tends to be an exponential increase in the incidence and severity of delays due to non-recurring and unpredicted events such as accidents, mechanical breakdowns, special events or hazardous material spills. Various studies have found that such incidents account for over half of total congestion delays on both freeways and arterial roadways. A variety of other studies have shown that diminishing reliability (increasing variation) in travel time has a particularly high cost for truck traffic, since it affects vehicle delivery schedules. Penalty factors have been developed for application to average time delays in situations where travel time reliability also degrades. Those factors can be used with travel demand models to effectively increase the valuation of time savings benefits for congestion reduction scenarios that also improve travel time reliability.

There is a full discussion of the measurement and modeling of travel time reliability, its valuation and application with travel demand models, in the previously-cited NCHRP Report 463: *Economic Implications of Congestion*. To avoid redundancy, readers of this guide are referred to that document for a more complete discussion of methods to account for reliability impacts of congestion. Readers are also referred to the previously-cited Portland report for case study examples of the impact of congestion-induced travel time reliability degradation on business scheduling costs.

(5.1f) Resources required.

In general, travel demand models involve data such as:

- Forecasts of trip generation rates by households and businesses
- Forecasts of car/truck/bus/rail mode split
- Model specification of road system links and nodes
- Model specification of traffic control data at intersections and junctions
- Observed traffic volumes (counts) on road links (daily or peak/off-peak)
- Observed travel time and speed data
- Observed traffic delay and queue data.

When considering rail freight solutions for traffic congestion, it becomes particularly important to have an ability to distinguish truck shares of traffic on the key congested areas and corridors, and to forecast changes in congestion during peak periods for those areas and corridors.

5.2 Identify Carrier Cost and Service Levels

(5.2a) Overview of the Analysis Step.

This step identifies the carrier costs and service capabilities of rail, truck and intermodal options for moving freight. An understanding of carrier costs is necessary to understand how new projects and facility investments, changes in operations, or new public policies can affect carrier costs. The outcome of this step is then used in a later step to calculate the broader logistics cost associated with use of truck and rail alternatives by freight system users (shippers).

(5.2b) Components of the Analysis.

The analysis of carrier costs and service features is based on a classification of different types of freight carriage, each of which has its own set of cost and service features. The classes are:

- Truckload freight service
- Intermodal (rail/truck) freight service
- Unit train freight service
- General rail freight services

(5.2c) Background.

An understanding of relative costs and prices of the various transport options is essential as a fundamental step for anyone trying to identify useful projects. In recent years, cost and service models have been developed at many different levels of detail. It should be noted that many of the costs shown in this section were originally developed as estimates of transportation costs and/or rates as of the year 2000 or earlier. Costs are now somewhat higher as of the year 2006 and they will likely grow further in future years. Rough estimates of costs, operations, and resource utilization can be extremely helpful in initial planning studies. These estimates are not intended to be used for any specific shipment, and they are certainly should not be used as indications of future cost or price levels.

(5.2d) Factors to be Considered.

The carrier cost and service features are very different for the various classes of truck and rail options, and those differences are reflected in both the “rules of thumb” methods and the more sophisticated costing model methods that are discussed next. However, all of these methods key off of common factors that serve to distinguish the various freight transportation options. Those factors are:

- Length of the average shipment (miles or km)
- Per mile line haul operating costs

- Size of the average shipment (whether it is truckload or less than a truckload, a full train or less than a full train)
- Additional terminal or transfer costs associated with less than truckload or less than trainload shipments
- Frequency and speed of shipment.

(5.2e) Methods for Analysis.

Element #1 - Truckload Freight Movement.

There are many different kinds of trucks to be seen on the highways, but it is only the largest that carry freight that might be divertible to rail. Tractor-trailer combinations that have a capacity of carrying 20 or more tons of freight are commonly used for long-distance trucking. Specialized trucks are used for moving automobiles, chemicals, bulk commodities, and other heavy products that might also be rail competitive. The routes taken and the miles traveled by smaller trucks might relate to the location of industrial plants, warehouses, and retail establishments, so there could be a long-term relationship between the use of rail, the location of such facilities, and the nature of local truck movements. However, discussions of diverting freight to rail must focus on the larger trucks.

Large trucks might be carrying freight to a single customer (truckload or TL) or freight destined to multiple customers (less-than-truckload or LTL). Both TL and LTL are divertible to intermodal and possibly to rail carload services. For LTL movements, railroads can be involved in the movement of a trailer or container of consolidated shipments from one trucking terminal to another; railroads are no longer competitive in terms of the pickup and delivery of the individual LTL shipments. The truck traffic of interest is therefore either TL or the line-haul portion of LTL.

Approach #1 – Overall Rules of Thumb. Distance is an important cost factor. For bulk traffic, as discussed above, railroads can handle even very short trips using a very efficient mini-train. For general merchandise traffic, rail is competitive only for hauls of at least a couple of hundred miles. For these rail competitive movements, the trucking operation is straightforward: drive to the customer's loading dock, load the truck, drive to the destination, and unload the truck.

While costs also vary with the specifics of the journey, trucking costs per mile are predictable. For many years, they have been on the order of \$1 to \$1.35 per mile^{xix} for general freight moving in standard equipment for distances over 300-400 miles. Costs for shorter haul movements depend to a great extent upon the time required to load and unload and the average speed of the highway trip. These factors determine the number of loads per day that can be handled by a truck driver, and that is a more important measure than distance for truckload costs. Interviews with truckers indicated that they need to charge a total of about \$500-525 per day to cover their costs in short-haul service.

The trucking market is highly competitive, prices were deregulated in 1980, and prices have been close to costs ever since. For the purposes of the preliminary analysis, it is probably sufficient to assume that truck costs for a standard tractor-trailer combination are in the range of \$1 to 1.35. However, truck rates have recently been rising, and somewhat higher costs may be needed in future studies.

For specialized trucking, a recent study estimated costs of \$1.35 per mile for system loads and \$2.60 for restricted loads. These costs were obtained from a larger, efficient tank carrier in 2003. System loads were shipments where the company would be able to reload the truck a) because commodities did not contaminate the trailer and limit its next use and b) because the length of haul was long enough to make it worth seeking a back-haul load. Restricted loads were the opposite: the nature of the commodity limited reuse, or the distance was too short to do other than return empty to base. The distance limit was defined by what a driver could do in an out-and-back run, which was about 250 miles each way. Thus, the cost of tank shipments under favorable reload conditions could also be on the order to \$1.35 per mile, but would likely be considerably higher.

Approach #2 – Modeling Cost Components. More precise estimates of trucking costs can be obtained with further knowledge of operating conditions and current costs. The major components of trucking costs fall into the following categories:

- Truck driver costs are on the order of \$0.35 - \$0.40 per mile for long-distance, non-unionized truck drivers who drive in excess of 100,000 miles per year. \$40,000 or more per year applies for unionized truck drivers, who are typically involved in LTL or specialized operations. Both costs have been rising in recent years and are expected to rise higher than the historical rate in order to attract and retain drivers.
- Ownership costs for the tractor-trailer combination are on the order of \$100,000; the tractor might have a useful life in long-haul service of 5 or more years and the trailer should last 10 or more years. Operators of big fleets typically will sell equipment before the end of its useful life. It is an advantage to them to sell tractors after 3-4 years, i.e. before the normal 400,000-mile engine warranty expires. Costs are higher and also rising for specialized equipment, such as refrigerated units or tank-trailers.

The purchase prices can be transformed into a cost per trip as follows:

- Calculate the equivalent annual ownership cost over the expected life of the vehicle assuming a reasonable discount rate (e.g. the weighted average cost of capital for the trucking industry)
- Estimate the number of days per year that the equipment will be utilized
- Divide the equivalent annual ownership cost by the expected number of days the equipment will be utilized to get the daily cost of the equipment
- Divide by the typical number of hours utilized per day to get hourly cost
- Estimate the cycle time, which is time required for the trip, taking into account the hours available for working each day (which can be as high as 10-11 hours per day for six days per week) and the time required for each activity.

Note 1: Positioning the equipment for loading - For most TL traffic, empty repositioning is small, on the order of 10% of total miles. For efficient bulk operations, large trucks cycle between a given origin and a given destination, and the empty miles equal the loaded miles. For general freight, it may be necessary to travel empty 50-75 miles to pick up the next load, independent of the length of haul. Empty mileage tends to be higher for specialized equipment.

Note 2: Loading, Loaded movement and Unloading - Allocate costs to a particular trip by multiplying the hourly or daily cost by the hours or days required.

- Maintenance costs for equipment. Some maintenance costs will vary with time, others with mileage.
- Fuel: Large trucks typically achieve 5-7 mpg (as of the year 2005). Fuel can be allocated on a per-mile basis along with maintenance.
- Tolls can be allocated on a per-mile basis using typical value for a generic trip or actual tolls for a specific route.
- Fees and taxes will vary by state; most can be included in daily equipment costs.
- Insurance costs have driven some smaller fleets out of business.

Some modifications to truck costs can be considered. The rate/ton-mile is what is important relative to mode split, and this can be estimated by dividing the rate by the shipment size or typical payload of the truck. (The 15 tons/load figure cited above is a good factor for general merchandise, but payloads will be higher for commodities that have higher density.) In most states, it is possible to use multiple trailers of various kinds, which will reduce the cost per ton on the order of 10 to 20%.

The service provided by rail competitive trucks is also easy to estimate, since most long-distance trucking uses the interstate system. A trip of up to 500 miles can be done overnight. A trip of 1000 miles can be done in 2 days. Faster service (1000 or more miles per day) can be provided by using two drivers. Long-distance trucking is very reliable compared to rail, so it is usually not necessary to worry about the distribution of trip times.

Low empty mileage and efficient equipment utilization are the keys to low operating costs. In order to maximize loaded-miles and the total weight carried, carriers will sometimes consolidate several loads, often from one origin to several destinations or from multiple origins to a single destination. Congestion is a major concern for truckers, because congestion increases travel time, reduces utilization, and limits the amount of work that can be completed in a day. On a very short-run basis, costs of drivers and fuel are the most important, as the cost of equipment is not a day-to-day issue.

Element #2 – Intermodal Freight Movement.

Intermodal freight involves a combination of trucking for the pickup and delivery ends (drayage), transferring at an intermodal terminal for rail movement for the longer distance line haul travel. In general, intermodal is faster and more reliable than general rail service and cheaper than truckload service. Intermodal service levels are generally similar to those for truck. Additional time is required in the terminals, but trains generally can move traffic further in a day than can trucks. For long hauls, therefore, intermodal can be faster than truck, while for shorter hauls, trucks can be faster than intermodal service. The differences are likely to be on the order of hours, not days. Truck operations also tend to be more reliable, and pickup and delivery times are more flexible, two aspects of service that can be important to some customers.

To evaluate the relative cost of intermodal freight compared to other options, it is necessary to separately consider the three distinct elements of intermodal service: (1) drayage, (2) terminals/hubs, and (3) line-haul.

- Drayage: Costs of drayage are largely comprised of the costs related to the driver and the tractor, both of which are largely proportional to the time required per dray. Hence, draymen focus on the number of trips per day that they can make and they are concerned about taking excessive time to pick up or deliver a container. In addition, there are public concerns with traffic congestion near the intermodal terminal, vehicle-miles traveled within the congested area, and the related effects on noise, air quality, and quality of life along the routes used to access the terminal. Drayage costs can be below \$50 for short hauls, but up to \$500 or more for trips more than 200 miles from the terminal; \$150 per trailer or container is a typical figure. Drayage costs can be modeled in detail using the same approach described in the previous section for trucking costs.
- Terminals/Hubs: Terminal costs include the costs related to the gate operation, lifting containers and trailers on and off the trains, storage of containers, and management of empty equipment. There are economies of scale in intermodal terminals, so that railroads and terminal operators try to concentrate the workload at a few high volume facilities rather than at more, smaller-volume but perhaps better-located facilities. Depending upon the nature and size of the operation, terminal costs can be \$50 to \$150 per lift. Some intermodal terminals also act as hubs where intermodal traffic is transferred between trains. The transfer operation adds to operating costs, but using hubs makes it easier to consolidate traffic and increase train frequencies in key lanes.
- Line haul: Variable line haul costs include the costs of operating the train, the equipment costs for locomotives and freight cars, maintenance costs for the right-of-way, and costs related to communications and control. As of the year 2005, these costs are in the range of \$0.70 to \$0.80 per container-mile or trailer-mile for TOFC (truck on flatcar) or COFC (container on flatcar), but only \$0.40 to 0.50 per mile for

double stack trains. This compares to trucking costs of \$1.00 – 1.35 for TL or the line-haul portion of LTL.

Many of the basic concepts of the competition between truckload and intermodal freight options can be understood in terms of a very simple cost comparison:

$$\begin{aligned} \text{Intermodal – Truck Cost} &= \text{Drayage} + \text{Terminal} + \text{Intermodal Linehaul} - \text{Truck Linehaul} \\ &= \text{Drayage} + \text{Terminal} + (\text{Trk\$/mile} - \text{Int\$/mile} * (1 + \text{circuity})) * \text{Distance} \end{aligned}$$

Since the line-haul costs are fairly constant for competitive distance, the basic question is whether the intermodal savings per mile are sufficient to offset the added costs for drayage and terminal costs. Generally, the trip must be several hundred miles before the line haul savings from intermodal shipment becomes larger than the added costs associated with drayage and terminals.

Factors Affecting Carrier Costs. Lane density is also an important consideration for intermodal operations. The higher the density, the easier it is to provide frequent service to customers and the easier it is to fill up trains. The geography of the region and the location of the intermodal terminals in respect to the lane also are significant cost factors. A substantial drayage of a hundred miles or more is not necessarily a problem, so long as it is in the general direction that the shipment is moving; the distance-related portion of drayage costs would not be much different than if the move were the first portion of a TL move. If the drayage required backtracking a hundred miles or more, then the drayage costs would be a much more significant burden in competing with the direct TL move.

Double-stack has grown dramatically because the line-haul savings are so much greater than they are with TOFC. Instead of a line-haul service that offers a modest saving over TL, doublestack cuts the line-haul costs to less than half of truck costs. Railroads and, in some cases, public agencies, have invested in increasing clearances along the right-of-way in order allow operation of doublestack trains.

Other technological changes are further reducing intermodal costs or flexibility. The RoadRailer technology allows specialized trailers or containers to be hauled in very efficient trains that can be assembled in small terminals without using expensive equipment. There are two primary concepts that have been used in specialized services. The original concept was to use trailers that had a rail axle as well as the traditional highway axles; the axles could be lowered or raised hydraulically in order to assemble and disassemble trains. The extra weight of the rail axle proved to be a competitive burden, as it reduced the load that could be carried on the highways. The newer concept was to use rail “cars” that were basically a pair of axles with a shelf that could hold up a trailer. A forklift could move these bogies around to facilitate train assembly, and the trailers would not have the extra weight of the wheels. A RoadRailer train is remarkable for its low wind resistance, which improves fuel efficiency at higher speeds, and for its very low loss and damage rate. This type of equipment is not quite as efficient as double stack trains, so

it has been used in specialized traffic lanes that lack the volume to support double stack service.

Other innovations that may also change intermodal costs are the Expressway and Rolling Highway classes of equipment, and similar rail systems. These provide what is effectively a long, articulated platform for hauling any kind of trailers, containers, or even tractor-trailer combinations. Like the RoadRailer technology, no specialized terminal lift equipment is necessary and very little space is needed for loading or unloading. This type of technology has been used in Canada for tank and flatbed highway trailers as well as vans, and for many years in Europe to shuttle trucks through tunnels in the Alps. The ability to carry tractor-trailer combinations means that this technology could support other kinds of shuttle services that take highway trucks off the road for movement through metropolitan areas. For example, Chicago Metropolis 2020 has recently recommended that “intermodal bypass service should be developed to shuttle trucks 100 to 400 miles through and around the region.”^{xx}

Element #3 – Unit Train Freight Movement.

Unit train costs are straightforward. The main cost elements are (1) equipment, (2) operations, and (3) track maintenance.

- Equipment costs are generally considered to be the cost of ownership and maintenance, and they are allocated based upon time (for ownership and some maintenance) or distance traveled (for most maintenance). Equipment costs can be allocated to a shipment based upon the cycle time required for the trip and the distance traveled. The modeling approach is the same as described above for TL operations.
- Operating costs include the costs of the crew, fuel, and communications & control. Crew and fuel costs are most important. Crew costs are determined by complex labor agreements, but for most unit train services they will be approximately proportional to train-miles. Fuel costs vary with gross tonnage and the terrain. Track maintenance includes the costs of installing, inspecting, and maintaining rail, ties, ballast, and structures. These costs generally vary with the gross tonnage that is carried. Costs will be somewhat higher if axle loads or operating speeds are higher.

Administrative costs and most other costs are commonly assumed to be fixed costs that can be allocated on the basis of tonnage or shipments.

Unit train service is generally easy to understand, as it operates similar to truckload service. The train operates on a continuous cycle between a shipper and a receiver, making 5-10 or more cycles per month depending upon the distance and the time required to load and unload the train. While average speed might only be 20 miles/hour, this allows unit trains to travel on the order of 500 miles per day, which is competitive with trucks for longer distances. Since terminals are usually bypassed, unit train service is reasonably reliable.

Element #4 – General Freight Train Movement.

General freight service is used when a shipper uses one or more railcars but less than a full train. The resulting service is more complicated to operate than intermodal or unit train service. The main difference is that freight must go through a series of rail yards; at each yard, freight cars are sorted and assembled into trains.

The variable costs of yard operations are on the order of \$25 to \$100, depending upon the size of facility, the complexity of the operation, and the amount of traffic. There are economies of scale and of density, and railroads have long attempted to expand the geographic coverage of their networks while at the same time consolidating switching operations into fewer, larger yards.

General freight service requires the railroad to serve the customer directly. Placement of an empty car for loading, picking up the loaded car, delivering the load and picking up the empty tend to be time-consuming operations performed by crews handling short trains on light-density lines or in terminal areas. Important trade-offs are embodied in two fundamental decisions: how often to provide service on a branch line and how well to maintain the branch line. Higher frequency of service increases crew costs, but lower frequency services leaves cars at customers' sidings for extra days and increases car costs. Lower quality maintenance reduces trains speeds and adds to the time required for switching, but better maintenance can greatly increase costs if there is only a small amount of traffic using the line. The trend since the 1920s has been for railroads to reduce the number of branch lines in order to avoid the high costs of operations and maintenance.

The size of the shipment is a key factor for general freight service. A rail car can typically carry 3-5 times as much freight as a truck, yet the line-haul costs will be similar (i.e. on the order of \$1/mile for boxcar service). Even with the added costs associated with terminals and branch line operations, costs/ton can therefore be much lower than for TL or intermodal. However, the costs are very situation specific: a move involving many terminals and very light-density branch lines can easily be more expensive than going by truck. Also, a move involving short-line railroads can be cheaper than an equivalent move involving one of the larger railroads, because they may have a much different cost structure related to train crews, track maintenance, and other cost factors.

While low cost is a benefit for merchandise traffic, service quality is a major problem. It takes approximately a day for each terminal, and there is a chance of missing a connection at each terminal because of delays or lack of room on the outbound train. As a result, service is slow and unreliable; the typical 600-mile trip takes 6-8 days, which is much longer and far less reliable than truck service. During congested periods, service deteriorates dramatically.

Additional Rail Performance Models.

Besides the “rules of thumb” estimation approaches and more detailed “cost component” approaches discussed in the preceding text, there are also computer models that can be used for rail system cost, performance and supply adequacy. They include:

- Train performance calculators: a TPC calculates train performance (speed and energy consumption) as a function of train and route characteristics.
- Dispatching models: these models predict the movement of trains along a route, taking into account the need for trains to use passing sidings on single track routes, and the need to allow high priority, fast trains (passenger or intermodal) to overtake slower trains. These models can include disruptions related to weather or maintenance; similar models are used by some railroads to assist in real-time dispatching of trains.
- Train scheduling models: these models are similar to dispatching models, in that they create a schedule for trains operating over a route, given the scheduled departure times, route characteristics, and train priorities.
- Terminal performance models: simple models estimate terminal processing time and cost requirements as functions of traffic volumes, schedules, and processing capabilities; more complex simulation models can analyze the effects of changes in layout or processing capabilities on performance.
- Track maintenance models: these models predict maintenance requirements as a function of the traffic mix and volume, equipment characteristics, track components, and maintenance strategies.
- Network simulation models: these models can simulate the operation of a terminal area, a region, or an entire system.
- Rail cost models: service unit costing is commonly used to estimate rail costs; this technique is an example of what is currently called “activity-based costing”, as it relates costs to activities or service units such as train-miles, car-miles, cars handled at yards, and ton-miles.
- Rail service models: these models relate trip times and reliability to schedules, terminal capabilities, and traffic volumes.
- Equipment utilization models: these models predict cycle times for freight cars (which is the number of freight car-days that are required to move a load and to reposition the car for its next load). Fleet sizing, empty car distribution, and fleet management are very important matters for achieving efficient rail service; equipment costs can be very critical for some market segments.

(5.2f) Resources required.

The various types of truck and rail carrier cost estimation methods all require data (or assumptions) about factors such as:

- Typical travel distance
- Vehicle fuel use rate and associated distance-based costs
- Typical travel times and speeds
- Crew or driver time-based costs
- Typical terminal requirements
- Terminal time and expense costs
- Typical vehicle (truck or train car) requirements
- Vehicle ownership and maintenance costs
- Typical taxes, tolls and fees collected by agencies

Realistic data is required to ensure appropriate comparisons of the rail and truck costs for various different classes of freight travel.

5.3 Analyze Overall Logistics Costs

(5.3a) Overview of the Analysis Step.

This step develops estimates of the direct shipping cost and overall logistics cost considerations as viewed by shippers involved in evaluating rail and truck alternatives. The basic concept is that if a project can improve rail service or operating efficiency, then it can potentially reduce logistics costs sufficiently to induce some customers to shift from truck to rail. Alternately, if service is attractive but capacity-constrained, a project could allow utilization of rail by customers in greater volume. However, before modal diversion can be estimated, it is first necessary to develop measures of the logistics cost and service features associated with rail and truck alternatives.

(5.3b) Components of the Analysis.

The analysis of logistics costs involves two elements:

- **Logistics Cost Analysis** to estimate the total cost of shipping via applicable truck and rail freight shipping options;
- **Service Features Analysis** to identify differences in capacity, reliability and other features that also affect the freight mode decisions of shippers.

(5.3c) Background.

Freight flows result from the interaction of many thousands of customers seeking sources for their raw materials and markets for their outputs and many hundreds of carriers offering transportation services. It is therefore useful to view freight transportation as a component of a broader logistics system that includes warehousing, location of factories, choice of suppliers and selection of markets.

Freight shippers and their customers are not necessarily looking for the cheapest or the fastest transportation, but the transportation that best fits their overall logistics objectives. A shipper interested in minimizing total logistics costs will be concerned with various aspects of the services that carriers offer: (a) shipping rate charged, (b) shipment trip time and reliability, (c) size of the shipment, (d) costs to the customer for ordering and paying for a shipment, and (e) costs to the customer for loading and unloading the shipment

Therefore, to understand logistics decisions, it is necessary to understand elements of the service provided by the carriers. For shippers of bulk products, the transportation rate per ton might be the dominant concern. For high valued commodities, where inventory costs are important, customers will also be very interested in shipment sizes, trip times, and reliability. For many situations, ordering costs or loading/unloading costs will be critical. In general, to understand why freight flows on particular modes, it is useful to understand how each carrier's costs and service affect the logistics costs of potential freight shippers.

(5.3d) Factors to be Considered.

Freight mode choice decisions are based to a large extent upon logistics costs, which include ordering costs, inventory costs, loading and unloading costs and loss & damage as well as the rate charged by the freight carrier. (See Exhibit 5-2.)

EXHIBIT 5-2. Elements of Logistics Cost

- Transport Cost** - The amount charged by the carrier(s) for transporting the shipment plus the costs related to any equipment owned by the customer
- Ordering Cost** - The customer's cost associated with arranging and paying for the shipment, which will be a fixed cost for each mode and class of service
- Loss & Damage** - The expected costs related to either losing or damaging some or all of the shipment, which can be expressed as a percentage of the value of the shipment
- Perishability** - The potential for loss of value of the shipment caused by deterioration of the commodity (e.g. fresh fruits & vegetables) or delays in reaching the market (e.g. greeting cards being distributed to retailers for a holiday season); perishability can be expressed as a function that increases rapidly with transportation delays; perishable products might require specialized equipment or warehousing
- Inventory Costs** - Costs associated with holding inventory can include warehousing, insurance, and capital costs; these costs are commonly expressed as a percentage of value of the commodity, e.g. 10-20% of the value of the commodity per year
- *Origin* - Inventory held at the origin until there is enough available to ship to the destination. If production and shipments are uniform throughout the year, then the average amount of inventory at the origin will be ½ of the shipment size.
 - *In-transit* - The capital carrying costs associated with the shipment while it is in transit
 - *Destination* - Inventory held at the destination until it is used. If shipments and usage are uniform throughout the year, then the average inventory will be ½ the shipment size.
 - *Safety Stock* - Additional inventory will be kept to protect against higher-than-expected demand or delays in producing, ordering, shipping, or transporting shipments. The more variable the time between ordering and delivery, the higher the safety stock must be to protect against stock-outs.

Exhibit 5-3 portrays the factors covered in the preceding exhibit into three categories: commodity, customer, and transport characteristics. These factors can be used to estimate the logistics costs for a particular shipment by each of the available modes. Depending upon the situation, options could include express package, air freight, truckload (TL), less-than-truckload (LTL), rail-truck intermodal, rail carload, rail multi-car, rail unit train and barge. Within each of these modes, there could be multiple options regarding shipment size or service quality. For any particular shipment, the choices can quickly be narrowed down to two or three of the most relevant modes.

EXHIBIT 5-3. Factors Influencing Logistics Costs

Factor	Elements Affected
<u>Commodity Characteristics</u>	
Value per unit weight	Inventory, perishability, and loss & damage costs
Density	Shipment size and inventory costs
Shelf life	Perishability
<u>Customer Characteristics</u>	
Annual volume shipped from one origin to a particular destination	Inventory costs (since the average inventory is ½ the shipment size, this fixed cost will be spread over the total annual shipments)
Inventory carrying costs	Inventory costs
Distance (origin-to-destination)	Transportation costs
<u>Mode Characteristics</u>	
Cost per shipment (transport rate)	Transportation costs
Capacity (weight)	Shipment size and therefore inventory costs
Capacity (space)	Shipment size and therefore inventory costs
Trip time	Inventory costs
Reliability	Stock-out costs
Loss & damage probability	Loss & damage costs
Loading & unloading capabilities (manpower, equipment, time required)	Loading and unloading costs

(5.3e) Methods for Analysis.

The logic for logistics cost analysis might be straightforward, but the differing factors and information requirements can be overwhelming, especially when there can be thousands of different types of shipments that might be moving along a congested highway. Clearly, a sound methodology and some simplifying assumptions are needed for dealing with the data problems. In fact, there are four approaches to assembling inputs for a logistics analysis:

Approach #1 - Use “rules of thumb” values prepared by experts for prior studies – The most crude form of logistics cost analysis is to ignore differences among commodities and merely identify the average costs of rail and truck alternatives. For example, rail unit trains generally have a cost of about \$0.01 per ton-mile compared to \$0.025 for general freight service or \$0.05 for heavy trucks. These costs can then be compared to differences in delivery schedule and reliability needed for shipping of the relevant commodities, in order to derive cost-delivery tradeoffs. The limitation of this approach is that it ignores delivery schedule and reliability requirements that are vastly different among various commodities, so it is most useful only when an area’s freight shipments are dominated by one or two commodities (e.g., incoming wood and outgoing lumber or paper products).

The additional importance of delivery schedule reliability for products that commonly move by truck is demonstrated by findings of NCHRP Study 2-18 (*Development of an Innovative Highway User-Cost Estimation Procedure*), which surveyed trucking companies and confirmed findings of prior studies that they place a value on freight transit time savings that is far beyond the equivalent hourly driver wage rate alone. A compendium of value placed on avoiding time delay for truck deliveries is also provided in findings from NCHRP 2-21 (Report 463: *Economic Implications of Congestion*, 2001).

Approach #2 - Use commodity-specific logistic factors prepared by experts - Many studies have been conducted concerning all aspects of logistics analysis for specific commodities. Reports have compiled the characteristics of thousands of individual commodities, giving typical density, shelf life, and value. Studies have documented customer characteristics for many different industries, and the basic parameters of mode performance are well understood. Many prior studies have used general concepts, such as “high”, “medium”, or “low-valued” commodities, and coarse characterizations are likely to be sufficient, at least for preliminary analysis. Therefore it is in fact possible to identify and to use typical values for all of the factors that are required. Care is required in selecting typical values, so this is a task that should be assigned to someone with considerable prior experience.

Approach #3 -Use values from experts familiar with the present study - The next level of effort is to assemble an advisory group for a particular study that includes carrier officials, customer representatives, planners, and consultants. The members of the advisory group might be able to provide guidance concerning what ranges of values to consider for many or all of the various factors that are required.

Approach #4 -Conduct a survey of customers and carriers involved in the present study - Potentially affected carriers and shippers can be surveyed to determine whether the cost and service changes associated with an investment project are likely to influence their modal choices. For example, a study of freight investments in Chicago involved surveys of rail users to estimate expected changes in shipping costs associated with changes in the quality of freight survey (Reebie and EDGR, 2003). These data were used to estimate how costs associated with different investment alternatives were likely to fall on each industry group. These costs were then entered into an economic simulation model as changes in cost of doing business by industrial group. Because businesses were directly asked about how investment scenarios would affect overall costs, the approach implicitly allows for the possibility of modal substitution. Unlike the traditional approach (which focuses only on carriers), this approach captures the different sensitivities of individual sectors to changes in cost structures (i.e., different effects on output and employment depending on competitiveness of market). By assigning cost reductions across industry groups, this approach also accounts for the fact that many firms have in-house trucking services and therefore do not outsource or outsource only a portion of their transportation requirements to carriers. The downside of this approach, however, is the cost and difficulty of obtaining data on shipper responses to changes in freight cost and service, which can only be gathered using survey techniques.

Considerations for All Approaches. Whichever approach is used, it is important to focus on the customers and commodities that are most relevant. When seeking rail solutions for highway congestion, it is only necessary to consider those shipments for which rail and truck are both reasonable options. There are two broad categories of shipments of interest. First, there is a range of containerizable shipments for which rail, truck and intermodal options are the major choices. Containerizable commodities include general merchandise and many other commodities that could move in a boxcar, an intermodal container, or a (normally dry van) trailer. Within this group of potential shipments, rail and intermodal become more attractive as distances increase and as costs become more important to customers than service. The second category of shipments is bulk commodities, with rail increasingly favored over truck as distances increase. Rail options, whether for bulk or for containerizable shipments, become more attractive as annual volumes increase; with higher volumes, inventory costs become less important and the large shipment sizes offered by rail can be used effectively.

Since most freight customers are concerned with minimizing total logistics costs, it is possible to develop a simple mode-split model based upon the factors and relationships shown in Exhibits 5-2 and 5-3. A spreadsheet can be used to compute total logistics costs as a function of the commodity, customer and mode characteristics. The shipment size, which in theory could be continuously variable, in practice will be determined by the characteristics of the equipment. Bulk shipments will fill the truck or rail car to limits imposed by space or axle loads. General merchandise shipments that are rail competitive will generally either be truckload or carload, with loads limited by either space or axle loadings. The economic order quantity (EOQ) can also be used to determine if a smaller shipment size is justifiable because of inventory savings.

It is worth noting that in a head-to-head comparison of intermodal rail against over-the-road truck service, many logistics features will be comparable in the eyes of shippers, and can be canceled out of the calculation because they have an equivalent effect on both sides. Equipment types, order sizes, handling characteristics, and even loss and damage can be negligibly different between the truck and intermodal modes. The logistics factors then simplify down to trip time, reliability, and transport costs. In high service intermodal lanes, the time and reliability differences also may shrink to become less important, allowing for an even greater simplification of the analysis down to cost considerations.

(5.3f) Resources required.

To study the relative costs (and characteristics) of shipping by truck or rail freight, it is necessary to develop data for typical shippers who move freight over a corridor, through a city, or within a region. The data base needs to have customer, commodity, and carrier characteristics for a representative set of movements. Using this data, the logistics costs can be estimated for each mode used, and it will be possible to identify movements where rail can be a viable alternative to truck. The effects of a proposed project, change in operations or new pricing strategy must then be translated into changes in the commodity, customer or carrier characteristics, so that the logistics costs can be re-estimated.

Carriers seldom have access to detailed information concerning the total logistics costs for particular types of shipment. Moreover, they are likely to be thinking in terms of “shipping lanes,” e.g. New York City to Chicago or Atlanta to Jacksonville. Each lane is made up of many different kinds of shipments from many different types of customers. Lanes are relevant to carriers, because they relate to how they organize and manage their operations and their networks.

Shippers can provide information on the cost and schedule reliability characteristics of their shipping services. If data can be collected or estimated for a typical group of shippers, then a logistics cost model can be used to estimate the cost and service characteristics of the competing modes, and that information can be applied to estimate resulting changes in mode shares.

The data base can include actual and/or hypothetical data. The advantage of using actual data is that the study will be more realistic and more believable; the disadvantage is that it may be very time-consuming and costly to collect the data. The advantage of using hypothetical data for typical cases is that the study can produce some results very quickly; the disadvantage is that it may be difficult to ensure that the typical case is truly representative of actual conditions.

For bulk shippers, it may be possible to identify a small number of customers who are currently using truck and who would be excellent candidates for using mini-unit trains. If the shippers cooperate, it will not be difficult to obtain the relevant information concerning the commodity, the customer, and the modal options. For “containerizable” freight, there will be many more potential customers, and a survey will be more difficult.

5.4 Estimate Truck to Rail Diversion

(5.4a) Overview of the Analysis Step.

This step estimates project effects on freight traffic diversion, i.e., the expected level of freight movement that is likely to be shifted from congested roads to new, better, or expanded rail services. It builds on the analysis of logistics cost and service quality features and tradeoffs as identified in the preceding step, to identify the potential for a project to allow some customers to save cost by shifting from truck to rail.

(5.4b) Components of the Analysis.

The analysis of freight modal diversion involves two elements:

- **Mode Choice and Modal Share Analysis** to estimate changes in rail and truck modal shares associated with proposed project investments; and
- **Sensitivity Analysis** to estimate identify the extent to which small refinements in the proposed project can be make rail more attractive than trucks.

(5.4c) Background.

The rail and truck shares of freight trips are the result of decisions by many different shippers. Even within a single company, there may be different transportation requirements for various shipments involving different origins and destinations. For some of these shipments, rail or intermodal could be the obvious choice, but for others, truckload or LTL could be preferred. Hence, shippers and their customers are likely to select multiple freight modes. Policies can be established regarding when it is appropriate to use each mode. There may even be traffic managers who don't ship by rail because of bad past experiences, no matter how long ago and no matter how compelling the economics of using rail. Over a period of years, customers' overall use of rail often changes, partly in response to changes in freight service, but also in response to changes in how they manage their supply chains. Generally, modal choice models work on an aggregate level that ignores the idiosyncrasies of individual firm decisions. Instead, they work by estimating the impact of cost and other shipping changes on the overall share of shipments moving by each mode, given a particular commodity mix.

(5.4d) Factors to be Considered.

Any analysis of existing freight mode split or future freight modal diversion is necessarily based on consideration of six key factors:

- Mix of commodities moving to/from or through the study area or corridor;
- Existing rail and truck mode shares for those commodities and industries;
- Availability of rail options for commodities now traveling to/from the area by truck;
- Carrier service and cost features for rail and truck options (discussed in Section 5.2);
- User logistics costs associated with rail or truck options (discussed in Section 5.3);
- Additional taxes, fees or subsidies that affect decisions about rail or truck choices.

(5.4e) Methods for Analysis.

The analysis of modal diversion can be viewed from two perspectives: (1) from an individual case perspective, in which a *mode choice* model identifies the best and most likely mode choice for a given type of business, commodity and origin-destination combination, or (2) from an aggregate perspective, in which a *modal share* model estimates the overall portion shipments moving by each mode, given a mix of business types, commodity types and origin- destination characteristics. In fact, a common approach spans both perspectives by applying a mode choice model for a representative set of individual cases and then developing a weighted sum of those cases to estimate aggregate mode shares.

In most individual situations, one mode will clearly be the best, so it will be expected to capture all of the freight. Still, there will be many situations where two or more of these models will be close. For policy analysis, it is generally more realistic and more informative to assume a mode will get some of the freight if its total logistics costs are close to the other modes. The modal shares for these cases can be estimated by comparing the total logistics costs for rail, rail-truck intermodal, and truck. Various techniques can be used to estimate modal shares given the total logistics costs for each mode. The math can become complicated, but the logic is simple: if the total logistics costs are about equal, then the two modes should be predicted to each get about half the freight; as the total logistics costs for one mode increase, then its share should go down; if the total logistics costs for one mode are much higher, then it should not be expected to carry any of the freight. Two approaches are commonly used to calculate these shares, and the effect of proposed projects on them:

Approach #1 - Use Logit Models of Discrete Choice Decisions. Logit models, which have been extensively used in modeling mode choice for commuters, are statistical models that allocate mode shares based upon a comparison of the “utility” (estimated overall benefit) of each available mode of transportation. The basic form is as follows:

$$\text{Mode share (A)} = e^{-U(a)} / \Sigma(e^{-U(i)}), \text{ for all modes } i$$

In this equation, U(i) is the utility associated with mode i. For freight analysis, the total logistics cost has most commonly been used as the predominant measure of utility, so that this formulation can easily be used with the logistics cost model.

Approach #2 - Use Statistical Analysis of Logistics Cost Variation. A second approach is to assume that the estimates of total logistics costs are the expected values of a random variable that is normally distributed with a known variance. The mode split can then be thought of as being the probability that the logistics costs of the mode are in fact lower than the logistics costs of the other options. If the estimates of logistics costs are very good, and if the analysis includes all of the variables used by the shipper, then the standard deviation of the total logistics costs will be small (this is the kind of analysis that a shipper will perform – identify the best option and use it). If the estimates of logistics cost are less precise, and if it is unclear that all important elements have been properly included, then the standard deviation of the total logistics costs will be larger (this is the more usual case for a researcher or a planner). The difference in the estimated costs can be compared to the standard deviation of the costs in order to estimate the probability that one cost will be lower than the other. While this requires complex mathematics, spreadsheets typically have a function that will return the probability that a is less than b, under the assumption that a and b are the expected values of normally distributed random variables with a known standard deviation s (in Microsoft Excel, the desired probability is calculated as `NORMDIST((a-b)/s,0,1,true)`).

Policy Analysis. The process of policy analysis involves re-estimating the truck and rail mode shares, using either of the above-cited techniques, while varying the assumed values of costs and service levels associated with those alternatives. This tests the sensitivity of the results to variations in the assumptions. It is useful to show how changes in mode characteristics (e.g. rates or service quality) will affect the split of mode shares.

For example, public subsidies of or investments in rail could be reflected as a change in service, a changes in rates, or a change in loading/unloading costs, depending upon the nature of the investment. Public investment in rail-truck intermodal could be represented by adding an intermodal option or by changing the characteristics of the intermodal option. Public actions that increase costs to highway users (such as tolls) could be reflected in the truck characteristics.

To conduct this type of policy analysis, it is necessary to create a database to represent the profile or mix of shippers and shipments that move freight over a corridor, through a city, or within a region. The database needs to have information related to a sample of O-D movements to which the logistics cost model can be applied. The database will therefore need to have customer, commodity, and carrier characteristics for a representative set of movements. Using these data, the logistics costs and then the mode share can be estimated. The effects of a proposed project, change in operations or a new pricing strategy must be translated into changes in the commodity, customer or carrier characteristics, so that the logistics costs and estimated mode shares can be re-estimated.

Two types of studies can be done, one using actual data and the other using representative but hypothetical data. The advantage of using actual data is that the study will be more realistic and more believable; the disadvantage is that it can be very time-consuming and costly to collect the data. The advantage of using hypothetical data is that the study can

produce some results very quickly; the disadvantage is that it can be difficult to ensure that the hypothetical data are completely realistic. Examples of both approaches are provided in the collection of Project Resources, cited in Chapter 6.

For bulk shippers, it might be possible to identify a small number of customers who are currently using truck and who would be excellent candidates for using mini-unit trains. If the shippers cooperate, it will not be difficult to obtain the relevant information concerning the commodity, the customer, and the modal options. For containerizable freight, there will be many more potential customers, but it will still be possible to conduct a survey in order to obtain representative information concerning commodity, customer, and modal characteristics. For either situation, it will also be possible to use data representing a hypothetical set of customers. This approach can be useful because it allows rapid assessment of the relative merit of various changes in the freight system.

(5.4f) Resources required.

To study the potential for freight traffic diversion, it is necessary to develop profiles of commodity mix, shipper/customer types and carrier price and service characteristics. Then a modal choice or market share model can estimate the shift in truck and rail shares that would result from changes in logistics costs and service levels available from alternative modal options. However, all such models depend on assumptions regarding the mix of customers, shipments, and available carriers. It will normally be much too difficult to attempt a comprehensive analysis of thousands of individual shipments. Instead, it is more realistic to utilize statistical models with assumptions about a given mix or representative set of shippers and shipments.

5.5 Calculate Traffic & Economic Benefits

(5.5a) Overview of the Analysis Step.

This step evaluates the benefits of projects and policies that reduce traffic congestion by reducing truck traffic in those areas and shifting it to rail freight services. There are four distinct perspectives for viewing their impacts and benefits: (a) transportation system efficiency, (b) user benefit, (c) economic growth benefit, and (d) total societal benefit.

(5.5b) Components of the Analysis.

Different analysis methods are required for analysis of benefits as viewed by each perspective. Accordingly, the analysis approaches are discussed separately for each of these four views:

- *transportation system efficiency benefit*, in terms of improved traffic flow and reduced cost for carriers,

- *user benefit*, in terms of reduced total logistics cost for freight shippers,
- *economic growth benefit*, in terms of resulting increase in jobs and income in a local, regional or national economy, and
- *total societal benefit*, including the value of environmental improvements that may be over-and-above any economic benefits.

(5.5c) Background.

Direct “*travel benefits*” associated with transportation investments include out-of-pocket operating cost savings and the value of time savings and safety benefits. These travel benefits are also referred to as “*transportation system efficiency benefits*” since they reflect performance characteristics of the transportation system. In urban planning contexts, these benefits are sometimes also referred to as “*user benefits*,” based on the notion that the vehicle drivers and passengers are the parties using the transportation system and hence benefiting from its improvement). However, freight studies may separately define the full user benefit of freight transportation system changes as the total logistics cost benefits accruing to shippers (rather than just the change in vehicle cost and staff time for the carrier).

Analysts sometimes disagree about the value of measuring benefits as carriers’ cost changes (here referred to as “*freight travel benefits*”) vs. measuring benefits as shippers’ total logistics cost changes (here referred to as “*freight user benefit*”). Both measures can be useful, and they can be seen as different perspectives for viewing the benefits of rail freight projects and programs. The freight user cost impact is more complete in its coverage and is particularly important for calculating truck/rail modal diversion effects and impacts on economic growth.

Freight user benefits, in turn, can have significant impacts on *economic activity*. The diversion of some freight to rail can potentially save operating and safety costs for all affected groups: (a) freight shippers making the switch from truck to rail, (b) freight shippers still relying on trucks using the affected highways, and (c) passenger car and bus travelers who also use the affected highways. The latter two groups benefit insofar as the highways remain less congested than they would have been without any modal diversion.

The benefits for shippers using both rail and truck modes can lead to increased *business productivity* (which is the level of economic activity that can be generated per dollar of labor and materials). That, in turn, can enhance the cost competitiveness, profitability and economic expansion of directly-affected shippers and indirectly-affected firms that are their suppliers and customers. Of course, the extent of these broader economic benefits will depend on the extent to which benefiting shippers, suppliers and customers are locally based within the affected region. To calculate those effects, a regional economic model is necessary.

In the end, the economic expansion of benefiting firms can expand *employment* opportunities and *income* levels for workers throughout the affected region. In addition,

the local communities and states in which investments are made can become more attractive sites for business activity, leading to growth of existing firms and in some cases, greater attraction of new or expanding businesses. Changes in economic activity levels, then, generate *fiscal impacts* on government revenues and costs at the local, state, and national levels.

(5.5d) Factors to be Considered.

The various benefits of encouraging rail freight options in congested highway segments come as a consequence of the following factors:

- Rail and Truck cost and delivery performance changes;
- Overall vehicles and total ton-miles of diverted freight;
- Production cost and market access changes;
- Regional job and income generation by affected industries;
- Air quality and other environmental impacts of traffic congestion reduction.

Each of the methods discussed below relies on some subset of these factors to calculate benefits from a particular perspective.

(5.5e) Methods for Analysis.

Element #1 - Transportation System Efficiency (Carrier Benefit)

Traditionally, transportation system efficiency benefits have been calculated as the sum of traveler savings in out-of-pocket operating costs, time savings, and safety costs (i.e., costs associated with fatal and non-fatal accidents). We can refer to the value of these three types of savings as the overall savings for travelers. Ideally, analyses should capture benefits to all classes of travelers, including (a) existing travelers, (b) “modal diversion” travel changes associated with modal switching and (c) “induced” travel changes associated with changes in length and frequency of travel.^{xxi}

The transportation system efficiency benefits can include travel savings impacts for both highway system travelers and rail system travelers. For analysis of rail freight solutions to highway congestion, though, the main emphasis is on benefits from reduced highway congestion that accrue to existing highway system travelers. However, some rail improvement projects may also bring added benefit for existing rail system travelers. For analysis of passenger-oriented rail projects, such as introduction of high-speed rail, benefits to “diverted” and “induced” users also become important for estimating total travel related benefits. It is also important to note that focusing only on benefits of congestion reduction that accrue to existing highway travelers will provide a conservative estimate of total transportation efficiency benefits.

Calculation of Traveler Benefit. A shift of some truck traffic to rail freight can reduce traffic congestion and improve travel times for all (car and truck) travelers that remain

highway users. The value of the highway traveler benefit *for all car and truck travelers who remain highway users* is calculated as the difference between the higher travel time and expense incurred if no changes were made and the lower time and expense incurred if the project is instituted and congestion is reduced. It can be represented as:

$$\begin{aligned} &[(\text{highway travel time value and expense}_{\text{without investment}}) \\ &- (\text{highway travel time value and expense}_{\text{with investment}})] \end{aligned}$$

If we focus instead on the benefit for all freight travelers (carriers) including both trucking and rail carriers, then the value of the traveler benefit is calculated using information on expected cost changes for rail and truck freight and expected changes in modal share. The total expected savings for existing freight carriers can be calculated as:

$$\begin{aligned} &[(\text{truck freight cost}_{\text{without investment}} \times \text{truck share}_{\text{without investment}}) + (\text{rail freight cost}_{\text{without investment}} \times \text{rail share}_{\text{without investment}})] \\ &- [(\text{truck freight cost}_{\text{with investment}} \times \text{truck share}_{\text{with investment}}) + (\text{rail freight cost}_{\text{with investment}} \times \text{rail share}_{\text{with investment}})] \end{aligned}$$

This, however, only captures the benefits that accrue for current freight travel. For some projects, including large, long-range projects that might take 5 or 10 years to complete, it will be important to capture benefits that will accrue to all future users, i.e., current and expected new users. The impacts of the project on all future users can be estimated as:

$$\begin{aligned} &[(\text{projected truck freight cost}_{\text{without investment}} \times \text{projected truck share}_{\text{without investment}}) + (\text{projected rail freight cost}_{\text{without investment}} \times \text{projected rail share}_{\text{without investment}})] \\ &- [(\text{projected truck freight cost}_{\text{with investment}} \times \text{projected truck share}_{\text{with investment}}) + (\text{projected rail freight cost}_{\text{with investment}} \times \text{projected rail share}_{\text{with investment}})] \end{aligned}$$

Available Modeling Tools. There are modeling tools that can be used to represent transportation system performance and then calculate the total savings in delivery times, operating expenses and accident rates resulting from freight transportation projects. Available models are discussed in the Caltrans Benefit-Cost web site

(http://www.dot.ca.gov/hq/tpp/offices/ote/Benefit_Cost/models/index.html).

Most of the available tools focus exclusively on highway user benefits, though there are a few that also address rail user benefits. Examples of available options are noted below:

- *STEAM* is a well known modeling tool for urban transportation planning that calculates traveler benefits at the regional or corridor levels, and distinguishes peak and off-peak impacts. It then calculates the economic value of those benefits. It can also account for air quality benefits.

State or regional highway network models use more sophisticated network simulation techniques to calculate the highway system benefits of proposed projects, and they can also capture small area changes affecting highway network connectivity and additional benefits of projects affecting connections between highways and special generators such as ports or intermodal rail terminals. Results of highway models can be

translated into dollar values using values as shown in the AASHTO Red Book, or using broader factors that are discussed more fully in the Caltrans Benefit Cost Guide: (http://www.dot.ca.gov/hq/tpp/offices/ote/Benefit_Cost/index.html). It is also possible to automatically perform these calculations using a highway-oriented economic analysis tool such StratBENCOST or Cal-B/C or NET_BC.

- For rail system benefits of proposed projects, the time and cost impacts on carriers and shippers can be calculated based on rail carrier cost and service models that were previously discussed in section 5.2. Detailed examples are provided in the collection of Project Resources cited in Chapter 6. A rail-oriented economic analysis tool, such as RAILDEC^{xxii} can then be used to calculate and assess the relative benefit of alternative rail projects.

It is also possible to allocate freight carrier benefits to industries using them. The most direct way is to utilize USDOT's FAF (Freight Analysis Framework) data that profiles the industries and commodities moving through large regions and along major corridors. The alternative, that is particularly applicable for urban freight cases, is to use the US Bureau of Economic Analysis's TSA (Transportation Satellite Accounts) data, which estimate spending by mode per dollar of output, and multiply it by the actual local profile of business output by industry. The product of these two vectors will yield an estimate of total local spending by mode by industry, which can be used to apportion total carrier benefits to individual shipping industries.

Element #2 – Additional Freight User Impact (Shipper Benefit)

The preceding calculations capture total cost savings for truck and rail carriers. Recent research describes the sequence by which transportation investments can translate into economic efficiency benefits on shippers, who are the true “users” of freight transportation services. By introducing, improving, or reducing freight costs in one or more transportation modes, transportation investments can lower logistics, loading, warehousing and production costs and potentially also provides economies of scale by increasing market delivery areas. So even though cost reductions at carriers may be fully passed on as price reductions for shippers (the long-term trend in the transportation industry), the changes in service levels associated with decreased congestion and improved reliability can also lead to additional changes in operating costs, market opportunities, and behavior at the shipping firms. It has been estimated that the traditional transportation efficiency measure of benefit, which examines only impacts on carriers, underestimates the total value of benefits for freight travel by 10-40% because it neglects additional shipper benefits (FWHA, 2004).^{xxiii} As laid out in the FHWA Freight Benefit-Cost Study (ICF and HLB, 2002),^{xxiv} benefits to shippers can be thought of as occurring in three stages:

- In the first stage (i.e., “short-term”),^{xxv} shippers incur changes in direct transportation (carrier) costs as a result of new transportation projects. Any realized increase in transportation speed and reliability and decline in transportation costs does not affect

the amounts of each type of transportation and logistics service purchased by firms (e.g., rail, truck, marine, inventory, warehousing, administration, customer interactions) but only the prices that they pay for outside transportation services or costs they incur for self-transportation. In this stage, shippers benefit from the reduction in transportation costs but do not change their production or distribution processes—they merely realize a savings on the basket of logistics-related services they already purchase. These savings have been termed “first-order benefits” (ICF/HLB, p.A-12).^{xxvi}

- In the second stage (“medium term”), firms shift the relative proportions of modal inputs to take advantage of the price reduction in one or more modes. That is, an increase in service quality and decline in costs in one transportation mode can lead firms to substitute spending on this mode for other transportation modes (e.g., more rail and less trucking). The logistics models discussed above and other mode choice models capture inter-modal substitutions, i.e., freight diversion. These savings are the first component of what have been termed “second-order benefits” (ICF/HLB, p.A-12).^{xxvii} Preliminary research suggests that to account for second stage (i.e., substitution) impacts, “the benefits found in current benefit-cost models should be increased by about 15 percent to account for these newly measured [i.e., shipper] effects” (FHWA, 2004; p.8).^{xxviii} Diversion will account for most but not all of these effects, which can include gains from modal shifts (i.e., diversion) as well as substitution of (newly-improved) logistics services for other inputs.
- In the third stage (“long-term”),^{xxix} firms can reorganize their entire distribution systems around the availability of better or cheaper transportation services, leading to shifts among the types of logistics-related services purchased (e.g., more reliance on trucking and less on warehousing). Case studies also show that better freight transportation services can eventually spur firms to reorganize their entire distribution process, including (but by no means limited to) introduction of just-in-time systems. This can occur as, for example, a firm that relies increasingly on direct shipment to customers ends up adding investment and staff in computerized tracking systems while reducing warehouse-related labor, inventory and insurance. (FHWA, 2004; pp. 6, A-9, A-10).^{xxx} Although logistics models generally capture inter-modal substitutions, none has been identified that explicitly models substitutions between transportation and other logistics services. Survey approaches that capture both intermodal substitution and substitution between transportation and other logistics services could potentially be designed.

These savings are second-order benefits. The benefits associated with reorganization of distribution will vary according to the size of the transportation cost reduction but can be substantial. Prior studies suggest that when transportation cost reductions are less than 2%, there is little or no measurable impact on shipper benefits, but that at transport cost reduction levels of 20%, reorganization effects can add an additional 9% in benefits (ICF/HLB, p. A-14).^{xxxi} Other potential benefits include additional adjustments in

operations due to reduced need for schedule padding to allow for uncertainty in delivery times.

Related work has identified additional stages related to shipper response to reduced cost of transportation and logistics services. In particular, firms that have reorganized their distribution systems can also reorganize their production systems. For example, firms that develop just-in-time distribution systems can use this change as an entrée to introduce just-in-time production systems. Case studies indicate that savings from introduction of JIT manufacturing methods can create large savings on the assembly line.^{xxxii} However, it is very difficult to predict whether and which firms will reorganize their production systems in advance of transportation investments. To do so would require analysts or firms themselves to be able to predict the types of broad reorganization that could be undertaken years down the road; and to predict how competitors and other related actors (e.g., carriers, suppliers, and customers) would respond. For these reasons, these effects are usually not considered in economic impact studies for major projects.

Calculation of Freight User (Shipper) Benefit. The simplest approach for estimating the total freight transportation user benefit is to start with the measure of freight carrier benefit that was previously defined, and then multiply it by a factor that accounts for the shipper benefits that are beyond carrier cost savings. Based on the cited literature, this would mean adding roughly 15% to account for second-stage effects and 0-10% to account for potential third-stage effects (depending on the size of the transportation cost reduction). Although this approach would yield only a rough estimate of total user benefits and would yield little information on user impacts by industry, it has the merit of being less data-intensive than methods that rely on surveys of shippers and/or additional analyses of likely second- and third-stage effects.

A second approach relies on estimating directly the impacts of transportation improvements on shippers using survey methods. Surveys can be designed to capture estimates of first-, second- and even third-stage cost reductions. Two survey approaches are possible. For the first approach, industry users would be surveyed about the likely cost changes associated with investments and the results directly used to capture shipper benefits. For the second approach, industries would be surveyed about transportation, modal dependence and transportation substitution possibilities to estimate the *relative* benefits likely to accrue to each industry. The relative measures can then be utilized to apportion total expected user benefits to individual industries. This method was employed in the study of freight investments in Chicago (Reebie and EDRG, 2003).

A practical reason to prefer the direct approach is to confirm the sufficiency of benefits to induce modal shift. The previous chapter under "Designing Transactions" prescribed a number of steps for the assurance of traffic volumes. They were founded on the engagement of shippers in first-hand discussions, which ought to begin in the early stages of a project – if for no other reason than information gathering – and should certainly take place before an evaluation is fully developed, in order to demonstrate market acceptance. Quantitative methods of diversion analysis are derived from and are meant to model

shipper behavior; however, they should not replace the direct affirmation by transportation purchasers that a particular service will win their business. Realistically, this can be done just as well during the estimation of diversion as during the calculation of benefits, and at either time can satisfy both purposes. The key thing is for shippers to agree with what the models represent, and ultimately be willing to commit traffic.

Element #3 – Broader Economic Impacts

There are three general types of economic impacts associated with transportation projects: (a) productivity, (b) location, and (c) fiscal impacts.

Economic productivity benefits are those that raise the level of economic output produced per unit of labor and material cost. These come about in two general ways. First, the reduction in the cost of (freight and passenger) transport allows businesses to reduce the cost of inputs required to produce a given level of output or conversely, to increase the amount of output for a given dollar level of inputs. Second, transportation improvements provide businesses access to larger labor, supplier, and customer markets, which results in better cost and quality in terms of inputs and greater economies of scale in production of outputs. Both raise the productivity of economic activity in the affected area and (to a much smaller degree) in the national economy.

Location of economic activity can also be affected by transportation projects. The reduction in costs and increase in productivity in project areas can result in a shift in business activity towards those areas. There is some national productivity gain associated with such shifts because businesses that relocate due to transportation improvements do so in order to experience higher productivity than they otherwise would in their original location (otherwise they would not be moving). However, the impact at a larger national level can be mostly distributive, as a major portion of the gain at the new location occurs as a transfer of activity from another (non-project) area.

Shifts in business location patterns can be viewed as a net national social benefit under two conditions: 1) if the areas that gain growth opportunities have been identified by state or federal agencies as targets for economic development; or 2) if shifts in business location or increased output associated with projects represent net national gains in economic activity. For example, some portion of new economic output and employment in affected areas will be the result of increased exports to foreign markets that come at the expense of foreign rather than other US producers. Similarly, a portion of business location shifts will reflect foreign investors taking advantage of better productive conditions in the project areas. Although some of the foreign direct investment (FDI) stimulated by a project will come at the expense of other US locations, a portion could come at the expense of foreign (i.e., non-US) locations. Thus, where transportation projects stimulate exports and/or FDI, it is likely that some of this increase in output and employment reflects a net national economic benefit.

Fiscal impacts on government revenues and costs can also occur at the local, state, and national levels as a result of various business efficiency and location impacts. Fiscal impacts can be traced to capital, operating, and maintenance expenses associated with transportation investments; and changes in tax revenues from output and employment effects. Input-output and economic simulation models can provide estimates of fiscal impacts associated with user and economic benefits.

Calculation of Economic Impacts. Depending on project budget and the degree of confidence in results that is required, analysts can use different techniques and models to estimate economic impacts.

- If estimates of output impacts from carrier and/or shipper cost savings are available, input-output models (which can be relatively inexpensive) can be used to estimate total employment, output, and fiscal impacts.
- If only estimates of cost savings by carriers and/or shippers are available, economic simulation models can be used to estimate total employment, output, export, fiscal and other impacts.
- Neither input-output nor economic simulation models can capture likely business attraction effects, which must be estimated using a business attraction model or if resources are constrained, estimated based on information gathered from local and state economic development agencies.

Regional economic impact models. Economic impact models are frequently used to convert direct cost savings, market access and productivity effects into broader regional/macroeconomic impacts on measures such as employment by industry, gross regional/state product, and personal income. A listing of economic impact models, with links for further information about them, is provided on the web site of the TRB Committee on Transportation and Economic Development (www.tedcommittee.com). The most commonly-used types of tools are summarized below:

- *Regional Economic Models* - For cases where the primarily impact is on changing business costs, the most frequently used models are regional economic simulation models such as REMI, Global Insight or TREDIS-REDYN models. Sometimes, static input-output models such as IMPLAN and RIMS II are also applied in conjunction with price elasticity response calculations to estimate the full industry impacts of projects. Application of these models for highway and rail transportation projects are summarized in NCHRP Synthesis Report 290,^{xxxiii} and more recent experiences are discussed in Weisbrod (2006).^{xxxiv}
- *Business Attraction Models* – Sometimes, economic impacts accrue from changes in market access as much as from changes in cost. Methods for evaluating those market access effects are discussed in NCHRP Report 456 (Guide for Assessing Social and Economic Effects of Transportation Projects)^{xxxv} and NCHRP Report 463 (Economic Implications of Road Congestion).^{xxxvi} Those market access impact methods are also embedded in business attraction models such as ARC-Opps and

EDR-LEAP (now also part of TREDIS). Their impacts can then also be fed into the regional economic analysis tools noted in the prior bullet item.

Element #4 – Total Societal Benefits

Transportation planners often think of “social benefits” in the context of environmental impact studies, where the term can refer to the non-economic side of “socio-economic” impacts. However, to economists, the term “social benefits” refers to all benefits to society, including time, money, environment and quality of life factors. To avoid confusion here, we also refer to these total benefits as “societal benefits.”

Rail investments have the potential to reduce truck freight movements and thus reduce congestion, maintenance, environmental and other costs associated with truck traffic. These societal benefits of reduced highway congestion can accrue to highway users (crash and congestion costs), non-users (air pollution and noise costs) and government (highway maintenance costs).

The value of societal benefits associated with truck diversion will vary greatly depending on local conditions (“where”), the types of trucks diverted (“what”), and the time of day the diverted freight movement would have occurred (“when”). For example, areas with significant existing congestion or air pollution problems will benefit more from truck diversion than uncongested or less polluted areas; benefits are higher when diverted trips take place during high traffic time slots; and in general, the overall value of truck diversion is much higher in urban than rural areas because of congestion costs. Characteristics of trucks also matter: combination trucks are associated with higher maintenance, congestion, and safety costs than single unit trucks; larger trucks tend to create higher maintenance costs than smaller trucks; and 5-axle trucks create greater pavement and safety costs but contribute less to congestion than 4-axle trucks.

Calculation of Societal Benefits. A report published by FHWA (2000) has shown how the public costs associated with each additional highway vehicle-mile traveled can vary by type of trucks.^{xxxvii} These marginal costs were presented in Step 4 and are reproduced in Exhibit 3-19. As the data in that table show, social costs associated with truck movements can be as high as almost 70 cents per mile for an 80 kip 5-axle combination truck driving in an urban area. In general, diverting a truck mile of freight will reduce social costs by 8 to 20 cents in rural areas and 34 to 70 cents in urban areas.

The costs presented in Exhibit 5-4 provide only an approximation of the type and magnitude of social cost savings that can be expected from truck diversions. The estimates of unit values presented in that table can be applicable when combined with additional information about rail mode alternatives as shown earlier in Exhibit 3-16 (Section 5). However, care must be taken to avoid combining disparate information that compares costs per vehicle-mile and costs per ton-mile, since analysis findings can vary depending on specific size and weight restrictions on trucks and rail cars in various states.

EXHIBIT 5-4. Marginal Costs of Highway Use by Trucks, 2000 (Cents per Mile)

Cents per Mile						
<u>Vehicle Class/ Highway Class</u>	<u>Pavement</u>	<u>Congestion</u>	<u>Crash</u>	<u>Air Pollution</u>	<u>Noise</u>	<u>Total</u>
<i>Urban</i>						
40 kip 4-axle S.U. Truck/Urban Interstate	3.1	24.48	0.86	4.49	1.5	34.43
60 kip 4-axle S.U. Truck/Urban Interstate	18.1	32.64	0.86	4.49	1.68	57.77
60 kip 5-axle Comb/Urban Interstate	10.5	18.39	1.15	4.49	2.75	37.28
80 kip 5-axle Comb/Urban Interstate	40.9	20.06	1.15	4.49	3.04	69.64
<i>Rural</i>						
40 kip 4-axle S.U. Truck/Rural Interstate	1	2.45	0.47	3.85	0.09	7.86
60 kip 4-axle S.U. Truck/Rural Interstate	5.6	3.27	0.47	3.85	0.11	13.3
60 kip 5-axle Comb/Rural Interstate	3.3	1.88	0.88	3.85	0.17	10.08
80 kip 5-axle Comb/Rural Interstate	12.7	2.23	0.88	3.85	0.19	19.85

NOTE: S.U. = Single Unit, Comb. = Combination; Air pollution costs are averages of costs of travel on all rural and urban highway classes, not just Interstate. Available data do not allow differences in air pollution costs for heavy truck classes to be distinguished.

Source: Reproduced in part from Addendum to the 1997 Federal Highway Cost Allocation Study Final Report; U.S. Department of Transportation Federal Highway Administration, May 2000, Table 13.

In addition, actual societal cost savings will be highly dependent on a number of factors, including local conditions; truck and trip characteristics; and expected increases in costs associated with greater freight movements by rail. Thus, the estimates below provide only rules of thumb regarding the expected changes in social cost associated with diversion of freight from truck to rail. In situations where local conditions or truck or rail characteristics are atypical or when the analysis must provide detailed, high-confidence estimates, a separate analysis of social costs should be undertaken using more sophisticated models, such as network optimization and highway capacity models.

Underlying Logic of Societal Impacts - For the purposes of illustrating calculations and reporting of user and economic costs and benefits, the flowchart in Exhibit 5-5 provides an outline of the logic underlying the estimation of project benefits. There are multiple ways to estimate benefits from freight diversion: in the exhibit, “Level 1” refers to methodologies that are generally less time- and resource-consuming than “Level 2” options. Included among Level 1 methodologies are logistics models and marginal cost factors. Level 2 methodologies include surveys of carriers and users, to forecast shifts in mode choice, and diversion, network optimization, and highway capacity models, which can be used to estimate the impact of truck diversion on the highway transportation system. The latter models are quite complex, but are useful in situations where the marginal benefits of truck diversion are high. In these cases, small amounts of truck diversion could have potentially large effects on congestion and social costs because of network configuration or other local conditions (e.g., proximity to an international port). Social equity may also be a factor. Diverting traffic from one congested corridor to a less

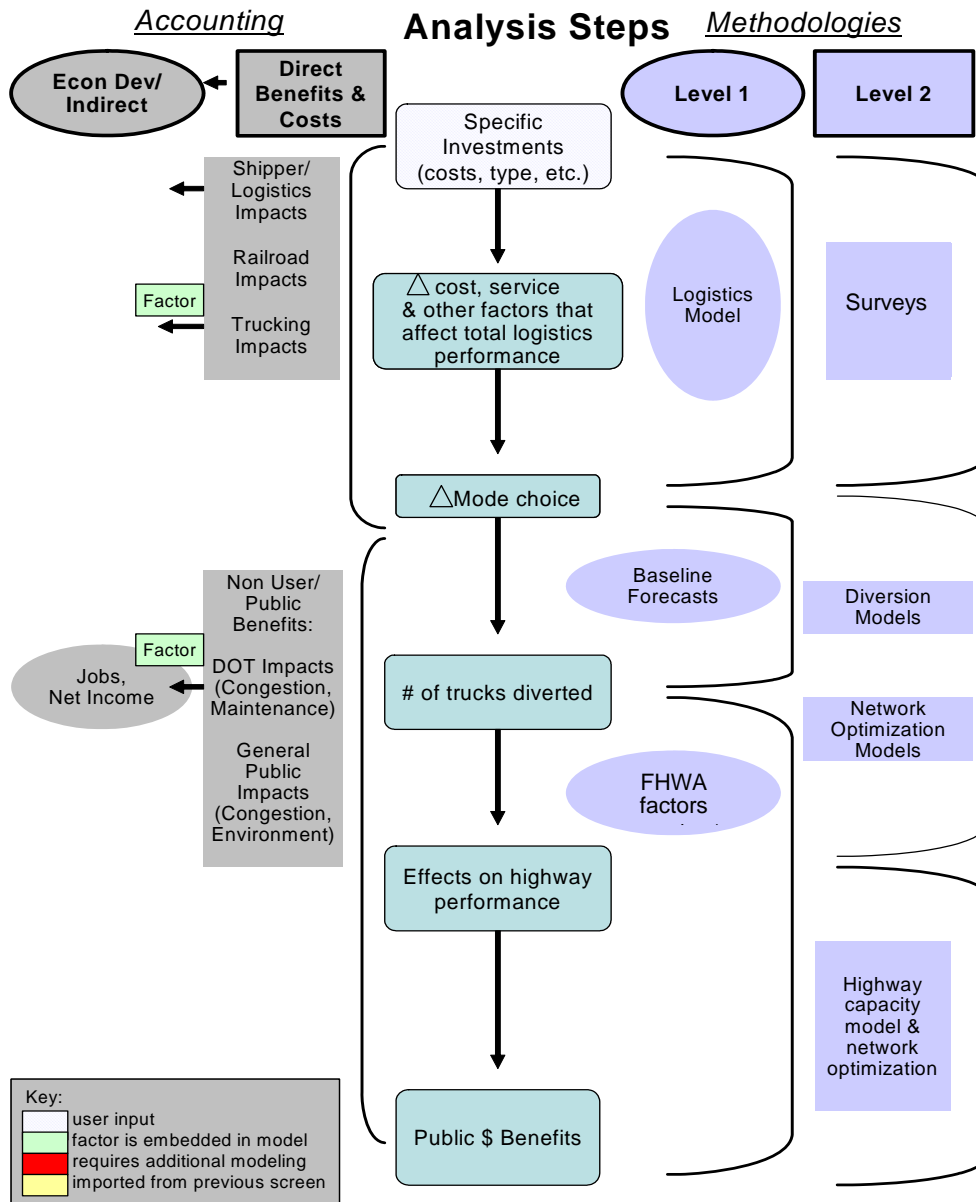
congested corridor, whether by truck or to rail, may increase traffic, noise, and grade crossing incidents in other areas.

For all analyses, the reduction in social costs associated with diverted truck traffic must be compared to any costs (environmental, noise, safety) associated with increased rail freight. In general, railroads should be a good source of information on expected increases in the factors that contribute to these social costs, e.g., crashes, emissions, etc.

Air Pollution Impacts - Special attention should be given to air pollution costs when the proposed investment is to take place in an area that has been designated by EPA as not in attainment with national air quality standards,^{xxxviii} or when the investment will be in a rural area. In non-attainment areas, rail projects that divert truck traffic can have much larger societal cost reductions than the averages. In rural areas, air pollution costs account for 20-50% of total societal costs; in these cases, the accuracy of estimates of social costs will depend strongly on the accuracy of air pollution cost reduction estimates.

In general, freight movements that involve rail are understood to generate less air pollution than those that rely wholly on trucks. The US EPA recently concluded that “For shipments over 1000 miles, using intermodal transport cuts fuel use and greenhouse gas emissions by 65%, relative to truck transport, alone.”^{xxxix} A 2004 study reported that “per ton-mile, trucks emit three times more nitrogen oxide and particulate matter than a locomotive does,” and that despite new regulations on trucks emissions that will be in place by 2007, “for the foreseeable future, freight trains should be considered cleaner and more efficient than tractor-trailer trucks on a per-ton-mile basis.”^{xl}

EXHIBIT 5-5. Elements of the Calculation of Total Project Benefits
 (Level 2 provides a more detailed analysis requiring more time and effort than Level 1)



(5.5f) Resources required.

The calculation of total project benefits can be data and model intensive, especially as the scope of benefits and the scale of analysis is expanded. The types of information and models that may be required are enumerated below. However, an elaborate analysis of every element is by no means always necessary, and it is possible to mix a detailed evaluation of one facet with an estimate of another, if practical conditions require it.^{xli}

Data

- Rail carrier costs per unit of freight movement;
- Truck carrier costs per unit of freight movement;
- Total shipper logistics costs per unit of freight movement;
- Commodity mix and trip distance profile
- Regional economic profile
- Regional air quality conditions

Models

- *Modal Diversion Model* – Forecast of total ton-miles of diverted freight, and resulting change in truck and rail vehicle volumes;
- *User Benefit Model* -- Calculation of shipper cost savings and market access changes;
- *Economic Benefit Model* – Productivity benefit due to cost savings and scale economies from production and market access changes;
- *Regional Economic Impact Model* –job and income generation from freight dependent industries, their customers and suppliers (as viewed from local or national levels);
- *Environmental Impact Model* – Air quality impacts of reductions in traffic congestion;
- *Government fiscal impacts model* – changes in public agency revenues and expenditures as a result of regional economic changes.

5.6 Representation of Benefit-Cost Findings

(5.6a) Overview of the Analysis Step.

The previous step calculated various measures of carrier, shipper, economic, and societal benefits associated with rail freight investments. This final step portrays how these measures can be compared to project or program costs and portrayed in ways that are relevant to the perspective of different affected groups.

(5.6b) Components of the Analysis.

There are four general approaches that are most commonly used to assess and compare the relative benefits and costs of proposed transportation projects. They are:

- (1) cost-benefit analysis,
- (2) cost-effectiveness analysis,
- (3) data envelopment analysis, and
- (4) multi-criteria assessment analysis.

These four types of analysis are discussed here as alternative methods, although they are not mutually exclusive and each of these analysis approaches can be applicable for a different type of situation.

(5.6c) Background.

The cost of implementing rail freight solutions and the various categories of benefit from doing so are not always simple to compare. Exhibit 5-6 can be viewed as a “checklist” of information the analyst may need to represent the full benefits of rail freight projects.

EXHIBIT 5-6. Categories of Potential Project Benefits and Costs

Benefit Category	Railroads	Trucking Companies	Shippers	Government	Public
Operating Costs	X	X	X	X	
Productivity	X	X			
Breakage			X		
Congestion					X
Environmental Quality					X
Safety & Security	X	X	X	X	X
Tax Revenue				X	
Scheduling/Reliability	X	X	X		
Economic Development				X	X
Facility Capital Costs	X			X	
Facility Maintenance Costs	X			X	

The difficulty that is presented by these various cost and benefit considerations are that:

- Some of these factors can be measured in quantifiable numbers easier than others,
- Some of these factors can be monetized in dollar terms easier than others, and
- The incidence of cost and benefits for various parties can be politically sensitive.

These difficulties are the major reason why there are four different approaches discussed here for comparing the relative benefits and costs of rail freight projects and policies.

(5.6d) Factors to be Considered.

The overall value and usefulness of implementing rail freight solutions to road congestion depends on a set of common factors:

- The magnitude of *congestion reduction* that it achieves and the value of that impact;
- The effect that it will have on *freight transportation cost or service quality* for carriers and shippers, and the relative value of the impact on those parties;
- The value of *environmental and quality of life impacts* on the general public;

- The *cost of implementing* the project or policy, and the incidence of those costs for various public agencies, private organizations and the general public.

All of these factors are considered in the four alternative methods that are presented here.

(5.6e) Methods for Analysis.

Alternative #1 - Benefit-cost analysis (BCA)

BCA is the traditional method used by economists for assessing the social value of investments. (It is sometimes also referred to as Cost-Benefit Analysis or CBA.) It examines the benefits and costs associated with a particular project and reports results in terms of two measures:

$$\begin{aligned}\text{Net Benefit} &= \text{Gross Benefit} - \text{Gross Cost} \\ \text{Benefit/Cost Ratio} &= \text{Gross Benefit} / \text{Gross Cost}\end{aligned}$$

Thus, a benefit-cost (B/C) ratio of 1.5 implies that each \$1.00 of project investment will yield benefits valued at \$1.50. Benefit-cost analyses are used in two general ways: 1) to determine whether the benefits associated with a project are sufficient to justify project spending, i.e., the B/C ratio is greater than 1.0; and 2) to rank proposed projects in terms of their return on investment, e.g., a project with a B/C ratio of 1.5 has a higher return per dollar invested than a project with a B-C ratio of 1.4 and a lower return than a project with a B-C ratio of 1.6.

Benefit-cost studies, however, are limited by the requirement that only costs and benefits that can be monetized can be included in analysis. This creates two fundamental limitations. First, there are a number of important benefits associated with transportation investments that either cannot be monetized (e.g., the social benefit of economic development in low-income areas) or that are very difficult to monetize (e.g., more frequent rail stops). Second, results from BCAs are sensitive to judgments about valuation of different benefits. For example, historically EPA and DOT have used different valuations of the expenditures that can be justified by the expected elimination of a premature death, with EPA using \$4.8 million and DOT using \$2.6 million (DOT, 2000). In general, there is no consensus on “correct” valuation of such benefits and evaluation of projects will be sensitive to analysts’ decisions about the proper valuation.

There are two basic shortcomings in the use of BCA for evaluation of rail freight projects. The first is that BCA is designed to aggregate all benefits and all costs for society, without regard to their incidence. In the case of integrating highway and rail investment, the different roles of public agency investment for roads and private investment in railroad functions should be recognized and considered in evaluating opportunities for “win-win” propositions in public-private partnerships.

Available Tools. BCA tools for highway-oriented projects include STEAM, StratBENCOST, Cal-B/C, NET_BC and MicroBenCost. Available tools for BCA of rail-oriented projects include RAILDEC. A more general BCA framework that covers both rail and highway projects is the newer TREDIS system.

Further details on BCA tools and methods are available from existing documents that are widely available:

- Caltrans Transportation Benefit-Cost Analysis web site
http://www.dot.ca.gov/hq/tpp/offices/ote/Benefit_Cost/index.html
- FHWA Cost-Benefit Forecasting Toolbox web site
http://www.fhwa.dot.gov/planning/toolbox/costbenefit_forecasting.htm
- Transport Canada Guide to Benefit-Cost Analysis
<http://www.tc.gc.ca/finance/bca/en/bca.pdf>
- FHWA Asset Management: Economic Analysis Primer
<http://www.fhwa.dot.gov/infrastructure/asstmgmt/primer.htm>

Alternative #2 - Cost-Effectiveness Analysis (CEA)

CEA differs from BCA in that it does not seek to simultaneously evaluate all positive and negative impacts, and it does not require that all positive and negative effects be boiled down to a common measure of dollars. Rather, CEA compares the effectiveness of project alternatives in achieving various individual indicators of desired benefits. For example, CEA can portray the cost per ton of emissions reduction, or the cost per thousand passengers carried.

If most of the costs can be expressed in monetary terms and if most of the benefits can be quantified at least in non-monetary terms, then it is possible to use measures of cost effectiveness that show the cost per unit benefit. This makes it possible to compare different designs and entirely different approaches to achieving quantitative, non-financial goals such as improving air quality and reducing congestion. However, CEA is limited as it examines single dimensions of impact that may affect different parties (such as shippers or transportation providers) and it still does not differentiate coincidence of costs.

In the context of this guide, CEA can be applicable if the primary goals of rail freight solutions are focused solely on reducing aggregate vehicle-time or reducing emissions. However, if the analysis seeks to examine broader impacts on carriers, shippers and the general public, then the other methods are more applicable.

Alternative #3 - Data Envelopment Analysis (DEA)

DEA is related to CEA in that it attempts to compare the effectiveness of alternative projects or programs in achieving results that can be measured, but not in monetary terms. Basically, DEA is a form of graphical analysis that simultaneously displays the

effectiveness of alternatives in achieving multiple criteria. This makes it possible to identify alternatives that are clearly superior to other alternatives at all spending levels, those that can provide greater benefits along all dimensions per dollar of spending at certain levels of implementation, and those alternatives that provide tradeoffs in results.

In public funding of transportation projects, it is seldom possible to reduce the analysis to financial terms, and it will even be difficult to quantify some of the costs and benefits. Therefore, a more elaborate scheme is needed to allow rating of multiple criteria with attention to incidence.

Alternative #4 - Multi-Criteria Analysis (MCA)

The shortcomings of BCA have led to the creation of methodologies that can more easily accommodate and evaluate a range of monetizable and non-monetizable benefits. Chief among these newer methodologies is multi-criteria analysis (MCA), which attempts to consider all benefits associated with a project and weight them according to their importance. This approach is aimed at producing a comprehensive assessment of project benefits. Employing MCA requires that analysts identify all benefits — including those which can be monetized (like reduction in air pollution control costs), those that cannot be monetized but can be expressed with quantitative metrics (like number of jobs that relocate from high- to lower-income areas), and those that cannot be expressed with quantitative measures (like civic pride associated with state-of-the art transportation infrastructure) — and a ranking to weight benefits according to their relative importance. A key example of this last kind of measure is the safety risk perceived by motorists who share the road with large trucks, especially when trucks form a material component of the traffic stream. Quite apart from actual safety performance, these perceptions carry weight in public opinion. MCA has become increasingly popular for transportation “project appraisal” by transportation agencies in Europe and by the World Bank, because of its ability to account for broader societal impacts that cannot be monetized.

Exhibit 5-7 provides an example that uses hypothetical data to illustrate how MCA is operationalized. Three aspects are worth noting.

- First, MCA allows inclusion of variables not normally considered in BCA, such as the job creation and civic pride dimensions just noted.
- Second, project rankings will depend on the weights (i.e., importance) attached to different variables. In the example in Exhibit 5-7, Project 1 yields large reductions in air pollution and high levels of job creation, while Project 2 generates significant growth in personal income and tax revenues. Thus, in the first weighting scheme, which gives the highest weighting to tax revenues, Project 2 is the preferred project. Under weighting scheme 2, however, where job creation and air pollution reductions are valued as highly as tax revenues, Project 1 scores higher.

- Third, variables such as “civic pride”, for which it is difficult to assign a quantitative value, might (as they are in the example) be reported but not used in calculating project scores. Including these variables in the reporting framework, however, could be important to decision makers in cases where competing projects have similar or identical assessment values.

EXHIBIT 5-7. Using Multi-Criteria Analysis (MCA): An Example

	Values:		Weighting Scheme :	
	<u>Project 1</u>	<u>Project 2</u>	<u>Project 1</u>	<u>Project 2</u>
Benefits				
<i>Monetizable</i>				
Tax revenues (\$M)	2	5	3	3
Air pollution reductions (\$M)	10	5	1	3
Personal Income	6	10	1	1
<i>Quantifiable</i>				
Jobs Created ('000s)	3	1	0	3
Jobs Created in Low-Income Areas ('000s)	1	0	0	3
<i>Qualitative</i>				
Civic Pride	YES	NO	1	1
Assessment				
<i>Quantitative</i>				
Weighting 1	22	30		
Weighting 2	54	43		
<i>Qualitative</i>				
Factors	Civic Pride	None		

Like BCA, MCA has its limitations. For example, although it provides a more comprehensive way of ranking the benefits of alternative projects, it does not (by design) yield an estimate of the monetary value of a project’s benefits. As such, it cannot be used to address whether a particular project has a B-C ratio of greater than one, or an adequate financial return on investment.

It is possible, however, to utilize both BCA and MCA for project assessment. For example, an analyst could use BCA to determine which of a set of projects has a B-C ratio of greater than 1.0 and thus, can be justified based on quantifiable benefits and costs. After BCA is used to identify economically feasible/attractive projects, MCA could be used to select the project likely to yield the highest total (monetizable and non-monetizable) benefits.

Available Tools. TransDec (Transportation Decision Analysis Software) was developed as part of NCHRP 20-29 (2) to assist public officials in implementing multi-criteria analysis for multi-modal transportation investment decisions. It also specifically

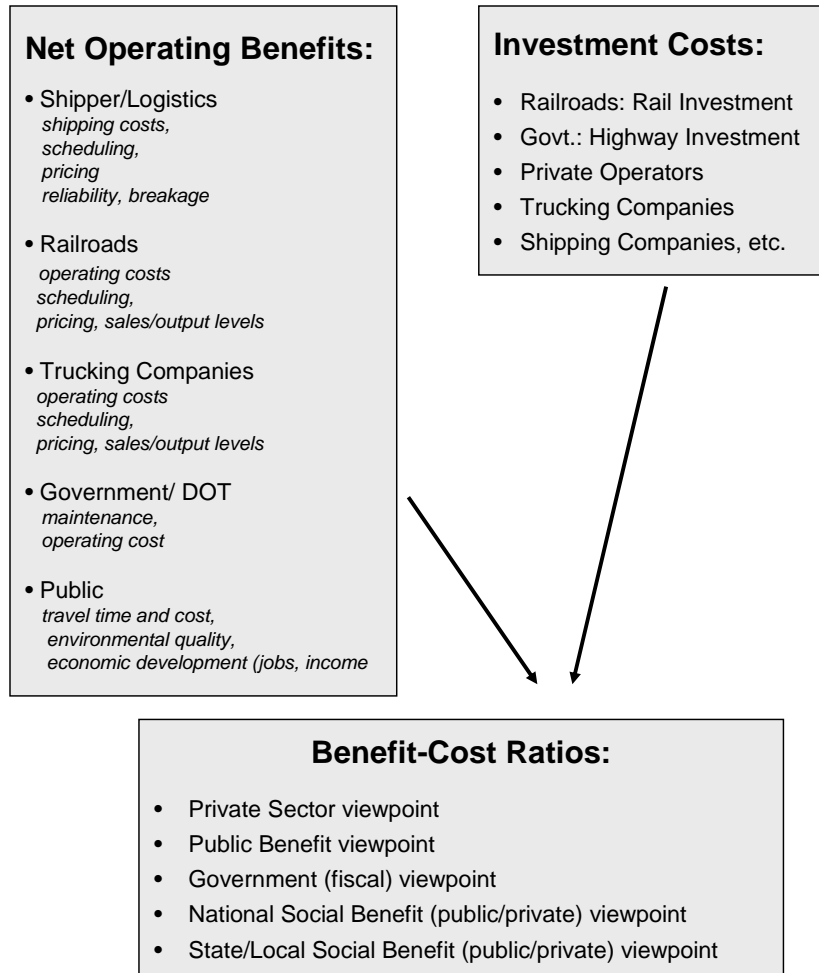
distinguishes freight from passenger transportation effects. It is designed for evaluating transportation investments on the basis of multiple goals that are tied to specific objectives and values. The following types of goals might be considered: (a) improve mobility, (b) improve connectivity, (c) increase cost-effectiveness, (d) increase energy efficiency, (e) improve air quality, (f) reduce resource impact, (g) reduce noise impact, (h) improve accessibility, (i) reduce neighborhood impact, and (j) improve the economy.^{xliii}

Assessing the Distribution of Benefit and Cost Results

Methods described above provide guidance on how to evaluate the overall costs and benefits associated with projects. For many rail freight or other transportation projects, however, a set of related questions is just as significant: namely the proportion of costs and benefits that accrue to different groups. This is especially important in cases where private interests, such as railroads, are seeking public funds for investments; where local or state governments are seeking federal funds; or where private, local, state, and federal interests are trying to determine the appropriate allocation of project costs. In these cases, there are multiple benefit-cost ratios, each of which describes a different perspective or viewpoint.

This is presented schematically in Exhibit 5-8, which portrays the different types of operating benefits and capital costs associated with rail freight projects, as well as the benefit-cost viewpoints that can be relevant for project assessment. Five viewpoints are relevant: private sector; government; public; national social benefit; and state/regional social benefit. These can be measured in the following ways:

EXHIBIT 5-8. Cost-Benefit Accounting



- **Private Sector:** For rail freight projects, the relevant private sectors include railroads, trucking companies, and shippers. Private sector *benefits* include reduction in operating costs and increased revenue. Ideally, change in profit levels (which captures changes in both output and revenue per unit of output) will be used and compared to investment costs to yield an estimate of return on investment (ROI). The ROI, when annualized, should be greater than the current interest rate, which proxies for cost of capital as well as the return on capital if it were invested in a no-risk asset (e.g., certificates of deposit).

In cases where effect on profits is difficult to estimate or where railroads, trucking companies, and shippers have objectives other than profit maximization, then the other metrics above might be more useful. Common objectives for private actors include maximizing sales or gaining market share when establishing a new market or product line. In the highly-competitive rail sector, sales growth is often an important objective. In these cases, the appropriate measure could be volume or market share.

Private sector *costs* are the investments made by railroads, trucking companies, shippers, and private operators in the project itself or in accessing the project benefits.

- **Government:** The direct *benefits* to government are the highway maintenance and operating cost reductions associated with reduced congestion; the reduction, avoidance, or deferral of new highway lane construction, and the increased tax revenues from increased business output and personal income. The costs are the government portion of the project investment costs. Depending on the funding scheme for a project, analysis of more than one level of government (local, state, and federal) could be required. In all cases, it is important to compare investment costs by level of government with benefits that accrue to that level of government. This could require, for example, estimating the portion of maintenance and operating costs paid by state and federal DOTs; and estimating local, state, and federal tax impacts.

Costs to government are generally confined to project costs and if relevant, any increase in operations and maintenance of transportation infrastructure. In multi-jurisdictional projects, the distribution of costs can be different from the distribution of benefits, which is important for the managing agency to recognize.

- **Public:** “Public” benefits can be defined narrowly or broadly, depending on the needs of the analysis. The narrow definition includes the value of changes in congestion, environmental quality, and other quality of life considerations, like noise. The broad definition of “public” recognizes also the costs and benefits that accrue to taxpayers and includes the effects of transportation investments on tax revenues and government spending. For projects that involve more than one level of government - say, state and federal - public costs and benefits can be calculated for the state and national levels.

Under narrow definitions, there are few, if any, public sector costs (perhaps, for example, the inconvenience and noise associated with large-scale transportation projects). Under the broader definition, public sector costs would include costs to local, state, and/or federal governments for project investment and if relevant, any increase in operations and maintenance of transportation infrastructure.

- **Societal Benefits (National):** The national societal benefit is defined as the sum of the social benefits (congestion, safety, air pollution, and noise) and the net national economic and fiscal impacts. To estimate net national economic impacts (as described above), the user should include only those benefits that can be tied to increases in productivity and should ignore economic impacts that are the result of shifts in business location to the affected project area from other parts of the United States. A portion of economic impacts associated with increased trade and foreign direct investment can also be considered as net national impacts. Unfortunately, it is difficult to estimate the portion of new trade and investment activity in the project area that represents new activity in the US, rather than a shift from other parts of the country, and the types of macroeconomic models that are otherwise useful for transportation analysis offer little guidance. As such, analysts will likely have to estimate this

portion or survey local businesses to assess the proportions of their competition that are national and international.

National social *costs* would include all private and government spending on project investment and if relevant, any increase in the costs of construction, operation and maintenance of transportation infrastructure.

- **Societal (State or Local):** The state (or local) social benefit includes all social, economic, and fiscal benefits that accrue to the state. Unlike calculations for assessment of national social benefits, the analyst does not need to be concerned with economic benefits that represent shifts in activity from the rest of the US. From the perspective of the state, all new economic activity is a gain regardless of whether it decreases activity in other parts of the US.

State or local social *costs* would include spending on project investment by local/state firms and the local/state government, as well as any increase in operations and maintenance of transportation infrastructure paid for by local/state governments.

Portraying of Cost and Benefit Incidence

The basic format for measuring and portraying benefits and costs is as shown in 5-9. This format shows the incidence of various time, cost, safety and production related benefits for carriers (“transportation system efficiency”), users (“user cost savings benefit”), and society (“total benefit”). This format is most useful when a breakdown of costs and benefits by general category is needed.

EXHIBIT 5-9. Summary of Benefits and Costs at a Societal Level

(A) Target Year Benefit

Mode	(A) Cost of Transport	(B) Cost of Time	(C) Cost of Accidents	(D) Cost of User Operations	(E) Social & Environ
Truck Freight	xxxxx	xxxxx	xxxxx	xxxxx	Xxxxx
Rail Freight	xxxxx	xxxxx	xxxxx	xxxxx	Xxxxx

(B) Net Present Value of Benefit Stream

Mode	(A) Cost of Transport	(B) Cost of Time	(C) Cost of Accidents	(D) Cost of User Operations	(E) Social & Environ
Truck Freight	xxxxx	xxxxx	xxxxx	xxxxx	Xxxxx
Rail Freight	xxxxx	xxxxx	xxxxx	xxxxx	Xxxxx

(C) Benefit Perspectives

Category	Definition	Design Year	Net Present Value of Stream
Transport System Efficiency	= A+B+C	xxxxx	Xxxxx
User Cost Savings Benefit	= A+B+C+D	xxxxx	Xxxxx
Total Benefit	= A+B+C+D+E	xxxxx	Xxxxx

There are cases where it is also important that costs and benefits be presented in a way that contributes to negotiations and decisions regarding which affected parties should bear the costs. In these cases, a more detailed format, like the one presented in Exhibit 5-10, may be warranted. This table reports costs and benefits by group (e.g., public versus private) and type of benefit (e.g., environmental versus economic development). The latter can be useful if public funding will potentially come from multiple governmental agencies, in which case information about the contribution of a project to different agencies' missions could be useful in negotiations. Getting parties to agree on risk sharing is also important.

EXHIBIT 5-10. Breakdown of Benefit and Cost Incidence Among Various Parties

Project Benefits	First Year Benefit (\$)	Net Present Value (\$)	KEY	
TRANSPORT CARRIERS			 	Private costs/benefits
Rail Net Revenue	 	 	 	Public (non-Gov't) C/B
Truck Net Revenue	 	 	 	Public (Gov't) C/B
Intermodal Net Revenue	 	 		
Shipper/Logistics Net Revenue	 	 		
INDUSTRY SHIPPERS & RECEIVERS			B - C	BENEFIT COST
Industry			Private	
• Transport Costs	 	 	Public	
• Logistics Costs	 	 	Fiscal	
• Production Costs	 	 	Social	
Consumers				
• Prices/Consumer Surplus	 	 		
EXTERNALITIES (IMPACTS ON NON-FREIGHT)				
Congestion				
• Personal Travel--vehicle time	 	 		
• Business--vehicle time	 	 		
• Personal Travel--operating cost	 	 		
• Business--operating costs	 	 		
Emissions (\$ value of tons/year)	 	 		
Safety/Accidents (\$ value)	 	 		
ECONOMIC DEVELOPMENT				
Income in Transportation Sectors	 	 		
Income in Non-transport Sectors	 	 		
Total sales (D,I,I) in Trans Sector	 	 		
Total sales in Non-trans sector	 	 		
GOVERNMENT				
Construction and Maintenance	 	 		
Operating Costs	 	 		
Tax Revenue	 	 		
Project Costs	Cost Per Yr	Net Pres Val		
Government	 	 		
Railroads	 	 		
Trucking Companies	 	 		
Shippers/Logistics	 	 		
Other	 	 		

A common problem in benefit-cost estimation and accounting is double-counting of benefits. Two potential sources of double-counting are:

- ***Change in costs:*** All costs reductions at carriers are realized as either increased profits for the carriers or price reductions for shippers. Research to date has not been able to establish definitively the likely split between profits and prices from cost changes, and it will vary with market conditions. Cost reductions in the rail and trucking freight sectors often get translated into price reductions for shippers, but the extent to which that occurs depends on the commodity and competitiveness of specific routes (General Accounting Office, 2002). When modeling impacts, it is important not to double-count the impacts of cost reductions. As such, the analyst should model cost reductions by reducing the cost of doing business at carriers or by reducing the cost of doing business for shippers in an economic simulation model. When cost reductions are modeled as a change to carriers' cost-of-doing-business, the model will estimate some increase in demand for carrier services. When cost reductions are modeled as a change to shippers' cost-of-doing-business, the model will estimate impacts on shipper output as well as the change in goods and services purchased to meet new output demands. Transportation is one of the goods and services purchased by shippers.
- ***Regional versus national economic impacts:*** As discussed earlier, some of the growth in economic activity in areas with improved infrastructure investment will represent a shift in business activities (sales, output) from other parts of the United States. These generally should not be considered in estimates of national economic gains from transportation investment. Typically, analysts will have to estimate using whatever local information is available the portion of activity that likely represents a shift in national activity rather than a net gain. For the portion of new business activity realized by increases in international trade or foreign direct investment, a larger portion can be considered as new national activity.

(5.6f) Resources required.

The process of portraying incidence of benefits and costs associated with rail freight solutions can go far beyond the direct project cost and the direct effect on congestion levels. It can be shown at many levels, ranging from an overall benefit/cost ratio to a detailed breakdown of the incidence of who the pays the various costs and who receives the various elements of benefit. The choice of how to measure and portray these impacts will depend on the particular project situation and the parties involved. At the simplest level, a spreadsheet process may suffice. At the other extreme, a series of rail performance and highway network simulation models could be employed and linked to a regional economic model to calculate overall impacts, and the results then put into a separate benefit/cost analysis system to calculate the net present value of benefits and costs.

6

ADDITIONAL RESOURCES

Accompanying this guide is a separate collection of *Project Resources* developed as part of NCHRP Project 8-42. This document contains five major sections, along with an introduction, and an overview of the framework structure used here in the guide:

1. Literature Review of Truck, Rail, Freight and Congestion Issues
2. Detailed Case Studies of Rail Freight Solutions to Traffic Congestion
3. Shipper Needs & Structural Factors Affecting Road-to-Rail Diversion
4. Trends Affecting Traffic Congestion and Reliance on Rail Freight
5. Data Sources for Measuring Truck and Rail Freight Characteristics



24 Hartwell Avenue
Lexington, MA 02421
Phone: +1.781.301.9321
Fax: +1.781.301.9402
www.globalinsight.com



2 Oliver Street
Boston, MA 02109
Phone +1.617.338.6775
Fax +1.617.338.1174
www.edrgroup.com

-
- i The authors of this report conducted private studies in the mid-90's that showed this, and are aware of others also done privately that produced the same conclusion.
- ii The lane between Nashville TN and Dallas TX is one of many examples. The 660-mile total distance is a haul length where railroads are active, yet the lane crosses between the service regions of eastern and western rail systems. With a 210 mile run in the east and 450 miles in the west, the business opportunity is less appealing to both carriers.
- iii For example, the break-up of Conrail saw great resistance to higher train volume through Cleveland, OH. In Virginia's I-81 study, the construction of certain routes was ruled out by the state, because of citizen resistance in well-healed rural areas.
- iv Initiated by the Federal Motor Carrier Safety Administration in 2004.
- v An example of this strategy as pursued by railroads is the "logistics hub", described in a trafficWORLD article "Logistics Hubs' Promise", 4/5/04, page 21.
- vi Economic Implications of Road Congestion, Weisbrod, G., D. Vary and G. Treyz. National Cooperative Highway Research Program, Report 463, National Academy Press, 2001.
- vii Text is drawn from NCHRP Report #463; op cit.
- viii <http://www.census.gov/svsd/www/02CFSdata.html>
- ix http://ops.fhwa.dot.gov/freight/freight_analysis/state_info/state_profiles.htm
- x Geofreight Intermodal Display Tool, <http://www.fhwa.dot.gov/freightplanning/geofreight.htm>
- xi http://ops.fhwa.dot.gov/freight/freight_analysis/state_info/state_profiles.htm
- xii Forkenbrock, David J., 2001. "Comparison of external costs of rail and truck freight transportation," Transportation Research Part A; p. 322.
- xiii Forkenbrock, David J., 1999. "External costs of intercity truck freight transportation," Transportation Research Part A; Volume 33, pp. 505-526.
- xiv For example, the Florida High Speed Rail Authority was mandated by state statute to implement a conflict resolution process to handle disputes with environmental and growth management agencies, and with citizens. Florida governmental entities as a whole are encouraged by the legislature to utilize such processes, and several MPOs have adopted programs.
- xv Roger Fisher and William Ury, "Getting to Yes: Negotiating Agreement Without Giving In", Penguin Books, 1983, pg. 42.

-
- xvi Center for Negotiation and Conflict Resolution, Bloustein School for Planning and Public Policy, Rutgers, The State University of New Jersey. The framework is courtesy of the Center's Co-Directors Linda Stamato and Sanford Jaffe, whose advice and assistance in this section of research the authors gratefully acknowledge.
- xvii A partial list of university centers and consortia: University of Colorado, Florida State, Harvard, Michigan, Minnesota, Northwestern, Penn State, Rutgers, Stanford, and Wisconsin.
- xviii The costs presented in both graphics are long-term variable costs, which contain major capital components. When some components fluctuate in price, they affect the weight of other factors. (Fuel is a key example; the graphics represent fuel prices in 2003-2004.) Numbers are calculated per shipment for typical train sizes, implying for instance that atypically short trains would bear a greater locomotive expense, allocated over fewer shipments. Finally, the costs are for a shipment across its entire rail journey (pickup and delivery drayage is excluded). Thus, it will pass through at least two terminals and cross many miles of track. A normal rail project will contribute a portion of such expenses but not all of them, although it will do so for many shipments. As a result, where the chart shows public investment in track and terminals affecting costs that account for 37% of the total, it means that those areas of contribution are substantial in the railroad cost structure, and it does not mean that the public is covering all of those costs. Source: Global Insight, based on the Surface Transportation Board Uniform Rail Costing System.
- xix These figures include fuel costs, but could be significantly higher during periods of fuel price spikes.
- xx "The Metropolis Freight Plan: Delivering the Goods," Chicago Metropolis 2020, 2004, p. 28
- xxi Weisbrod and Weisbrod, p.20
- xxii RAILDEC is a family of software programs designed to evaluate the economic benefits from rail-related infrastructure benefits. It is available from the Federal Railroad Administration.
- xxiii Freight Transportation: Improvements and the Economy. US Department of Transportation, FHWA, Washington, DC; June 2004.
- xxiv Economics Effects of Transportation: The Freight Story. Final Report. ICF Consulting and HLB Decision Economics; January, 2002. Appears as Appendix A in FHWA, 2004, op cit.
- xxv "Short-term" refers to a time period that is short enough that firms do not have a chance to change any factors of production, i.e., cannot change the "recipe" they use to produce and distribute goods. The "long-term" refers to a time period of sufficient length that all factors of production can be changed. The "medium-term" here is used to capture that period that is long enough that some factors of production can be changed (e.g., less warehousing and more frequent deliveries) but too short for all factors to be changed (e.g., changes in capital and labor mix and utilization associated with adoption of just-in-time production schemes). Note that "short-", "medium-" and "long-term" are not used in the ICF/HLB (2002) report, but are introduced here.
- xxvi Op cit.

xxvii Op cit.

xxviii Op cit.

xxix The third stage (or “phase”, which ICF/HRB use) is marked by a shift in shippers’ demand curves in response to new prices and services at carriers.

xxx Op cit.

xxxi Op cit.

xxxii Economic Implications of Road Congestion. Weisbrod, G., D. Vary and G. Treyz. 2001. National Cooperative Highway Research Program, Report 463, National Academy Press.

xxxiii Current Practices for Assessing Economic Development Impacts from Transportation Investments, NCHRP Synthesis 290, TRB, 2000.

xxxiv Weisbrod, Glen: Evolution of Methods for Assessing Economic Development Impacts of Proposed Transportation Projects, paper presented at International Conference on Transportation and Economic Development, 2006.

xxxv Guidebook for Assessing Social & Economic Effects of Transportation Projects, Forkenbrock, D. and G. Weisbrod. NCHRP Report 456, National Academy Press. 2001. (see Chapter 8)

xxxvi Economic Implications of Road Congestion, Weisbrod, G., D. Vary and G. Treyz. 2001. National Cooperative Highway Research Program, Report 463, National Academy Press.

xxxvii Addendum to the 1997 Federal Highway Cost Allocation Study Final Report. U.S. Department of Transportation; Federal Highway Administration, May 2000.

xxxviii To determine the ozone and particulate matter non-attainment status of counties potentially affected by rail projects, go to www.epa.gov/ozonedesignations and www.epa.gov/pmdesignations.

xxxix “A Glance at Clean Freight Strategies,”
www.epa.gov/smartway/documents/intermodal%20shipping.pdf

xl Investing in Mobility, Environmental Defense Fund, 2004; p.40.

xli For example, under Element #2, above, was an FHWA citation to the effect that shipper benefits represent a 10-40% increase over carrier benefits. Thus, in the absence of better information, a detailed analysis of carrier benefits could be multiplied by this factor to yield an estimated range of the benefits to shippers.

xlii NCHRP Research Results Digest 258