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16. Abstract

This project developed a system of evaluative tools for the Texas Department of Transportation (TxDOT) to prioritize its investments in rail-related projects on a statewide basis. This work is meant to ensure that the limited available funding for rail projects is applied in the most beneficial and efficient manner and is focused upon addressing TxDOT's strategic goals. From the findings, researchers recommend a transparent methodology for evaluating proposed rail projects and establishing an initial process through which rail-related investments can periodically be re-evaluated.

Existing project ranking tools were examined and assessed in order to determine opportunities for direct application or adaptation toward TxDOT uses and objectives. A set of performance-based criteria for TxDOT-funded rail projects were developed in the course of the project and adopted into the 2010 Texas Rail Plan. A guidebook to assist local and regional planners in routinely executing the methodology with an example case study project evaluation is also included in the report. Further refinement of the prioritization process will take place under TxDOT's Short Term Rail development process in accordance with the Texas Rail Plan.

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IDENTIFICATION OF PRIORITY RAIL PROJECTS FOR TEXAS-INITIAL METHODOLOGY/USER MANUAL AND GUIDEBOOK

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DISCLAIMER

This research was performed in cooperation with the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA). The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the FHWA or TxDOT. This report does not constitute a standard, specification, or regulation.

The United States Government and the State of Texas do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

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- Sarah Stroman, TxDOT Environmental Division.
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- Joe Adams and Clint Schelbitzki, Union Pacific Railroad.
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CHAPTER 1
PURPOSES FOR A STATEWIDE RAIL PROJECT PRIORITIZATION PROCESS

PRIORITIZATION OF RAIL PROJECTS

Introduction

The need for improved rail systems to facilitate more efficient movement of both passengers and freight is expected to grow dramatically in Texas over the next half-century as the state's population rapidly increases. TxDOT's involvement in rail planning and rail safety has been rising over the past decade in response to this emerging and continuing trend resulting in the formation of a separate Rail Division within TxDOT in late 2009, shortly after this project began. Unfortunately, the funding sources for rail projects available to TxDOT, and other state departments of transportation (DOTs), have been largely limited, both in terms of funding levels and in terms of allowable uses, were greatly restricted up to the time that this project was beginning. For instance, some funds may only allow use toward grade crossing safety improvements, while others may only allow use toward intercity passenger rail capital projects excluding on-going maintenance or operational costs. In Texas, the majority of funding for specific rail projects has historically come on an irregular basis from the state legislature as a "rider" to the general appropriation bill rather than on a programmed and regular basis to be applied statewide in order to address overall TxDOT goals.

Several new sources of rail funding at the state and federal levels have emerged in recent years that have allowed state and local TxDOT planners and their partners at Metropolitan Planning Organizations (MPOs), Regional Mobility Authorities (RMAs), and Councils of Governments (COGs) more leeway in allotting project dollars over time to provide needed rail improvements. Table 1 shows several examples of such new funding sources. Because of the backlog of worthy rail projects and the high cost for implementing each one, there is a great need to develop a transparent and straightforward system by which TxDOT can prioritize among the many possible projects to select those that best meet the goals of the TxDOT Strategic Plan.

As a result of funding restrictions and limitations, the distribution and level of funding for rail projects has remained largely both ad hoc and opportunistic—taking advantage of rail funding when it is available and applying it to any allowable purpose, but without an established rail transportation project prioritization and ranking process that has the flexibility to strategically invest in both passenger and freight rail projects where they could be most effective and beneficial. TxDOT rail planners have realized that there is a need to transition to a more transparent process that can incorporate selection and funding of rail projects that can both address rail system needs and promote the overall, strategic goals of TxDOT across all transportation modes. This project developed an initial process for ranking rail projects and doing so at the statewide level.

RECENT AND TRADITIONAL FUNDING SOURCES FOR RAIL PROJECTS

Table 1 shows several new funding sources that have only recently become available to states for rail projects. Table 2 lists several major categories of rail funding that have traditionally been available to state DOTs. The rail funding picture is a complex issue in which any prioritization method must be able to interpret and address that complexity appropriately. Each of the funding sources listed in these tables involves matching of federal funding with non-federal funds in varying percentage combinations. The needs for states to have eligible matching funds adds additional complexity in decision-making in terms of which projects will allow the limited rail-related funding to be engaged in its entirety (i.e., not leaving available dollars on the table) while at the same time maximizing total benefit from those funding sources selected. Put another way, if a state chooses to spend all of its available matching funds on one or two large, beneficial rail infrastructure construction projects, many worthy, but smaller projects must be forsaken or delayed.

Table 1. New/Emerging Rail Project Funding Sources.

Potential Funding Source	Description/Types of Projects
Rail Safety Improvement Act of 2008	Section 105: Rail Safety Technology Grants • Grants to states and passenger and freight railroad carriers for the deployment of train control technologies. • Authorized $50 million per year between 2009 and 2013. • Federal Match: 80 percent. Section 207: Highway-Rail Grade Crossing Safety • Grants to states for safety improvements at highway-rail grade crossings, including active warning devices, highway traffic signals, highway lighting, and related projects. • Authorized $1.5 million per year between 2010 and 2013. Section 418: Railroad Safety Infrastructure Improvement Grants • Grants to states, local governments, and railroad carriers for safety improvements to railroad infrastructure, including track, bridges, passenger facilities, and yards. • Authorized $5 million per year between 2010 and 2013. • Federal Match: 50 percent.
Passenger Rail Investment and Improvement Act of 2008 (PRIIA)	Section 301: Capital Assistance for Intercity Passenger Rail • Grants to states or a group of states for capital projects related to intercity passenger rail service, including track and structures, rolling stock, and planning activities. • Authorized $100 million for 2009, increasing to $600 million for 2013. • Federal Match: 100 percent. Section 302: Congestion Grants • Grants to states for intercity passenger rail service for capital projects that are expected to reduce congestion or facilitate ridership growth in heavily traveled corridors. • Authorized $50 million for 2010, increasing to $100 million for 2013. • Federal Match: 80 percent. Section 501: High-Speed Rail Corridor Program • Grants to states or a group of states for capital projects associated with the development of high-speed rail service, including track and structures, rolling stock, or planning. • High-speed rail service defined as intercity passenger rail service reasonably expected to reach speeds of 110 MPH. • Authorized $150 million for 2009, increasing to $350 million for 2013. • Federal Match: 80 percent.
American Recovery and Reinvestment Act of 2009	Appropriated $8 billion for the Section 501. High-speed Corridor programs authorized by the PRIIA as described above and an additional $1.3 billion for Amtrak. The Transportation Investment Generating Economic Recovery (TIGER) Discretionary Grant program is one provision of this act that has been used to fund rail studies/projects throughout the U.S.
Texas Rail Relocation and Improvement Fund	Capitalization of this fund by the Texas Legislature would potentially fund several hundred million dollars in rail relocation or other rail improvement projects throughout Texas through bonding of the annual or biennial appropriation. Future funding amount is unknown at this time.

Table 2. Major Existing/Traditional Public Funding Sources for Rail Projects.

Funding Source	Matching Funds Requirement
FHWA Section 130 Highway-Rail Grade Crossing	90% federal 10% state/local
FHWA Surface Transportation Program (STP)	80% federal 20% state
FRA Intercity Passenger Rail Improvement Grants	50% federal 50% state (could change to 80%-20%)
FHWA High-Speed Rail Hazard Mitigation Funds	
FHWA Congestion Mitigation Air Quality (CMAQ)	
Transportation Innovative Finance and Investment Act (TIFIA) Loans	Varies
FRA Railroad Rehabilitation and Improvement Fund (FRA RRIF)	Varies

Implementation Focus

Implementation of an accepted rail project appraisal and prioritization methodology into TxDOT practice is the paramount goal of this project. In order to achieve this goal, the research team engaged TxDOT and other statewide stakeholders to ensure that the project appraisal methodology becomes a staple in TxDOT's planning process and, more specifically, an integral part of its state rail planning process.

As the methodology is adopted within TxDOT, this report/user's manual and the attached guidebook will play a critical role in communicating to local and regional planners (and/or private railroad companies) the types of projects that meet the desired performance-based criteria and are eligible for TxDOT funding or for TxDOT assistance as part of a public-private partnership. A recurring process such as a "program call" similar to the federal enhancement program may be recommended as a method for periodic re-evaluation and re-prioritization of rail projects to address emerging conditions. Alternatively, a state-level process similar to the federal transit "new starts" program may be developed through which an extensively detailed system of known, evaluative criteria is provided to local/regional planners before advancing the project to TxDOT for statewide competition and prioritization. In either case, only those rail projects that maximize the strategic goals of TxDOT and meet the needs of Texas should be considered by TxDOT and advanced to the funding phase.

CHAPTER 2
REVIEW OF PREVIOUS RAIL PROJECT RANKING/EVALUATION METHODOLOGIES

REVIEW OF EXISTING PROJECT EVALUATION METHODOLOGIES

The research team conducted a literature review focusing on pertinent literature related to successful and systematic implementation experience of rail project evaluation and prioritization tools at the national and state levels as well as international methods for ranking projects. The following is a short summary of those prospective methodologies that were identified during the review. A more detailed summary was submitted in Technical Memo 2 for the project. Each program description consists of the interesting features associated with that particular method. Many of the ideas from these programs went into the development of the overall evaluation program recommended for TxDOT and incorporated into the 2010 Texas Rail Plan.

National Level Evaluation Processes

Transportation Decision-Making (TransDec) Analysis- TTI/NCHRP 20-29

At the U.S. national level, the Transportation Decision Analysis System (TransDec) developed by TTI is a computer-based tool to perform multi-criteria transportation decision analyses by following broadly defined project goals that are tied to specific objectives with each objective and an assigned value measure. Each TransDec analysis proceeds according to the following steps:

1. Identifying overall transportation policy goals (e.g., safety, environment, mobility, cost effectiveness).
2. Identifying project evaluation objectives for each goal (e.g., increasing highway safety, decreasing environmental contamination).
3. Assigning a measure to each objective (e.g., annual highway traffic deaths, annual emissions of criteria air pollutants).
4. Assigning a rating scale to each objective's measure.
5. Identifying alternatives.

6. Weighting each objective (direct, pairwise, swing, and standardized).
7. Normalizing the data (0- to 10-point value scale); and performing a sensitivity analysis (*1*).

Highway Freight Logistics Reorganization Benefits Estimating Tool- FHWA

The Highway Freight Logistics Reorganization Benefits Estimating Tool is a Microsoft Excel®-based tool developed by HDR Decision Economic under the direction of the U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations to estimate additive freight benefits resulting from highway performance improving investments (*2*).

Guidebook for Assessing Rail Freight Solutions to Roadway Congestion- NCHRP Report 586

The second part of NCHRP Report 586 provides *A Guidebook for Assessing Rail Freight Solutions to Roadway Congestion*, which follows three phases of initial screening, identifies situations where rail might help and the expected benefits associated with congestion relief; detailed analysis, includes rail cost of performance analysis, logistics cost, or mode-split analysis, highway performance analysis, and economic and financial evaluation; and decision-making support, which focuses on using procedures to compare alternatives in a broader context (*3*).

Transportation Economic Development Impact System (TREDIS)- Economic Development Research Group, Inc.

The Transportation Economic Development Impact System (TREDIS) is a web-based, proprietary analysis system that is used to assess the expected economic impacts of statewide multimodal transportation investments, including highway, bus, rail, aviation, marine projects, and multimodal projects by calculating different forms of impacts and benefits of transportation projects. The system includes five modules: the travel cost module, the market access module, the economic adjustment module, the benefit-cost module, and the tax impact module (*4*).

Guide to Quantifying the Economic Impacts of Federal Investments in Large-Scale Freight Transportation Projects

The Guide to Quantifying the Economic Impacts of Federal Investments in Large-Scale Freight Transportation Projects provides an economic analysis framework to assess the benefits and costs of potential large-scale freight investments, such like rail, roadway, air, or marine modes of travel. The economic analysis framework follows a five-step analysis process:

1. Identifying the nature and transportation purpose of the project in terms of its intended impact on improving freight non-freight travel conditions.
2. Identifying the nature of expected economic impacts in terms of the elements of the economy that feel they have a stake in seeing the project occur.
3. Applying transportation impact evaluation tools to assess the magnitude and nature of transportation system performance effects actually projected to impact shippers and carriers.
4. Applying economic impact evaluation tools to assess the magnitude and nature of economic effects actually projected to occur for elements of the economy that are either directly or indirectly affected by freight system costs and performance.
5. Applying decision support methods to identify the substantial positive and negative impacts of the project for the economy (at the local/state or national level) (*5*).

State-Level Evaluation Processes

Washington DOT Rail Benefit/Impact Evaluation Methodology

The Washington State Department of Transportation implements the Rail Benefit/Impact Evaluation Methodology, which focuses on the benefit-cost analysis with major evaluation categories of transportation and economic benefits (reduced road maintenance cost, shipper savings, and reduction in auto delays at grade crossing), economic impacts (new or retained jobs, tax revenues), external impacts (safety improvements, environmental benefits). With the benefit-cost ratio determined, the legislative priority matrix, the project management assessment matrix, and the user benefit levels matrix are used for the prioritization purposes (*6*).

Louisiana Freight Rail Project Evaluation Methodology

The Louisiana Department of Transportation and Development adopts a priority rating system to identify and prioritize rail projects in five categories:

1. Economic benefit to the state.
2. Non-economic benefit to the community (including safety, congestion mitigation, noise and vibration reduction).

3. Project type.
4. Facility usage by number of railcars per year.
5. Bonus points (including federally supported project, sponsor funding in excess of requirements, designated as special project, passenger rail impact, and phased project) (*7*).

Florida Freight Stakeholders Task Force Report

The 1999 Florida Freight Stakeholders Task Force Report identifies, prioritizes, and recommends freight transportation projects for fast-track funding. The major factors considered in this report for the planning and evolution of projects include economic factors (time savings, running cost savings, accident cost savings, typical cost); environmental factors (impact on environmental resources); and social and community factors (impact on the community). A scoring system is adopted to prioritize potential funding with criteria of benefit-cost ratio, stage of development/environmental compliance, estimated time to complete project, capacity changes, safety factor, projected neighborhood impacts, and daily freight volume in truck trailer equivalent units (*8*).

Vermont Transportation Project Prioritization and Project Selector

The Vermont Agency of Transportation developed a project prioritization approach that assigns a numeric score for transportation projects. The Vermont transportation project prioritization and project selector scoring criteria include: railroad freight operations, railroad passenger operations, line conditions, operational costs, facility standards, priority route, Vermont based activity, governmental and local support, economic development, documented non-state funding opportunities, resource impacts, regional scope, utilization of resource, and general safety (*9*).

Project Prioritization Methods Developed for/Used in Texas

TxDOT Public-Private Feasibility Analysis Model

The TxDOT Public-Private Feasibility Analysis Model provides stakeholders with a transparent assessment of public-private partnership funding transportation infrastructure projects. Built on a Microsoft Excel platform, this model has both public and private worksheets to calculate respective costs and benefits of specific projects (*10*).

Multimodal Analysis Freight Tool (MAFT)

The Multimodal Analysis Freight Tool (MAFT) is a sketch planning tool providing a Cost-Benefit Analysis framework with default values to appraise multimodal freight investment alternatives by TxDOT. MAFT considers three categories of costs: land and acquisition costs; construction costs; and operations and maintenance costs; and five categories of benefits: travel time benefits (time saved, value of time); vehicle operation cost savings (fuel, maintenance and tire costs); agency operation cost savings (maintenance cost savings); safety benefits (number of fatalities, number of injuries, and the cost of property damage only accidents); and emissions benefits (hydrocarbons [HC], carbon monoxide [CO], and nitrous oxides [NO_x]). There are four accepted methods for comparing costs and benefits: the net present value of the project, the internal rate of return, the benefit-cost ratio, and the payback period. Each impact statement is scored on a scale of 1 to 5, with a score of 1 indicating either very high cost or low benefit, and a score of 5 indicating either very low cost or high benefit. The scores are then summed for the all the impact categories, and highest scoring investment alternative is regarded as the most beneficial (*11*, *12*).

Texas Measures of Effectiveness for Major Investment Studies

The Texas Measures of Effectiveness for Major Investment Studies in 1996 developed guidelines for selecting appropriate performance measures for use in a transportation investment study. The performance measures were used to quantify the benefits or impacts of transportation improvements in five basics categories: transportation performance, financial/economic performance, social impacts, land use/economic development impacts, and environmental impacts (*13*).

International Rail Project Ranking Methodologies

Railway Project Appraisal Guidelines (RAILPAG)

Internationally, the Railway Project Appraisal Guidelines (RAILPAG) is the first example of joint effort between European Commission (EC) and the European Investment Bank (EIB) to provide a guide for analysts performing evaluations and as a benchmark for policy makers to judge the quality for appraisals. RAILPAG begins with traditional benefit-cost analysis (BCA) as a screening process but goes beyond this measure to encompass social, political, and economic benefits tied to the projects as well. The RAILPAG report describes the process as having three phases:

1. Defining the problem and choosing reasonable alternatives.
2. Performing a thorough BCA of these alternatives, supported by demand studies and a discussion of the distributional effects of the project including a matrix of stakeholder ranking of project evaluation factors.
3. Analyzing each alternative solution and comparing them, expressing their relative values leading to recommendations for the decision-makers (*14*).

Harmonized European Approaches for Transport Costing and Project Assessment (HEATCO)

Twenty-five European countries were included in the Developing Harmonized European Approaches for Transport Costing and Project Assessment (HEATCO) project in 2005, the purpose of which was to develop harmonized guidelines for transport project assessment. The factors considered by these countries in the cost-benefit analysis for transport appraisals include: construction costs; disruption from construction; costs for maintenance, operation and administration; passenger transport time savings; user charges and revenues; vehicle operating costs; benefits to goods traffic; safety; noise; air pollution-local/regional; climate change; and indirect socio-economic effects (*15*).

Some of the transportation project evaluation and prioritization tools developed by federal and state agencies and private companies provide methodologies and criteria applicable for multimodal projects, while many are applicable for just a specific mode. Based on the literature review, a list of proposed performance measures was developed under each TxDOT strategic goal for the project monitoring committee to review and provide feedback. These are discussed in Chapter 3.

CHAPTER 3
EVALUATION CRITERIA

Development of a project evaluation process for all types of rail projects presented several challenges. The evaluation factors and weighting of importance may vary greatly depending upon what type of project is being considered. One part of the project was for the research team to look at common factors across many different types of proposals. A comparison of evaluation measures for freight rail projects resulted in a Transportation Research Board (TRB) paper that is attached for information as Appendix A. A more elaborate and extensive discussion and study of an array of available tools, their requirements, issues, strengths, and limitations for use on freight projects across all modes is provided in the TRB National Cooperative Freight Research Program (NCFRP) Report 12 *Framework and Tools for Estimating Benefits of Specific Freight Network Investments,* prepared by Cambridge Systematics, Inc. and published by the Transportation Research Board. This NCFRP project was going on at the same time as this project.

The research team took into account the results of the overall literature review and developed a list of 11 common evaluation criteria in three broad categories that TxDOT should consider when evaluating rail projects. The three categories are Sustainability, Transportation, and Implementation. A more exhaustive explanation of the criteria and how they can be applied is included in the guidebook, which is included as Appendix B.

Throughout the criteria development process, input from the Rail Division and the project advisory committee, informed and impacted the ultimate products. As an example, Table 3 shows the 11 criteria initially proposed by TTI. Table 4 shows the criteria that were ultimately adopted into the 2010 Texas Rail Plan by the Texas Transportation Commission after input from the TxDOT Rail Steering Committee (made up of stakeholders from around the state) and from TxDOT Rail Division staff.

Table 3. Originally Proposed Project Evaluation Criteria by Categories.

Sustainability	Transportation	Implementation
1. Cost Effectiveness 2. Economic Impact 3. Environmental/Social Justice 4. Safety and Security 5. Asset Preservation	6. Connectivity 7. Mobility 8. System Capacity	9. Project Readiness 10. Partnerships 11. Innovation

Table 4. Texas Rail Plan Adopted Project Evaluation Criteria by Categories.

Sustainability	Transportation	Implementation
Economic Impact	Safety and Security	Cost Effectiveness
Environmental/Social Impact	Connectivity	Project Development
Asset Preservation	Congestion Relief	Partnerships
	System Capacity	Innovation

Additionally, each of the adopted criteria in Table 4 may be broken down by appropriate sub-criteria and evaluated by asking a number of questions as shown in Table 5. Table 5 also links each criterion to a specific primary and secondary TxDOT Strategic Goals. These links of each criterion to strategic goals will be discussed further in Chapter 4.

CRITERIA DESCRIPTIONS

The evaluation criteria are organized into three broad areas—sustainability, transportation, and implementation—and organized below in accordance with the alignment of criteria adopted in the November 2010 Texas Rail Plan. A short explanation of the scope of each criterion is listed below. A more thorough explanation of each of the criteria is included in the guidebook in Appendix B.

Sustainability

Economic Impact

The economic impact criterion examines the economic value of the project. A variety of factors such as direct and indirect job creation, shipper savings, tax revenues that could be potentially generated, and long-term economic growth that could be attributed to the project are accounted for under this criterion.

Environmental/Social Impact

The environmental and social impact criterion evaluates the economic and social impacts, both positive and negative, that are likely to accrue from the project. Examples of factors include air quality, energy use, impacts on natural resources, noise and vibration issues, and impact of the project on disadvantaged populations.

Table 5. Proposed TxDOT Rail Project Evaluation Matrix.

Project Name:			Project Type:			
Criteria	**Primary TxDOT Strategic Goal**	**Secondary TxDOT Strategic Goals**	**Rating**	**Weight (%)**	**Rating x Weight**
A. SUSTAINABILITY					
1. Economic Impact	**4**	**1,3,5**		10	0
Does the project provide for positive economic impacts on the community and/or state?			VH-H-M-L-N (10-7-5-3-0)		
2. Environmental/Social Impact	**4**	**1,3,5**		10	0
Does the project minimize/address environmental impacts?			VH-H-M-L-N (10-7-5-3-0)		
Does the project address community impacts?					
3. Asset Preservation	**3**	**1,4,5,6**		15	0
Does the project address the long-term preservation of the system?			VH-H-M-L-N (10-7-5-3-0)		
B. TRANSPORTATION					
4. Safety & Security	**2**	**1,3,4**		10	0
Does the project improve safety and security?			VH-H-M-L-N (10-7-5-3-0)		
5. Connectivity	**5**	**1,4,6**		10	0
Does the project improve/complete network linkages or connections?			VH-H-M-L-N (10-7-5-3-0)		
6. Congestion Relief	**5**	**1,2,3,4,6**		10	0
Does the project improve system operations?			VH-H-M-L-N (10-7-5-3-0)		
7. System Capacity	**5**	**1,2,3,4,6**		15	0
Does the project improve throughput?			VH-H-M-L-N (10-7-5-3-0)		
C. IMPLEMENTATION					
8. Cost Effectiveness	**6**	**1,3,4,5**		5	0
Does the project show positive economic value?			VH-H-M-L-N (10-7-5-3-0)		
Does the project have an identified funding source?					
9. Project Development	**6**	**1**		5	0
How developed is the project?			VH-H-M-L-N (10-7-5-3-0)		
Is the project part of an existing local or regional transportation plan?					
10. Partnerships	**6**	**1**		5	0
Does the project have committed partnerships?			VH-H-M-L-N (10-7-5-3-0)		
11. Innovation	**4**	**1,5,6**		5	0
Does the project involve innovative planning processes, technology, and/or financing?			VH-H-M-L-N (10-7-5-3-0)		
			(HAS TO EQUAL 100)	100	
			PROJECT COMPOSITE SCORE		**0**

Asset Preservation

The asset preservation criterion evaluates the ability of the project to assist in preserving existing TxDOT or state assets with a particular emphasis on existing public sector transportation infrastructure (e.g., highways and associated rights of way) and/or privately-held transportation infrastructure (e.g., freight railroad infrastructure and rights of way). It also allows for credit to be given for shared-use features of co-location of an additional mode within an existing transportation corridor.

Transportation

Safety and Security

The safety and security criterion evaluates the safety benefits and security enhancements that will accrue by implementation of the project. This will take into account crashes, fatalities, and injuries that may be prevented; property damage averted; and physical and operational security measures featured in the project. It may also give specific credit for projects that address the ability to handle transportation emergencies such as natural disasters or that address specific needs such hazardous material safety and security.

Connectivity

The connectivity criterion allows for project evaluation based upon its characteristics that relate to the ability to connect other existing and/or planned projects. Examples of a project attribute that would be evaluated under this criterion would be the way in which a proposed intercity or commuter rail service connected with the urban transit services in the urban areas it traverses or the way in which a proposed new freight rail line or urban bypass route serves existing freight centers.

Congestion Relief

The congestion relief criterion accounts for travel time improvements, relief or removal of rail traffic and/or highway bottlenecks, and for alleviation of non-recurring congestion as the result of special events. Examples of projects that might score well on this criterion might be those adding rail capacity improvements such as passing tracks or straightening curves to allow improved freight/passenger rail travel times, rail-rail grade separation projects addressing rail congestion, and adding commuter or intercity passenger rail service to address highway congestion.

System Capacity

The system capacity criterion allows for evaluation of the project as it relates to overall transportation system capacity needs. The goal of this criterion is to allow for rail projects to be considered as part of addressing multimodal transportation capacity needs. Examples of such a project might be adding rail passenger service to mitigate traffic congestion during highway reconstruction projects or adding freight rail capacity in a corridor to reduce highway truck traffic servicing an inland port facility.

Implementation

Cost Effectiveness

The cost effectiveness criterion looks at the overall benefit derived for the investment applied to the project. It could encompass several methods of calculation (benefit-cost analysis, etc.) and result in a composite score that will allow for comparison between two projects or for one package of projects with another package of projects.

Project Development

This criterion evaluates the stage of project development in relation to whether detailed engineering plans and environmental compliance documents are completed or in the process of being completed. Projects that have advanced toward completion may be more highly regarded under certain conditions while those that must be further examined before receiving required environmental clearances may not be scored as highly.

Partnerships

This criterion allows for credit to be given to a project for maximizing the partnership features to achieve a more appealing project. The partnerships may consist of public-private partnerships, private-private partnerships, or any other combination of partnership that makes the project more readily implementable.

Innovation

The innovation criterion provides an additional scoring opportunity for projects that exhibit technological and/or institutional innovation. This could be in the technology proposed for implementation of a certain service or innovation in creative funding from a variety of public and private sources.

WEIGHT AND RATING OF EACH CRITERION

Each criterion (and associated set of sub-criteria) must be assigned a weight according to its importance to the overall type of project being evaluated. The weighting is entered into the evaluation matrix as a percentage of the overall project evaluation—therefore, the total of the weighting column must equal to 100 as shown in Table 5. The rating assigned to each criterion for each project is assigned according to a defined scale that was initially set at the values in Table 5 by TxDOT staff and adopted by the Transportation Commission into the 2010 Texas Rail Plan. When the rating and weight are multiplied, a score for each criterion is calculated. These scores are totaled to provide a composite score for each project that is evaluated. The maximum composite score for any project is 1,000 points. Individual projects can be compared by their scores under any one of the criteria if a more specific goal such as connectivity was to be emphasized. Additionally, weighting of the criteria can be adjusted by the Transportation Commission in the future to reflect any newly emerging funding opportunities, legislative directives, or changes in TxDOT strategic priorities.

Chapter 7 of the 2010 Texas Rail Plan describes the full details of the currently adopted process for weighting of criteria in rail project evaluation. The rail plan also includes a section, specifically on pages 7-11 through 7-21, describing the additional evaluation recommendations from the Rail Steering Committee and several pages of discussion/clarification regarding each criterion and how to incorporate elements of each criterion covered elsewhere in the rail plan into the prioritization process. These are also more fully described in the accompanying Guidebook in Appendix B.

LINKING CRITERIA TO STRATEGIC GOALS

The importance of developing a project evaluation process that is both transparent and linked to the TxDOT Strategic Plan goals has been emphasized by TxDOT since this project was initially proposed. During the early months of the project TxDOT's strategic goals from the 2009–2013 TxDOT Strategic Plan were in place. Those goals were relatively straightforward and related to traditional goals for transportation projects. They were:

- Goal 1: Reduce Congestion.
- Goal 2: Enhance Safety.
- Goal 3: Expand Economic Opportunity.
- Goal 4: Improve Air Quality.
- Goal 5: Preserve the Value of Transportation Assets.

A new TxDOT Strategic Plan for 2011–2015 was adopted in early 2011 bringing new strategic priorities for the agency. The goals under the new strategic plan are similar; however many of the goals go beyond traditional goals to include other factors such as multimodal strategies and structural changes to the department itself. They are:

- Goal 1: Develop an organizational structure and strategies designed to address the future multimodal transportation needs of all Texans.
- Goal 2: Enhance safety for all Texas transportation system users.
- Goal 3: Maintain the existing Texas transportation system.
- Goal 4: Promote congestion relief strategies.
- Goal 5: Enhance system connectivity.
- Goal 6: Facilitate the development and exchange of comprehensive multimodal funding strategies with transportation program and project partners.

Although similar in concept, it is more difficult to tie specific transportation evaluation criteria to the 2011-2015 goals due to their expanded scope. For example, many of the project sustainability criteria developed under the original goals now fall more precisely under Goal 1 or Goal 4 in the new plan. Alternatively, some of the proposed evaluation criteria such as the use of innovative financing are more easily classified under Goal 6 in the new regime than in any of the previous strategic goals.

As can be seen from this example, the 11 criteria chosen for this project prioritization process are flexible and broad-based enough to be adapted to changes in strategic priorities and goals at the state level. The following chapter describes the project rating and scoring process.

CHAPTER 4
EXPLANATION OF GUIDEBOOK AND PROJECT EVALUATION CASE STUDY

PROJECT RATING AND SCORING PROCESS

Project Rating

The rating of a project with respect to each criterion is based on a user-defined (e.g., TxDOT staff) scale common to all criteria. The rating assigned to each criterion is then multiplied by its weight thus providing the composite score of the project with respect to that criterion. For each project that is evaluated a rating score using a scale from 0 to 10 will be assigned to each criterion, where in general 10 reflects the "highest positive outcome" and 0 reflects "no positive outcome."

The rating assigned to each criterion can be based on a qualitative assessment or the results of external quantitative analyses of a proposed project's *expected* performance toward each criterion. Quantification of several criteria takes place typically within external analyses such as Benefit-Cost Analyses and Economic Impact Analyses. Some criteria may lend themselves to direct quantification; others may not partly because clear definitions and methodologies to do so have not been fully developed yet. For non-quantifiable or qualitative criteria the rating will be determined based on the professional experience and expertise of TxDOT staff and/or an advisory panel consisting of industry experts and members of the public the latter of whom might rate a project based on personal preferences.

The scope of this guidebook is the prioritization process for proposed rail projects—or the "before" stage. Therefore it focuses on and discusses a project's *expected* performance and the criteria and elements to consider in the prioritization process. These criteria and sub-criteria, even ones that are non-quantifiable before a project is built, can correspond to specific performance measures. Performance measurement by definition takes place after a project is implemented, and performance measures are typically quantifiable. The most commonly employed methodologies and tools to develop indicators to forecast a proposed project's future performance (after implementation) at the pre-development stage for purposes of supporting the rating and prioritization process were discussed in the previous section of this guidebook. Table 6 describes the criteria, sub-criteria, corresponding elements to consider, and the initial rating method in order to assist project evaluators in making a determination when rating a proposed project against each criterion. A thorough description of the project rating and scoring process is also included in the guidebook in Appendix B.

Table 6. Project Criteria, Sub-Criteria, Considerations, and Rating Method.

Sustainability		
Criterion	**Considerations**	**Rating**
1. Economic Impact	Will the project have a positive economic impact on the community and/or state? *Elements to consider:* • Job creation. • Shipper savings. • Tax revenues. • Long-term economic growth.	10 = Yes – Exceptional 7 = Yes – Significant 5 = Yes – Moderate 3 = Yes – Minor 0 = No
2. Environmental/ Social Impact	Will the project reduce, minimize, or mitigate negative environmental impacts? Will it bring about positive environmental impacts? *Elements to consider:* • Air quality. • Natural resources, e.g., habitats, wetlands, national parks. • Energy usage. • Noise and vibration. • Visual aesthetics. Will the project reduce, minimize, or mitigate negative social impacts? Will it bring about positive social impacts? Elements to consider: • Neighborhood cohesiveness. • Disadvantaged populations, e.g., minorities, low-income, old, young, disabled.	10 = Yes – Exceptionally 7 = Yes – Significantly 5 = Yes – Moderately 3 = Yes – Slightly 0 = No

3. Asset Preservation	Will the project positively impact the long-term preservation or improvement of the system? *Elements to consider:* • Preservation of rail corridors. • Preservation of highway corridors.	10 = Yes – Exceptionally 7 = Yes – Significantly 5 = Yes – Moderately 3 = Yes – Slightly 0 = No
Transportation		
Criterion	**Description**	**Rating**
4. Safety and Security	Will the project completely remove or reduce risks associated with safety and security? *Elements to consider:* • Total number of crashes. • Number of fatalities. • Number of injuries. • Property damage costs. • Security. • Natural disasters. • Hazardous materials.	10 = Yes – Complete removal 7 = Yes – Significant reduction 5 = Yes – Moderate reduction 3 = Yes – Minor reduction 0 = No reduction
5. Connectivity	Will the project complete or improve critical network links or connections on/between existing or planned facilities? *Elements to consider:* • Connectivity, e.g., along a major road/rail network link and/or intermodal connector, between two or more road/rail network links and/or intermodal connectors.	10 = Yes – Exceptionally (critical link) 7 = Yes – Significantly 5 = Yes – Moderately 3 = Yes – Slightly 0 = No

6. Congestion Relief	Will the project improve systemwide mobility (traffic flow)? *Elements to consider:* • Travel Time. • Travel Speed. • Recurring congestion points (bottlenecks). • Non-recurring congestion.	10 = Yes – Exceptionally 7 = Yes – Significantly 5 = Yes – Moderately 3 = Yes – Slightly 0 = No
7. System Capacity	Will the project create additional capacity or otherwise improve system throughput? *Elements to consider:* • Throughput.	10 = Yes – Exceptional 7 = Yes – Significant 5 = Yes – Moderate 3 = Yes – Minor 0 = No
Implementation		
Criterion	**Description**	**Rating**
8. Cost Effectiveness	Will the project show positive economic value? *Elements to consider:* • Benefit-Cost Ratio. • Net Present Value. • Internal Rate of Return. • Identified funding source. • Operation and Maintenance cost.	10 = Yes – Exceptional 7 = Yes – Significant 5 = Yes – Moderate 3 = Yes – Minor 0 = No
9. Project Development	What stage of development are project plans currently at? *Elements to consider:* • Engineering design (preliminary and final). • Environmental documents (NEPA compliance). • Is the project part of a 4-year state or MPO TIP? (if not, federal funds cannot be used)	10 = Full development 7 = Significant 5 = Moderate 3 = Concept stage 0 = Proposal stage

10. Partnerships	What is the level of committed partnerships to the project? What is the level of general support for the project? *Elements to consider:* • Public-private partnerships. • Partnerships between local/regional/state public agencies. • General level of support from local/regional/private entities and the general public.	10 = Exceptional 7 = Significant 5 = Important 3 = Minor 0 = None
11. Innovation	Will the project involve implementation of innovative practices? *Elements to consider:* • Planning processes. • Technology implementation. • Funding/financing mechanisms. • Other.	10 = Yes – Exceptional 7 = Yes – Significant 5 = Yes – Moderate 3 = Yes – Minor 0 = No

Composite Score

When the rating and weight are multiplied, a score for each criterion is calculated. The sum of the criteria composite scores provides a final overall composite score, for which the maximum is equal to the maximum in the chosen rating scale (10) multiplied by 100. Thus the maximum composite score for any project would be 1,000 points. Individual projects could also be compared on the basis of their score in individual criteria if a more specific objective such as connectivity was of primary importance. The development of less discrete rating scales (for example, 7 rating levels instead of 5 for each criterion) could also refine the precision of the evaluation. The output (total score) from each project's matrix evaluation would then be used to populate a table that would allow for direct cross comparison of the projects to one another. Table 7 provides an example of how such a table would be formatted.

Once all projects are evaluated using the methodology described, a list of scored projects from which subsets of projects meeting the criteria of specific funding programs or projects addressing specific future TxDOT priorities can be selected. The use of this methodology should allow the flexibility to respond quickly to emerging funding opportunities and, at the same time, ensure the stability provided by a transparent, well-defined process for prioritizing rail project decisions. A thorough description of the project rating and scoring process is also included in the guidebook in Appendix B.

Table 7. Project Cross Comparison.

Project Name	Project Type	Sustainability			Transportation				Implementation				Composite Score
		1	2	3	4	5	6	7	8	9	10	11	
		EI	ES	AP	SS	CO	CR	SC	CE	PD	PA	IN	
	Criteria Weight (Total=100%)	10	10	15	10	10	10	15	5	5	5	5	Max = 1000
	Measure	VH-H-M-L-N	VH-H-M-L-N	VH-H-M-L-N	VH-H-M-L-N	VH-H-M-L-N	VH-H-M-L-N	VH-H-M-L-N	VH-H-M-L-N	VH-H-M-L-N	VH-H-M-L-N	VH-H-M-L-N	
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Rating Scale	
Exceptional (VH)	10
Significant (H)	7
Moderate/Important (M)	5
Minor (L)	3
None (N)	0

Criteria		
Sustainability	**Transportation**	**Implementation**
Economic Impacts (EI)	Safety & Security (SS)	Cost Effectiveness (CE)
Environmental/Social Impact (ES)	Connectivity (CO)	Project Development (PD)
Asset Preservation (AP)	Congestion Relief (CR))	Partnerships (PA)
	System Capacity (SC)	Innovation (IN)

TOWER 55 PROJECT RATING AND SCORING CASE STUDY

As an example of how the project rating and scoring process described in this report/user manual would be implemented, the research team originally planned to perform a series of case study examples exhibiting how current or proposed projects would rank under the newly developed and adopted prioritization process. Late in the project, however, TxDOT requested that only a case study of the well-documented Tower 55 Multimodal Improvement Project in Fort Worth be performed as part of the research project (*16*). Further analysis of additional projects were preferred to be conducted as part of the TxDOT Short Term Rail Program as described in Chapter 7 of the 2010 Texas Rail Plan for which contracting efforts had begun. The remainder of this section describes how the Tower 55 project would rate as an example of implementation of the prioritization process.

In order for the research team to evaluate the Tower 55 project, TxDOT provided several existing documents that describe various aspects of the project, its benefits, and estimated impacts upon the Fort Worth area and the larger rail and transportation networks that expand beyond the immediate area. Among them are:

- TxDOT Tiger II Grant Application, Tower 55 Multimodal Improvement Project (*17*).
- Environ Corporation, Memorandum on Emissions Reductions from Reduced Rail Congestion at Tower 55 (*18*).
- HDR Decision Economics, Tower 55 Multimodal Improvement Project Economic Impact Results (*19*).
- HDR Decision Economics, Cost-Benefit Analysis in Support of TIGER II Application, Tower 55 Multimodal Improvement Project, Fort Worth, Texas, for BNSF Railway and Union Pacific Railroad (*20*).

Example values for the criteria analysis in the remainder of this section are drawn from these documents. Previous chapters of this report/user manual described the 11 criteria adopted in the 2010 Texas Rail Plan. In this case study, each evaluation criterion will be examined and a representative score for the Tower 55 Project assigned based upon the rating values described in Table 7 above. As the prioritization process matures and/or more quantifiable measures are approved by TxDOT as authoritative, more exact numerical scoring methods may be defined and substituted for the current scoring scales. A discussion of which criteria have potential quantitative and which have more qualitative values is included in the guidebook in Appendix B.

Tower 55 Multimodal Improvement Project Background

The Tower 55 rail-rail intersection is one of the most congested rail intersections in the United States where 11 major freight and passenger routes converge into a single route where two north-south and two east-west rail lines cross. Currently, over 100 trains per day cross at this single point on the rail network resulting in congestion delay and associated economic activity losses. Prior to undertaking the project, the intersection operated at over 90 percent capacity daily and expected traffic growth would place the intersection over full capacity by 2014 in the no-build scenario. The planned project would result in:

- Added capacity through adding an additional north-south track, a new interlocker, and improved trackage and signaling.
- Improved bridges and underpasses.
- Improvements to city streets and intersections to support grade crossing closures.
- Construction of neighborhood underpasses for pedestrian and bicycle use.
- Improved emergency vehicle access to local neighborhoods through increased bridge-height clearances (*17*).

Tower 55 Project Sustainability Ratings

Economic Impact

The economic impacts of the Tower 55 Project were documented in a report by HDR Decision Economics (*19*). HDR used the IMPLAN economic impact software and 2007 data for the United States in their calculation of the short term and longer term impacts that could be expected from the project over the period for Q4 of 2010 to Q3 of 2012. They also used the Council of Economic Advisors (CEA) employment impact multiplier with varying results. Their estimates determined that the jobs created during construction would be the primary impact and calculated these benefits to be a cumulative effect on GDP of $133.54 million or approximately $66.77 million per year over the two-year construction period. Given this relatively large direct impact, the score for economic impact, considering other factors not accounted for would likely be a 7 due to significant job growth during construction. A second report by HDR further describes the economic benefits of the project, giving it a very positive benefit-cost ratio of between 8.2 to 1 and 13.7 to 1 (*20*). Some factors, such as shift from rail to road freight once the Tower 55 intersection exceeds capacity in the no-build scenario, were not calculated as part of the analysis but would add to the overall score. The estimated economic benefits of the project range between $666.8 million and $1.71 billion using 7 percent and 3 percent discount rates, respectively, over a 20-year period. As a result, the project would be given a score of 10 under economic benefit.

Environmental/Social Impact

Environmental and social benefits also score highly in the supporting documents of the Tower 55 Project. Emissions reductions associated with the proposed project were estimated using rail traffic simulation models. The results projected that emissions could be reduced between 2014 and 2028 before the intersection once again became congested. The analysis also took into account the emissions improvements that would take place as a result of introduction of new lower-emitting locomotives over the coming decade (*18*). Community access improvements and impacts on neighborhoods were also taken into account. Specific items that fall under this category are the provision of improved grade crossings for emergency vehicles and the provision of new bicycle/pedestrian underpasses to access schools in areas where some crossings are proposed for closure. As a result of these elements, the project would likely be scored as a 7 for environmental/social impact. This score might have been higher, if the rail-road diversion emissions had been taken into account.

Asset Preservation

The purpose of this criterion is to assess the long-term preservation of the system. Due to the acute nature of current rail system congestion, local impact, and impending saturation of the Tower 55 intersection, it is clear that the project is needed to preserve flow through the system. As saturation would likely force more freight to travel by road in the area, improving the Tower 55 intersection also preserves roadway maintenance expenditures in the future. This project would score a 10 for this category.

Tower 55 Project Transportation Ratings

Safety and Security

Safety features of the project such as improved access for emergency vehicles due to the removal of low-clearance crossings along with additional security fencing of the right-of-way and designated/improved bicycle/pedestrian crossings are examples of benefits in this area. Additionally several bridges will be improved and some at-grade vehicle crossings closed. For safety and security the project would likely be scored as a 7.

Connectivity

The project would provide for new rail-rail connections on the freight rail system in the area, thus improving connectivity and flow. While the main purpose of the Tower 55 project is freight rail related, the project would also provide additional capacity allowing for improved passage of the Trinity Railway Express and Amtrak trains that traverse the area resulting in reduced delay. For connectivity, a score of 7 would be assigned.

Congestion Relief

Rail system congestion relief is the primary reason for undertaking this project. In addition to rail congestion, the project would remove road congestion on many nearby roadways where currently automobiles must stop and wait while the trains queue through the Tower 55 intersection. In both cases, adding additional capacity to the intersection and making the associated improvements in bridges would be beneficial. The score would be a 10.

System Capacity

As stated under congestion relief above, adding the third north-south track capacity to allow the at-grade rail-rail intersection to function below capacity for 15–20 more years is the primary goal of the project. Other features of the project in the adjacent community also will aid in the movement of trains through the terminal area, adding even more system benefits. As a result, a score of 10 would be awarded for system capacity.

Tower 55 Implementation Ratings

Cost Effectiveness

The expenditure of state funds to make the proposed improvements would be a good decision due to the wide-ranging, positive impacts of this project. Well over half of the project was funded by the private railroads along with other local/regional partners; however, not all of the required project funding was secured at the time the project was being evaluated. For that reason a score of 7 is assigned.

Project Development

A comprehensive plan and detailed engineering studies for proposed elements of the project have been completed. The project appears on both the local MPO Transportation Improvement Program (TIP) and the State Transportation Improvement Program (STIP) as an improved project. This level of development merits a score of 10.

Partnerships

The level of commitment and partnerships for this project at the time of submittal to the TIGER II Discretionary Grant program was high as exhibited by the financial partnership between the two involved Class I railroads, TxDOT, the City of Fort Worth, Tarrant County, the North Central Texas Council of Governments (NCTCOG), and the Fort Worth Transit Authority ("The T"), which came together to fund over 58 percent of the cost of the project. Due to the complexity involved in completing all the proposed work within such a dense urban setting, this partnership is even more vital. For partnerships, the project is scored at 10.

Innovation

Innovation is specifically mentioned in the Tower 55 Project TIGER II proposal in regard to the Centralized Traffic Control (CTC) system that will be installed as part of the project. This system will be compatible with the federally mandated implementation of the Positive Train Control network in the next few years and assist dispatchers in moving trains through the rail intersection. Additional innovation in the number and type of financial partners, the planning process through which this was alternative project was selected, and in using initial funding from NCTCOG and "The T" to pay for environmental work to begin merits a score of 10 for innovation.

Calculating a Composite Score for the Tower 55 Project

Table 8 shows how the rating for each criterion for the project is multiplied by the weighting to calculate the composite score for the project. In this case, the Tower 55 project, based upon the example scores assigned in this case study, would score 895 out of a possible 1000 points. As rating methods are further refined in the upcoming months as part of the Short Term Rail Program, an even more precise score could be generated under this general framework for the scoring system.

Table 8. Tower 55 Multimodal Improvement Project Example Scoring.

Project Name: Tower 55 Multimodal Improvement		Project Type: Rail-Rail Intersection/Capacity Impr.			
Criteria	**Primary TxDOT Strategic Goal**	**Secondary TxDOT Strategic Goals**	**Rating**	**Weight (%)**	**Rating x Weight**
A. SUSTAINABILITY					
1. Economic Impact	**4**	**1,3,5**	**10**	10	100
Does the project provide for positive economic impacts on the community and/or state?			VH-H-M-L-N (10-7-5-3-0)		
2. Environmental/Social Impact	**4**	**1,3,5**	**7**	10	70
Does the project minimize/address environmental impacts?			VH-H-M-L-N (10-7-5-3-0)		
Does the project address community impacts?					
3. Asset Preservation	**3**	**1,4,5,6**	**10**	15	150
Does the project address the long-term preservation of the system?			VH-H-M-L-N (10-7-5-3-0)		
B. TRANSPORTATION					
4. Safety & Security	**2**	**1,3,4**	**7**	10	70
Does the project improve safety and security?			VH-H-M-L-N (10-7-5-3-0)		
5. Connectivity	**5**	**1,4,6**	**7**	10	70
Does the project improve/complete network linkages or connections?			VH-H-M-L-N (10-7-5-3-0)		
6. Congestion Relief	**5**	**1,2,3,4,6**	**10**	10	100
Does the project improve system operations?			VH-H-M-L-N (10-7-5-3-0)		
7. System Capacity	**5**	**1,2,3,4,6**	**10**	15	150
Does the project improve throughput?			VH-H-M-L-N (10-7-5-3-0)		
C. IMPLEMENTATION					
8. Cost Effectiveness	**6**	**1,3,4,5**	**7**	5	35
Does the project show positive economic value?			VH-H-M-L-N (10-7-5-3-0)		
Does the project have an identified funding source?					
9. Project Development	**6**	**1**	**10**	5	50
How developed is the project?			VH-H-M-L-N (10-7-5-3-0)		
Is the project part of an existing local or regional transportation plan?					
10. Partnerships	**6**	**1**	**10**	5	50
Does the project have committed partnerships?			VH-H-M-L-N (10-7-5-3-0)		
11. Innovation	**4**	**1,5,6**	**10**	5	50
Does the project involve innovative planning processes, technology, and/or financing?			VH-H-M-L-N (10-7-5-3-0)		
			(HAS TO EQUAL 100)	100	
			PROJECT COMPOSITE SCORE		**895**

EXAMPLE OF COMPARING PROJECTS/COMPOSITE SCORING

Table 9 shows an example of how the composite score for Tower 55 could be put in a table for direct comparison with other projects. Note that a table of this sort is useful for many purposes. First, it can serve as a compilation for comparison of the scores from all projects for direct comparison across all project types. This function may be useful for general ranking purposes, however, as discussed earlier in this report/user manual funding sources are often restricted to specific types of projects. In cases where funding is limited in this way, specific project types that were applicable to a given funding source could be grouped and then comparative scores could be examined. Another option for increasing the importance of a certain element of a project in evaluations is that the weighting of an individual evaluation criterion (or selected criteria) could be increased to match the emphasis sought by a specific funding program. For example, if congestion relief was of primary importance, its weight could be changed to be higher and the other scores adjusted accordingly. While the current system has a maximum weighting score of 100, that number could be increased or decreased as long as all projects are measured on the same scale basis for direct comparison. It is also a possibility that as more exact quantitative measures are identified for some criteria and/or the number of projects greatly increases, the need to expand possible scores to more than 10 points under each category might become necessary in order to provide additional precision in scoring.

Table 9. Comparison Table of Tower 55 to Hypothetical Projects.

Project Name	Project Type	Sustainability			Transportation				Implementation				Composite Score
		1	2	3	4	5	6	7	8	9	10	11	
		EI	ES	AP	SS	CO	CR	SC	CE	PD	PA	IN	
	Criteria Weight (Total=100%)	10	10	15	10	10	10	15	5	5	5	5	Max = 1000
	Measure	VH-H-M-L-N	VH-H-M-L-N	VH-H-M-L-N	VH-H-M-L-N	VH-H-M-L-N	VH-H-M-L-N	VH-H-M-L-N	VH-H-M-L-N	VH-H-M-L-N	VH-H-M-L-N	VH-H-M-L-N	
Tower 55 Multimodal	Rail Capacity	10	7	10	7	7	10	10	7	10	10	10	895
Project X	Grade Separation	5	5	5	7	5	10	7	7	10	7	5	645
Project Y	High Speed Rail	7	10	10	7	7	7	10	3	3	10	7	795
Project Z	Grade Crossing	3	5	7	10	5	3	5	10	10	7	3	590
													0
													0

GUIDEBOOK PURPOSE

Appendix B to this report/user's manual is a guidebook for use by local/regional rail and transportation planners to explain how the initially adopted rail prioritization process framework is formatted. It more fully explains the factors that can be accounted for under each evaluation criterion and how the process can be applied to projects. The guidebook does not include the case study application regarding Tower 55 that appears in this report/user's manual.

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Appendix A

EVALUATION OF METHODOLOGIES IN BENEFIT-COST AND ECONOMIC IMPACT ANALYSES FOR FREIGHT RAIL PROJECTS

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Evaluation of Methodologies in Benefit-Cost and Economic Impact Analyses for Freight Rail Projects

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ABSTRACT

Public investment in privately owned freight rail infrastructure is generally considered to be mutually beneficial (win-win) opportunities to the extent that it benefits the general public. Public-private partnerships (PPPs) are emerging as a viable procurement method to leverage public funding with private funding/financing in transportation projects in order to meet the mobility needs of an expanding economy. This paper summarizes the research conducted as part of a larger project to evaluate the state-of-the-practice in methodologies that estimate the benefits generated by freight rail projects. It examined existing research, case studies, and particularly benefit-cost analyses (BCAs) and economic impact analyses (EIAs) of implemented, approved, or proposed rail projects. A high degree of variation was found in the approaches, definitions, techniques and level of detail employed. The research defined and characterized projects, developed a generalized benefit classification scheme, and analyzed and evaluated data sources, methodologies, and assumptions upon which quantification and monetization of projected benefits was based. The paper draws conclusions and recommendations for improvements in approaches and methodologies in order to allow more objective cross-comparisons among projects, focusing on the parameters underlying the calculation of benefits and post-project performance measurement.

INTRODUCTION

Traditionally, transportation infrastructure (primarily highways) has been exclusively funded by the public sector (federal, state, local government) through direct user fees (e.g. motor fuel taxes), general revenue funds, bonds etc. However, the increase in user demand is far outpacing the ability of the public sector to fund additional highway capacity while at the same time giving rise to traffic congestion, air pollution, fuel waste, reduced safety, and accelerated infrastructure damage. The ability of the public sector to fund additional highway capacity is limited, at least in part, by the lack in the public's willingness to accept appropriate taxes or other charges. As a result alternative procurement methods, such as public-private partnerships (PPPs), are increasingly used to complement federal and/or state funds with private funding and/or financing as capital and/or lifetime operational and maintenance costs, most recently in privately owned freight rail infrastructure through discretionary grants. Public investments in privately owned freight rail are generally considered to be mutually beneficial (win-win) opportunities to the extent that they are shown to benefit the general public. Benefits accrued by the private sector can benefit the general public to the extent that they are re-injected into the economy, an event that may be driven by market forces. Generally, higher levels of competition in a market are more likely to lead to private benefits --or cost savings-- being passed through to customers, in the form of lower prices or rates for example.

Definitions from academia, federal guidelines, and some individual rail project documents stress the distinction between "public benefits" determined through a benefit-cost analysis (BCA) and "economic impact" determined through an economic impact analysis (EIA) *(1,2,3)*. Specifically a BCA measures the dollar value of quantified and monetized benefits and costs to all members of society e.g. travel time/delay, crashes, and externalities such as emissions. The monetized benefits represent a dollar measure of the extent to which people are made better off by the project, or the amount that all people in society would jointly be willing to pay to carry out the project, and feel as if the project had generated enough benefits to justify its costs. An EIA, on the other hand, is complementary to the BCA and typically measures the *direct* (or first-order), *indirect* (or second-order), and *induced* (or third-order) benefits. The latter two are restated by the value of the *direct* benefits generated at the local/regional level (rather than the national) in terms of employment, wages, or business activity.

While evaluation of the regional impacts is a valid means towards evaluating a project from a sub-national perspective some of the impacts considered in an EIA e.g., diversion of economic activity from one region of the country to another, represent benefits to one part of the country but costs to another, so they are not net benefits at the national level unless they involve imports/exports referenced to the national level. Moreover, EIAs estimate "impacts" rather than "benefits" which are different e.g., the total payroll of workers on a project is usually considered an "impact" but not a "benefit" because (a) payroll is a cost to whoever pays the employees, at the same time that it is a benefit to the employees, so it is not a net benefit; and (b) the employees have to work for their wages so the amount they are paid is not a net benefit to them; it is a benefit only to the extent that they value their wages more than their cost of having to work every day.

The objective of this study was to analyze, evaluate, synthesize, and mildly critique the state-of-the-practice in conducting BCAs and EIAs that estimate the expected benefits generated by freight rail projects that involve public investment in private freight rail infrastructure. Exhaustive, scrutinized, and stern criticism based on fundamental principles of economic theory was beyond the scope of the study. This paper is not intended to serve as a guidance document; it is rather intended to summarize the state-of-the-practice, highlight some prevailing strengths and weaknesses, and recommend general opportunities for improvement. The study examined several freight rail project applications which consisted of both types of analyses, BCAs and EIAs. Some of these were applications for the recent Transportation Investment Generating Economic Recovery (TIGER "I") grants introduced by the American Reinvestment and Recovery Act of 2009 (ARRA) while others involved past rail projects (implemented, underway, or proposed).

OVERVIEW OF FINDINGS

Table 1 summarizes several basic characteristics of each project, such as benefit-cost ratio (BCR), present value (PV) of benefits and costs, and the cost sharing structure, where available. Generally, TIGER grant applications provided considerably more detail related to methodologies and calculations than non-TIGER or older studies. The numbers for the BCR and PV of costs are shown as reported in the documents. The PV of benefits for all projects shown was recalculated by the researchers to incorporate the monetary value of the economic impact in order to permit a more equal comparison among different projects. The reason is that some project documents already incorporated it in the reported number for the PV of benefits (and BCR), possibly raising issues with double-counting, whereas others reported the PV of economic impact separately from the PV of public benefits (and did not include it in the calculation of the BCR).

The researchers found that public benefit considerations in BCAs for rail projects have greatly expanded in recent years, both in the number and type of public benefit categories considered, and in the analytical rigor used to demonstrate them. Public benefits in the 1990s and prior were largely demonstrated rather qualitatively, with human livability and environmental benefits receiving the least attention. BCAs gradually embraced these benefits and progressed to their current levels of quantification and monetization as methodologies developed. BCAs have also grown in sophistication and complexity related to estimation of the benefits that were already being quantified. It is also evident that the cost-sharing structure has shifted from exclusively public funds to greater and greater levels of contribution by private sector funding/financing with the advancement of the PPP concept.

BCRs and PVs of benefits and costs by category have become standard elements of recent BCAs and EIAs, but there is wide variation in the values reported for different types and sizes of projects. Figure 1 enables a relative comparison among the different types of public benefits and the economic impact through the corresponding *percent* PV for selected projects (ones that provided the required data). Due to considerable variability in the definitions and classifications found in the projects examined, a generalized benefit classification scheme was developed for the study in order to allow an across-the-board comparison consisting of five categories of monetized benefits which include pavement maintenance; energy and air quality (shown together for ease of visibility); congestion; safety; and economic impact.

The largest contributor to the majority of projects' total benefit amount was the economic impact. The focus of ARRA was to spur job creation and economic growth while improving on congestion, air quality, energy use, safety and infrastructure maintenance expenditures. So it can be argued that the funding program may influence the focus on and manner in which public benefits are calculated and reported. Other influencing factors would likely involve the justification for purpose and need for a project.

TABLE 1 Basic Characteristics of Rail Project BCAs and EIAs.

			Present Value (Million $)[2]		Cost Share (%)		
TIGER Applications		**Benefit-Cost Ratio (BCR)[1]**	**PV Benefits**	**PV Costs**	**Federal**	**State & Other**	**Private**
1	National Gateway Freight Rail Corridor	6.1	5,925	978	30	23	47
2	Crescent Corridor Intermodal Freight Rail Project	12	27,664	2,132	49	9	43
3	Alameda Corridor East: Colton Crossing	7.1	1,075	198	22	48	30
4	CREATE Program Projects	5.9	2,881	488	67	17	16
5	Tower 55 At-Grade Improvement Project	11.41	834	93.7	65	--	35
6	Kansas City Intermodal Facility Project	NR	1,893	250	20	--	80
7	Port of Gulfport Rail Improvements	NR	NR	NR	68	--	32
8	Fast Track New Bedford	NR	NR	NR	NR	NR	NR
Past Projects - Underway, Completed, or Proposed							
9	Colorado Front Range Relocation Project	NR	1,152	993	NR	NR	NR
10	Central Ohio Regional Rail Study	NR	NR	NR	NR	NR	NR
11	Galesburg Rail Relocation	NR	NR	34.8	NR	NR	NR
12	Grant Tower Curves	NR	NR	50	10	60	30
13	Kansas City Argentine Flyover	NR	NR	53	--	--	100
14	Columbia Rail Relocation	NR	NR	57	--	100	--
15	Central Florida Rail Relocation Study	NR	24[3]	145	--	100	--
16	Brownsville-Matamoros Rail Relocation Demonstration Project	NR	NR	52	75	18	7
17	Belen to Santa Fe Commuter Rail Project	NR	NR	1,600	--	100	--

[1] BCR as reported; PV Benefits recalculated (not as reported)
[2] Discount rate 7%
[3] Annual 2025 congestion benefits only

NR = Not Reported
Other Notes: Year varies by study

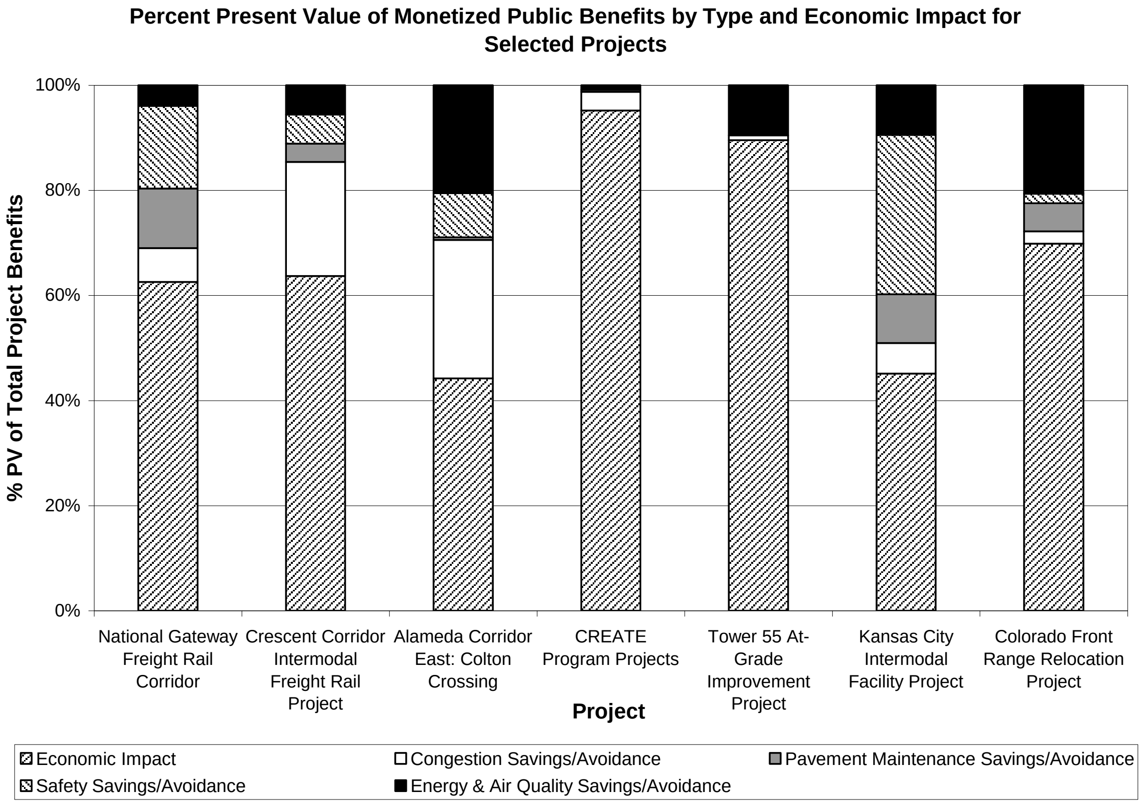

FIGURE 1 Percent present value of benefits of selected projects by public benefit type and economic impact.

The examined freight rail projects exhibited one of three types of objectives or characteristics:

- System Preservation – accommodate freight growth and avoid delays and/or diversion to other freight modes.
- System Improvement – improve freight rail service and divert freight from other modes (induced rail demand).
- Passenger Rail Improvement – improve passenger rail service in addition to freight rail service and divert passenger movements from other modes.

BCAs typically consider two scenarios when evaluating the benefits of a project, “Build” and “No Build.” Quantification of benefits in two distinct stages was identified, through BCAs and EIAs. In some cases, a third stage was identified that comprises Qualitative Public Benefits emphasizing externalities.

BENEFIT-COST ANALYSIS (BCA)

The BCAs studied involve five types of public benefits related to cost savings/avoidance: Congestion, Pavement Maintenance, Safety, Energy, and Air Quality.

The “Build” scenario is typically based on the estimation of the truck vehicle miles traveled (VMT) saved due to a potential truck-to-rail freight diversion (under the “Build” scenario); or the truck VMT prevented from a potential freight diversion from rail to truck (that could occur under the “No Build” scenario). This root calculation forms the basis for estimating most of the public benefits in BCAs. Thus, the case for quantification of almost all public benefits is made on the basis of estimates of the shift in modal share of freight movement expected under either scenario.

While these analyses provide useful findings for consideration, there is considerable variation among BCAs depending on the data sources and methods by which modal share estimates were developed. Estimates rely on several assumptions that are often not well documented. Modal share estimates might use figures provided by railroads, figures developed based on surveys or application of assumptions, or figures derived from output of a software model. In addition, the majority of BCA calculations do not include sensitivity analyses which would model scenarios under variable diversion estimates.

BCAs typically forecast the value of benefits into the future on the basis of modal share assumptions applied to the overall freight volume growth. Typically, the total annual monetary value of each category or subcategory of public benefit is first calculated, and then all categories are added together to obtain a total annual monetary value for all public benefits. PV of the annual totals is obtained (in current year dollars) using an appropriate discount rate (usually 7% or 3%) over the life of the project—which is usually projected to be 20 to 30 years.

Congestion

Congestion mitigation benefits involve the calculation of the total before-and-after VMT and travel time on the highway network. VMT and travel time savings (or avoided increases) represent the difference between the before and after cases. The savings are realized along highway links and/or at at-grade grade crossings, depending on the project’s characteristics. The difference between the before-and-after travel times is the improvement (decrease) in travel time due to:

- Reduced overall VMT on highway links from reduced truck VMT, hence higher link travel speeds and reduced travel times for all vehicles;
- Reduced (or eliminated) vehicular delay at grade crossings. Grade crossing delay reduction is realized when the project improves rail network speeds and reduces crossing closure times. Grade crossing delay elimination is realized when a grade separation takes place and grade crossing closure is no longer involved; and
- Reduced travel time for rail passengers if the rail project effects mobility improvements to passenger rail operations due to higher overall rail system speeds, and/or reduction or elimination of delays at rail-rail crossings.

The before-and-after travel times along links are calculated based on travel speeds, which are in turn calculated based on VMT values (traffic volumes) and (fixed) roadway capacity. Calculations can be done manually or through specialized modeling software. Some congestion benefit data are outputs of the Federal Highway Administration's (FHWA) Surface Transportation Efficiency Analysis Model (STEAM) model *(4)*.

In calculations for delay reduction or elimination at grade crossings, some BCAs use the Federal Railroad Administration's (FRA) GradeDec *(5)* methodology to calculate total time-in-queue (vehicle-hours) at each grade crossing to determine the before-and-after effect of the project. As with other categories, use of a variety of methods, data sources, and assumptions can often lead to comparisons that may not be equal across the board.

Analyses that do not involve grade crossing delay reductions or elimination often stay at the truck VMT calculation level and apply the marginal costs for congestion (in $/VMT) to each truck type to calculate total congestion monetary benefits. The marginal costs for congestion (as well as pavement, crashes, air pollution, and noise) attributed to trucks and autos (by weight class and/or area type) are reported in the Highway Cost Allocation Study (HCAS) *(6)* in 2000 dollars, which are converted to current year dollars for an evaluation.

Analyses that involve grade crossing delay reductions or elimination and rail passenger travel time savings proceed by calculating the travel time saved by motorists and/or rail passengers and applying dollar values per unit time to obtain the total monetary benefit of travel time saved or extra travel time avoided by the public. Sources for the value of time are generally stated to be federal *(7)* or state data, studies and models, which may recommend differing approaches or dollar values.

There is no official standard value for the value of time, but generally acceptable ranges are typically based on prevailing hourly wage rates. Thus travel time public benefits are sensitive to both truck VMT estimates and to the monetary value of unit time used in the calculation.

Pavement Maintenance

Pavement maintenance benefits are typically a direct function of the potentially saved or avoided truck VMT under the "Build" scenario. The truck VMT estimate is multiplied by a unit cost for pavement maintenance or damage (in dollars per truck VMT) to arrive at a total monetary value for the pavement maintenance/damage cost savings or costs avoided. The unit cost used in BCAs is usually the marginal pavement damage cost reported in the HCAS or Virginia Department of Transportation's average pavement maintenance value ($0.07/VMT).

The HCAS attributes pavement damage marginal costs (as well as congestion, crashes, air pollution, and noise) to trucks and autos (by weight class and/or area type) in terms of $/VMT. Costs are reported in 2000 dollars, which are converted to current year dollars in BCA comparisons. In the case of heavy trucks, the unit values are reported by truck Gross Vehicle Weight Rating (GVWR) of 60,000 and 80,000 pounds, for both urban and rural highway VMT. The values range from $0.03/VMT for 60,000-rural to $0.41/VMT for 80,000-urban.

The monetary value of the pavement maintenance cost savings (or costs avoided) is sensitive to both the truck VMT estimate and to the dollar value assigned to the pavement maintenance unit cost estimate. While the extent of pavement damage that can accurately be attributed to trucks is an estimate only, the basis described above is a generally acceptable one.

Safety

Safety savings are realized primarily along highway links and/or at at-grade grade crossings, depending on the project's characteristics. They consist of the number and monetary value of crashes, fatalities, injuries (often categorized by severity), and property damage crashes. Savings are realized on the basis of reduced exposure from reduced truck VMT (or avoidance of higher exposure from higher truck VMT) and eliminated exposure through grade separations.

Considerable variability can be found in the methods, sources, and forms of crash rates by type of crash along highway links. Some BCAs use national methods and crash rates while others use state-specific ones. Though crash rates may come in different forms, they are typically converted to crashes, fatalities, injuries, and property damage per truck VMT, and then multiplied by the truck VMT estimate to obtain the expected crash reduction or avoidance. Grade crossing specific crash rates are obtained from FRA *(8)* or state databases. Grade crossing crash forecasts utilize FRA crash prediction equations.

The majority of BCAs use the national average monetary unit values for lives (fatalities), injuries, and property damage. The unit values are usually prescribed by grant application guidelines or obtained independently for the BCA. The root source, in both cases, is typically the federal government through agencies such as the FHWA, Federal Motor Carrier Safety Administration (FMCSA) or the National Highway Traffic Safety Administration (NHTSA) of the USDOT *(9)*. Some BCAs use state-specific values. The expected reduced or avoided fatalities, injuries, and property damage crashes are multiplied by the monetary unit values to calculate the total monetary value of the safety benefits.

If a grade crossing already has low accident prediction rates or little/no crash history the public benefits from a grade separation will be lower than if a grade crossing has high accident prediction rates or extensive crash history. Projects that only include grade separations at crossings with no prior crash history and no truck VMT savings or avoidance show up in the calculations as offering no public safety benefits, since there will be no change in the number of crashes under the “Build” scenario.

Energy

Energy (fuel) savings or costs avoided are realized in any or all of the following situations:

- Along highway links due to reduced or avoided truck VMT,
- Along the rail network due to reduced train travel time resulting from reduced or eliminated delay at rail-rail crossings, and
- At at-grade grade crossings due to reduced vehicular delay (resulting from reduced crossing closure time due to higher train speed) or due to eliminated delay (resulting from grade separation).

The extent that each situation or combination of situations affects a BCA depends on the project characteristics and approach of the calculation. As in other benefit calculations, the methods, data sources, and assumptions in each BCA vary. However, truck fuel efficiency is typically obtained from a national source, such as the U.S. Environmental Protection Agency’s (EPA’s) MOBILE6 model, which outputs fuel efficiency by type of vehicle in miles per gallon, or from the source data for MOBILE6 *(10)*. When truck fuel efficiency is combined with the truck VMT estimate, the total annual gallons of fuel saved or avoided across the highway network are calculated.

Data for the fuel savings calculations of locomotives are seldom available publicly on a national level. They are often collected by the partnering railroad and/or consultant with some degree of involvement by the lead public agency. Most railroads use Berkeley Simulation’s Rail Traffic Controller (RTC) planning model *(11)* outputs to calculate the savings in hours and miles under the "Build" scenario. The output is combined with railroad-specific or the Association of American Railroads' (AAR) average values for train speed (mph) and fuel efficiency in ton-miles/gallon *(12)* incorporating additional fuel efficiency data from national agencies such as the EPA to calculate the total annual gallons of fuel saved from improved rail operations under the "Build" scenario.

Fuel savings from reduced or eliminated vehicular delay at rail crossings are calculated on the basis of the results of time delay reduction or avoidance calculations performed under congestion public benefits. The VMT or time savings estimate is combined with vehicular fuel efficiency, obtained from EPA's MOBILE6 model or the underlying national data, or other EPA data to calculate the total annual gallons of fuel saved or avoided.

Some BCAs calculate the saved/avoided gallons of gasoline, diesel, and motor oil, as well as the gallons of crude oil (imported) according to the yield rate obtained from the Transportation Energy Data Book *(13)*. Others calculate the cost savings/avoided costs of truck operations that include fuel, labor, and maintenance. The monetary value per gallon of fuel is almost always obtained from the Energy Information Administration *(14)*. The calculation approach used can result in varying representations of the total monetary value of energy public benefits.

Sensitivity issues regarding fuel savings seem to primarily arise from the root calculation of truck VMT saved or avoided. At a secondary level, sensitivity issues may exist with data and variables used in rail fuel savings calculations and vehicular delay reduction or elimination calculations at grade crossings.

Air Quality

Air quality benefits consist of emissions savings or costs avoided and are a direct byproduct of fuel savings—the less fuel burned, the fewer emissions result. They are therefore realized in any or all of the same situations as listed for energy savings.

The calculation methods, emission rates, and sources where truck emissions are concerned are easier to discern than those for some other categories of truck-related benefits. The analyses typically calculate tons saved for various air pollutants, most often nitrogen oxides, carbon monoxide, volatile organic compounds or hydrocarbons, particulate matter, and carbon dioxide. Emission rates for vehicles are almost always obtained from EPA's MOBILE6 model by type of vehicle in grams/VMT or grams/hour for each pollutant. When truck emission rates are combined with the truck VMT estimate, the total annual tons of each pollutant saved or avoided across the highway network can be calculated.

Calculation methods, data sources, and assumptions vary more widely for locomotive than for truck emissions. Calculations are often performed by the partnering railroad and/or consultant with some degree of involvement by the lead public agency. The emission standards are frequently obtained from EPA, but require conversion from EPA's grams/bhp-hr to arrive at annual tons saved or avoided, which can be accomplished by a number of methods *(15)*.

Emission savings from reduced or eliminated vehicular delay at rail crossings depend on the VMT or time delay reduction or avoidance that has already been calculated under the congestion public benefits. The VMT or time savings estimate is combined with the emission rates obtained from EPA's MOBILE6 model or other data by type of vehicle in grams/VMT or grams/hour for each pollutant. The total annual tons of each pollutant saved or avoided from rail crossing delay reduction or elimination are then calculated.

The monetary value per ton for each pollutant is prescribed or obtained independently from national sources—usually EPA—and shows little variation. Sensitivity issues regarding air quality public benefits seem to primarily arise from the root calculation of truck VMT saved or avoided. At a secondary level, sensitivity issues may exist with data and variables used in rail emission savings calculations and vehicular delay reduction or elimination calculations at grade crossings.

ECONOMIC IMPACT ANALYSIS (EIA)

Four measures of economic impact were identified in the project documents studied: job creation, shipper savings, tax revenue, and long-term economic growth. All project EIAs included estimates of job creation and varied in whether, how, and the extent to which they addressed the remaining three measures. In general, economic impact calculations are based on prior estimates and parameters, which in turn may be based on even earlier estimates, parameters, and assumptions. The effect of transportation-related investments on long-term economic growth is a complicated and multifaceted topic, exceeding the level of detail possible in all but the most critical EIAs. Input-output models can indicate a cause-effect relationship, but typically vary in capabilities, strengths, and weaknesses. The built-in multipliers are static in time and place, rather than dynamic, in contrast to transportation flow which is dynamic e.g., capacity constrained. Also issues with double-counting can overinflate output at a given input level. Input-output models used in reviewed EIAs include:

- The Bureau of Economic Analysis' Regional Input-Output Modeling System (RIMS II) *(16)*,
- The Minnesota IMPLAN Group Inc.'s IMPLAN multiregional input-output modeling software *(17)*, and
- The University of Illinois Regional Economics Applications Laboratory's Interregional Commodity Flow Model (ICFM) *(18)*.

Job Creation

Primary job creation due to capital investment creates three types of jobs considered to last through the duration of that spending (the construction phase) and are therefore considered short-term:

- Direct jobs created within the construction industry;
- Indirect jobs created with construction industry suppliers; and
- Induced jobs created in response to spending of earnings from direct and indirect jobs, such as in retail stores, restaurants, gas stations, etc.

Economic impact related to job creation is typically reported in terms of full-time jobs or job-years created, the payroll dollar equivalent, and the resulting short-term dollar output or Gross Domestic Product (GDP) for each of the three types of jobs. EIAs vary in the methods used to estimate job creation resulting from capital spending in rail projects. Some use White House estimates derived from the first round of ARRA (2009) which held that $92,000 of federal investment created one (1) job-year *(19)*. Other BCAs employ sophisticated economic input-output models. Yet other EIAs employ job creation estimates internal to the railroad industry based on past investments, or job creation estimates based on consultant-preparers' previous studies.

Shipper Savings

According to the project documents shipper savings are assumed to be passed on to the public and the economy in general by the initial beneficiaries, the shippers. The savings are realized in three ways:

- Reduced transportation costs and logistics costs, such as those offered by rail;
- Reduced inventory costs realized from the reduced need to keep stock due to reduced and more reliable transportation time; and
- Resultant capital gains realized from transportation and inventory cost savings, i.e., revenue is freed up for reallocation to capital investment, expansion of labor force, and increased production, all of which would create further economic development.

A considerable degree of variation can be found among EIAs in terms of which one or which combination of the three types of shipper savings may have been considered. This can be directly attributed to the variety of methods previously used to estimate economic impact. Shipper savings realized in the three ways listed above are typically included in the broader spectrum of economic output obtained through input-output models, so re-estimation in this category would constitute double-counting.

EIAs that did not use input-output models report shipper savings estimates developed by railroads, consultants, or shippers. As with other economic estimates, variations occur in calculation bases such as the unit value of keeping inventory and the reduced cost resulting from transportation time savings and higher reliability. Estimates also depend on whether shippers already ship by rail or divert from truck to rail (and vice versa).

The degree to which shippers realize savings, where typically rail transportation has an advantage over truck transportation in cost but not time, is sensitive to the degree to which shippers choose to divert from truck to rail or the degree to which they are prevented from diverting from rail to truck. This is the exact same premise on which cost savings/avoidance benefits in BCAs are estimated i.e., using the modal share of freight movement between truck and rail, the factors affecting it, and the magnitude of any modal shift.

Tax Revenue

Tax revenue benefits typically include property and sales tax revenue increases for the local government, and income tax revenue increases for the federal and state government. They are realized when the local resident population and business activity increase due to enhanced employment opportunities in the area, brought about by capital investment, and can project into the future. EIAs report the tax increases in tax dollars generated by type of tax.

A considerable degree of variation can be found among EIAs in terms of which one or which combination of tax type and beneficiary (level of government) may have been considered. This can be directly attributed to the variety of methods previously used to estimate economic impact. Tax-related revenue increases realized in any form are typically included in the broader spectrum of economic output obtained through input-output models and re-estimation would constitute double-counting. EIAs that did not use input-output models typically report estimates developed by railroads, consultants, or statistics compiled by state/local employment and tax agencies.

Long-Term Economic Growth

In the project documents examined long-term or cumulative economic growth is also referred to as growth in GDP from the very first infusion of capital throughout the life of the project including short-term growth. The injection of new money into the economy (such as capital investment) multiplies in output through production of goods and services, facilitated by transportation flows, which further stimulates repeating cycles—a process known as the "economic ripple effect." Long-term economic growth is typically reported in terms of dollars of GDP output and jobs created over a given number of years after the initial impact of a given level of investment in a given region.

Methods used to estimate cumulative, long-term economic growth are generally consistent among EIAs. Input-output models are almost always employed in this evaluation. The models have built-in economic multipliers to estimate the temporal and spatial extent of the initial investment by sector of the economy, but also come with deficiencies outlined above.

QUALITATIVE PUBLIC BENEFITS

Four types of qualitative, non-monetized public benefits can be identified in some of the BCAs studied: noise, natural resources, safety and security, and social equity.

Noise

Whether BCAs consider noise impact mitigation associated with the rail project depends on the project's characteristics. If a project has a positive impact or no impact it is explicitly stated in the BCAs. If it has a negative impact, mitigation plans are included in the documents. Projects involving highway-rail grade separations eliminate the need for a train to blow its horn when crossing. Projects involving rail-rail grade separations eliminate the need for train idling and noise production. Other projects involve construction of noise embankments or establishment of parks that are quiet zones in order to mitigate expected noise impacts.

Less than a handful of the studied BCAs for projects involving highway-rail and rail-rail separations quantify noise public benefits and none attempt to monetize them. Quantification of noise benefits comparatively lags in terms of priorities, expectations and requirements – hence so are official methodologies, data sources, and monetary values per unit of noise. BCAs that quantify noise benefits mostly address rail-induced noise and use the Federal Transit Administration's (FTA) Transit Noise and Vibration Impact Assessment Manual *(20)* or project/state noise manuals based on the federal methodology. Typically noise levels are expressed in decibels of Type A (dBA), the frequency heard by the human ear. Other BCAs state that noise-related impacts due to changes in rail and highway operations are an output of FHWA's STEAM model which is also used for calculation of other impacts. They are usually monetized directly and reported in dollars per year, with no available information on the quantification method.

Noise considerations have traditionally been addressed qualitatively through Environmental Impact Statements (EISs) rather than quantitatively through BCAs. Narratives in early BCAs briefly describe mitigation options for potential adverse noise impacts, e.g., noise barriers or scheduling/operating regulations for freight operations. The development of established methodologies and data sources in response to public expectations will gradually allow noise impacts to be quantified and monetized. This will enable their formal migration and standard consideration into BCAs, as has happened with air quality externalities.

Natural Resources

Public benefits with respect to natural resources are usually defined in terms of avoidance of negative impacts to or preservation of water sources, plant and animal habitats, wetlands, and archaeological or historic sites – based on the premise that any and all human-induced actions impact nature negatively. Most BCAs do not detail these impacts, and in absence of detail it is implied that the project will not introduce negative impacts.

If the project is expected to have negative impacts on natural resources, BCAs describe mitigation plans such as stream relocation and park landscaping or, as termed in one BCA, "creation of conservation corridors." Early BCAs have few comments on natural resource considerations; they are addressed in EISs.

Safety and Security

Public benefits related to safety (other than crashes) and security typically include enhancements associated with concerns such as national security/terrorism, emergency vehicle access, hazardous materials (hazmat) movements, location of hazmat/dump sites, and natural disasters. Many of these issues came to the forefront after the September 11, 2001 terrorist attacks and Hurricanes Katrina and Rita in 2005. Most BCAs do not detail these impacts, and in absence of detail it is implied that the project will not introduce negative safety and security impacts.

If there are specific positive impacts associated with the project, BCAs provide descriptions. Examples include projects involving grade separations that would enhance emergency vehicle access, or rehabilitation or new construction of drainage structures. Early BCAs have few comments on safety and security considerations, with the exception of one early BCA that explicitly mentions improved emergency vehicle access due to grade separation.

Social Equity

Public benefits related to social equity are usually defined as improvements in the standard of living of special populations such as ethnic minorities, low-income population groups, and mobility-constrained populations. These benefits are specifically addressed in BCAs prepared for grant applications to the extent prescribed by the requirements of each individual grant program e.g., TIGER. At a minimum, TIGER grant applications report the population in the vicinity of the project living in Economically Distressed Areas (EDAs)—or low-income populations—or simply state the number of EDA-designated counties in the area *(21)*. These are often augmented with supporting figures e.g., unemployment rates, foreclosure rates, per capita income, or expected project spending in EDAs.

Many BCAs reiterate job creation estimates prepared under the EIA in order to emphasize project benefits for low-income populations. BCAs of projects that effect rail passenger travel time improvements relate it to benefits for various special population groups e.g., child school pick-up. Early BCAs have few comments on social equity considerations or effects on special populations. In projects involving park development or street improvement, social equity benefits are sometimes merged with natural resource benefits.

CONCLUSIONS AND RECOMMENDATIONS

While research and common sense point to the many benefits of rail – such as improved safety, improved air quality, and more economical use of fuel *(22)* – a standardized, correctly defined, and generally acceptable methodology to accurately validate exactly how beneficial and in what ways public investment in privately owned freight rail infrastructure benefits the public has yet to be fully developed and is a work in progress.

The study found that, over the past decade, increased attention was paid to defining the public benefit and economic impact stream that is projected to accrue from carrying out freight rail projects – in both the number of benefits enumerated and in the sophistication of the measures and metrics employed to describe them. Total present value of benefits can vary considerably over different projects and can be influenced by the type and size of project. Also, the focus of the funding source can influence the relative contribution of each type of benefit to the total present value of all benefits. Further, with the advancement of the PPP concept, cost-sharing structures have shifted from exclusively public funds to greater levels of contribution by private sector funding and/or financing.

Historically, post-construction performance of infrastructure projects has not been as systematically monitored and measured after project implementation. This is planned to change starting with projects that were awarded the recent TIGER grants. It is expected that future national transportation policy will be performance-based, emphasizing post-project performance measurement, target-setting and benchmarking as means to measure and optimize investment outcomes especially where freight movement is concerned. This will in turn encourage better defined and more standardized methodologies for projecting the benefits to be realized from prospective projects.

In addition to the need for better definition and greater standardization in BCAs and EIAs, there is a need for clear and available documentation in terms of data sources, assumptions, and forecasts with respect to a wide array of varying input parameters. The complex nature of BCAs and EIAs, along with multifaceted calculations and modeling, creates challenges related to stakeholder understanding of the process. This study confirmed the need to develop and apply uniform and accessible analytical procedures that can raise the level of the public's confidence in project benefits.

In order to establish clear causal relationships between rail projects and expected public benefits, more work is needed on the core components that form the basis of benefits calculation. These include the need for further research in the following areas:

- Modal share and diversion potential with respect to changes in transportation price and operational performance, i.e. elasticity of demand for freight transportation;
- Systematic performance monitoring and post-hoc analyses of the short- and long-term benefits resulting from rail projects;
- Quantification of shipper savings, e.g., value of inventory time, type and extent of capital gains reinvestment;
- Definition and standardization in BCA and EIA processes; e.g., calculation methods, data sources, assumptions, forecast methods, sensitivity analyses, and unit monetary values; and

- Further development in methodologies to quantify, and/or possibly monetize, the public benefits associated with externalities such noise, aesthetics, community livability, etc.

Addressing these needs would lead to heightened confidence in BCAs and EIAs for individual projects and less subjectivity when comparing one project with another. Successful PPPs can be an important means towards maximizing the value received from the public funds invested in transportation projects. Identifying those projects that effectively benefit the public more than alternative projects is fundamental to improving the transportation system and, if done well, will lead to increased use of PPPs as a procurement method for a host of freight and passenger rail project applications. To achieve this, forecasting consistent and reasonable benefits and then validating the realization of those projections through post-implementation measurement will be necessary.

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APPENDIX B

GUIDEBOOK FOR RAIL PROJECT PRIORITIZATION

GUIDEBOOK FOR RAIL PROJECT PRIORITIZATION

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DISCLAIMER

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SECTION 1. INTRODUCTION

This section provides an overview of the guidebook, including project purpose and topics covered. It is organized into the following parts:

- Background related to the importance and necessity of prioritizing statewide investments in rail-related projects.
- Objectives of the guidebook.
- Evaluation criteria.
- Organization of this guidebook.
- Target audience for this guidebook.

Background

As the population of Texas rapidly increases over the next few decades, rail service in the state faces capacity constraints from expected demand growth in rail. Rail systems, therefore, are required to be improved in order to facilitate more efficient movement of both passengers and goods. Rail infrastructure improvements require maximum return on investment given their extensive capital costs as they appear at first glance to solely serve private interests. At the same time there is ever-increasing pressure on public budgets to provide essential transportation alternatives and improvements. Therefore it is paramount for rail-related public investment to demonstrate a clear associated public benefit. Thus, measuring and comparing the costs and benefits of various rail projects to both the private industry and the public can provide a logical method toward prioritizing projects that achieve the goals of both the public and private sector. Since the Texas Department of Transportation's (TxDOT) current and future involvement in rail planning is limited by the availability of funding sources for rail projects, it is necessary to ensure that the limited available funding for rail projects is applied in the most beneficial and efficient manner. This guidebook is intended to provide evaluation tools that can address TxDOT's strategic goals and allow the agency to prioritize its investments in rail-related projects statewide.

Objectives

A number of investments are necessary as Texas continues in its long-term vision to develop a comprehensive, multimodal transportation network geared toward providing efficient and sustainable movement of goods, services, and people. This guidebook aims to support these activities. The guidebook's objectives are therefore to:

- Assist users in evaluating proposed rail projects and identifying the most worthy potential improvements through a transparent methodology.
- Assist users in selecting funded, short-term projects that are ready for further development or implementation.
- Assist users in conducting pre-project performance forecasts of proposed rail-related investments that are closely linked to state goals and objectives.

Evaluation Criteria

A list of 11 evaluation criteria, shown in Table 1, will be considered when evaluating rail projects. These criteria, discussed in greater detail within this guidebook, are divided into the three broad categories of sustainability, transportation, and implementation.

Table 1. Rail Project Evaluation Criteria.

Sustainability	Transportation	Implementation
1. Economic Impact 2. Environmental/Social Impact 3. Asset Preservation	4. Safety and Security 5. Connectivity 6. Congestion Relief 7. System Capacity	8. Cost Effectiveness 9. Project Development 10. Partnerships 11. Innovation

Organization

In Section 2, a list of pre-project performance indicators that can be used to forecast the future performance of implemented rail projects is provided. This list was assembled based upon a review of literature and feedback received from the Project Monitoring Committee (PMC) and stakeholders. Methodologies, procedures, and typical tools for deriving and calculating these indicators of future performance are also described in this section.

In Section 3, a rail project evaluation process addressing TxDOT's Strategic Plan goals is presented by the TTI research team based on preeminent transportation project evaluation and prioritization processes developed by federal and state agencies and private companies. The process presented in this guidebook focuses on the pre-implementation (or proposal) stage of a project and discusses the evaluation criteria, weighing, rating, and scoring methodologies in detail.

Target Audience

The target audience of this guidebook includes state and local TxDOT planners, including TxDOT's Rail Division (RRD) and their partners at Metropolitan Planning Organizations (MPOs); Regional Mobility Authorities (RMAs); special rail-related districts such as Rural Rail Transportation Districts (RRTDs) and regional metropolitan Rail Districts; and Councils of Governments (COGs) who are involved in allocating available funding to rail projects and who must prioritize and manage investments in rail-related projects within their jurisdiction. Railroad companies who own and operate the rail network are also a target audience for this guidebook as primary stakeholders in rail related decisions made by the public sector.

SECTION 2. INDICATORS OF FUTURE PERFORMANCE

This section discusses the methodologies, procedures, and tools most commonly employed to develop typical indicators that can forecast a proposed project's future performance before it is built for purposes of supporting the rating and prioritization process. Quantitative indicators of future performance are accompanied by the typical calculation methods and tools. Qualitative indicators of future performance and means to their determination are also discussed. All discussions are based upon a review of literature, best practices, and feedback received from the TxDOT PMC members, Rail Division staff, and Rail Plan Steering Committee.

Overview of Performance Measurement

The criteria and corresponding elements considered in the rating and prioritization stage, even ones that are non-quantifiable before a project is built, can correspond to specific performance measures. Performance measurement by definition takes place after a project is implemented and performance measures are typically quantifiable. A performance measure is a quantifiable expression of the amount, cost, or result of activities that indicate how much, how well, and at what level, products or services are provided to customers during a given time period. All agencies involved in transportation decision making can benefit from and take a role in creating and tracking performance measures, including state DOTs, MPOs, and cities. Thus, performance measures are clear and concise statements with specific criteria or benchmarks that could help TxDOT and the stakeholders judge the condition and performance of rail projects. Systematic routine application of performance measurement can be valuable for regular system monitoring and management such as in TxDOT performance reports and can provide TxDOT staff with a continuing source of accessible information to guide decisions.

Performance measures should explicitly reflect visions and goals that have been established through a planning process, which includes stakeholders and the public. Once performance measures are established, they can strongly influence the goals of the planning process, so they should be chosen carefully. For rail-related projects, TxDOT may assess the value of its investments by monitoring their functionality, which can be measured along the same criteria and elements considered in the before-project phase: economic impacts, environmental/social impacts, safety, congestion relief/mobility, connectivity, cost effectiveness, and other factors. By monitoring these aspects through established performance measures after the project is implemented, TxDOT and its transportation partners can conduct before- and after-analyses to support planning for further rail project investments, maximize the value of existing and future rail assets, and ensure that the limited available funding for rail projects is applied in the most beneficial and efficient manner.

Performance Measurement for Rail Projects

Tracking performance measures for the transportation system helps identify trends and analyze the effectiveness of investments in meeting objectives. These efforts can in turn help support revisions to goals and objectives. In the context of enhancing the Texas rail system, performance measures can be used to help track progress towards meeting objectives and prioritize further rail investments. The scope of this guidebook is the pre-project phase but there is a close relationship between post-project performance measures and pre-project indicators of future performance. Table 2 lists the most typical future performance indicators developed at the pre-project stage through Benefit-Cost Analyses (BCAs) and Economic Impact Analyses (EIAs) whose results serve as bases for rating and prioritization decisions. They are mapped to the evaluation criteria introduced in Table 1.

Potential TxDOT rail projects can generally be classified into four major types:

- Highway-rail grade crossing rail projects.
- Rail capacity/facility improvement projects.
- Rail relocation projects.
- High-speed rail, regional rail, and intercity rail projects.

Since each type of project has unique characteristics, the future performance indicator should be applied for evaluation with relevant adjustment according to the characteristics of that particular type of rail project. For example, performance indicators related to safety should be emphasized when evaluating highway-rail grade crossing rail projects because such crossings may be located on public roads with high exposure levels. Rail capacity improvement is what the performance measures for rail capacity/facility improvement projects need to target, such as the additional number or weight of train cars that can be transported by the rail projects. The evaluation for rail relocation projects should be based on performance measures that can evaluate rail capacity improvement, environmental/social improvement, economic benefits generation, and cost effectiveness. The performance measures associated with high-speed rail, regional rail, and intercity rail projects should focus on environmental/social improvement, economic opportunities created, connectivity, and mobility improvement.

Calculating Indicators of Future Performance

Performance indicators at the pre-project stage aim to forecast the likely outcomes of transportation agency operations and programs. Indicators of future performance of a project are estimated through external analyses such as BCAs and EIAs before a project is built (i.e., while it is still just a proposed project) whose results are used to base rating and prioritization decisions. However, different methods of quantifying future performance indicators introduce further complexity in measuring the efficiency or effectiveness of the rail-related projects. This section describes the typical calculation procedures most often deployed in practice to quantify indicators and discusses determination techniques for non-quantifiable (or qualitative) future performance indicators. The discussion is structured around the methodologies to calculate an interrelated cluster of performance indicators and is followed by short descriptions of typical off-the-shelf models and tools used to conduct the analyses.

Two scenarios are typically considered in BCAs and EIAs—"build" and "no-build." The "build" scenario is typically based on the estimation of the truck vehicle miles traveled (VMT) saved due to a potential truck-to-rail freight diversion (under the "build" scenario); or the truck VMT prevented from a potential freight diversion in the opposite direction, i.e., rail-to-truck (that could occur under the "no build" scenario). This root calculation forms the basis for estimating most of the public benefits typically accounted for in BCAs. Thus, the case for quantification of almost all public benefits is made on the basis of estimates of the shift in modal share of freight movement expected under either scenario.

The following section describes the manner in which data or qualitative estimates of the indicators are typically determined in current practice for each of the criteria and sub-criteria shown in Table 2. Generally the estimates will be called upon to determine the scoring for each criterion, which is used to calculate overall project evaluation scores in the prioritization process.

Table 2. Typical Indicators of Future Performance of Rail Projects.

Sustainability		
Criterion	**Sub-Criterion**	**Future Performance Indicator(s)**
1. Economic Impact	Job Creation (short term direct)	Number of Full Time Equivalent (FTE) jobs (during construction phase typically), number of job-years, dollar wage equivalent, average dollar wages per month
	Shipper Savings	Reduction in transportation costs, reduction in logistics costs (inventory, warehousing, distribution)
	Tax Revenues	Increase in property tax, sales tax, and income tax revenues
	Long-Term Economic Growth	Projected increases in Gross Domestic Product (GDP)/Gross National Product (GNP) output, number of direct, indirect and induced jobs created over the lifetime of the project (short and long term)
2. Environmental/ Social Impact	Air Quality	Tons of emissions (CO, NO_x, PM, CO_2) saved; monetary value
	Energy Usage	Reduction in fuel usage and corresponding monetary value
	Natural Resources	Usually qualitative indicator; number or area (e.g., acres) of natural resources preserved or created, discussion of the impact level of the project and if negative, discussion of mitigation plans, e.g., creation of new areas
	Noise & Vibration	Qualitative indicator; discussion of the impact level of the project and if negative, discussion of mitigation plans, e.g., sound walls
	Disadvantaged Populations	Qualitative indicator; discussion of the impact level of the project and if negative, discussion of mitigation plans
3. Asset Preservation	Preservation of Rail Infrastructure	Track miles revitalized, maintained, upgraded, and/or saved from abandonment
	Preservation of Highway Infrastructure	Truck VMT saved or avoided, lane-miles with avoided pavement maintenance/damage costs, or the pavement maintenance/damage savings

Transportation		
4. Safety and Security	Crashes, Fatalities, Injuries	Reductions in total crashes, number of fatalities and number of injuries by severity, and associated value
	Property Damage	Reductions in number of property damage crashes and associated value
	Security	Qualitative indicator; discussion of positive impact of the project if any, e.g., technology
	Natural Disasters	Qualitative indicator; discussion of any positive impact of the project, e.g., reductions in risk vulnerability and/or severity of consequences
	Hazardous Materials	Qualitative indicator; discussion of any positive impact of the project, e.g., reductions in accident risk and/or severity of consequences
5. Connectivity	Connectivity of Transportation Network	Qualitative indicator; discussion of positive impact of the project, e.g., critical connection between existing or planned facilities
6. Congestion Relief	Travel Time	Reduction in travel time, delay, and costs across network
		Increase in average train speed
		Reduced travel time variability; increased reliability
	Recurring Congestion (Bottlenecks)	Reductions in travel time, delay, and costs over links with recurring congestion
	Non-recurring Congestion	Reductions in travel time, delay, and associated costs over links with non-recurring congestion
7. System Capacity	Throughput	Increase in number or weight of train cars

Implementation		
8. Cost Effectiveness	Net Present Value	Difference between the present value of benefits and the present value of costs
	Benefit-Cost Ratio	Benefit derived from the investment divided by the cost
	Operation and Maintenance Cost	Operational and maintenance costs per mile per year
9. Project Development	Stage of Development	Qualitative indicator; discussion on the stage of development of project plans, e.g., engineering design, NEPA, inclusion in TIP
10. Partnerships	Public-private partnerships, public agency partnerships, public support	Qualitative indicator; discussion of partnerships and general support
11. Innovation	Technological Innovation	Qualitative indicator; discussion of implementation of institutional, technological or other innovations

CATEGORY: SUSTAINABILITY

Criterion 1. Economic Impact

Job creation (short-term), shipper savings, tax revenue, and long-term economic growth (including long-term job creation) are four indicators of economic impact. These economic impact calculations generally are based on prior estimates and parameters, which in turn may be based on even earlier estimates, parameters, and assumptions. The effect of transportation-related investments on long-term economic growth is a complicated and multifaceted topic, exceeding the level of detail possible in all but the most critical EIAs. Input-output (IO) models can indicate a cause-effect long-term relationship, but typically vary in capabilities, strengths, and weaknesses. The built-in multipliers are static in time and place, rather than dynamic, in contrast to transportation flow which is dynamic, e.g., capacity constrained. Also issues with double-counting can overinflate output at a given input level.

Sub-Criterion 1.1: Short-Term Job Creation

Job creation as used in this sub-criterion is a relatively short-term economic impact because capital spending only lasts through the duration of the project construction phase. Three types of jobs are usually created under this premise: direct jobs created within the construction industry; indirect jobs created with construction industry suppliers; and induced jobs created in response to spending of earnings from direct and indirect jobs, such as in retail stores, restaurants, gas stations, etc. The economic impact related to job creation is typically reported in terms of full-time equivalent (FTE) jobs or job-years created, the payroll dollar equivalent, and the resulting short-term dollar output or Gross National Product (GNP).

Job creation can be estimated by various methods, resulting from capital spending in rail projects. Some use White House estimates derived from the first round of ARRA (2009), which held that $92,000 of federal investment created 1 job-year [1]. Other BCAs employ sophisticated economic IO models to calculate the short- and long-term jobs created. Yet other EIAs employ job creation estimates internal to the railroad industry based on past investments, or job creation estimates based on consultant-preparers' previous studies to estimate the short-term job creation during construction.

Sub-Criterion 1.2: Shipper Savings

Shipper savings are assumed to be passed on to the public and the economy in general by the initial beneficiaries, the shippers, in a discretionary manner and are realized in three ways: reduced transportation costs and logistics costs, such as those offered by rail; reduced inventory costs realized from the reduced need to keep stock due to reduced and more reliable transportation time; and resultant capital gains realized from transportation and inventory cost savings, i.e., revenue is freed up for reallocation to capital investment, expansion of labor force, and increased production, all of which would create further economic development.

A considerable degree of variation can be found among EIAs in terms of which one or which combination of the three types of shipper savings may have been considered. This can be directly attributed to the variety of methods used to estimate economic impact. Shipper savings realized in the three ways listed above are typically included in the broader spectrum of economic output obtained through input-output models, so re-estimation in this category would constitute double-counting.

EIAs that do not use IO models to estimate shipper savings within the larger pool of long-term economic growth, report shipper savings estimates developed by railroads, consultants, or shippers. As with other economic estimates, variations occur in calculation bases such as the unit value of keeping inventory and the reduced cost resulting from transportation time savings and higher reliability. The magnitude of shipper savings estimates also depends on whether shippers already ship by rail or divert from truck to rail (and vice versa).

Sub-Criterion 1.3: Tax Revenue

Tax revenue benefits typically include property and sales tax revenue increase for the local government, and income tax revenue increases for the federal and state government. They are realized when the local resident population and business activity increase due to enhanced employment opportunities in the area, brought about by capital investment, and can project into the future. EIAs report the tax increases in tax dollars generated by type of tax.

A considerable degree of variation can be found among EIAs in terms of which one or which combination of tax type and beneficiary (level of government) may have been considered. This can be directly attributed to the variety of methods used to estimate economic impact. Tax-related revenue increases realized in any form are typically included in the broader spectrum of economic output obtained through IO models and re-estimation would constitute double-counting. EIAs that do not use IO models typically report estimates developed by railroads, consultants, or statistics compiled by state/local employment and tax agencies.

Sub-Criterion 1.4: Long-Term Economic Growth

Initial job creation due to capital spending lasts through the duration of that spending (the construction phase) and is therefore considered short-term. However, the benefits of capital investment are considered to multiply and create additional jobs economy-wide over the long term. The injection of new money into the economy leads to an increase in efficiencies of transportation flows. In other words, the investment multiplies in output through continuous production of goods and services—that imply job creation—which further stimulates repeating cycle; this process is known as the "economic ripple effect."

Overall long-term economic growth is referred to as growth in GDP or GNP from the very first infusion of capital throughout the life of the project capturing both short- and long-term growth. Long-term economic growth is typically reported in terms of dollars of GDP/GNP output and jobs created over a given number of years after the initial impact of a given level of investment in a given region. Methods used to estimate cumulative, long-term economic growth are generally consistent among EIAs. Input-output models are almost always employed in this evaluation. The models have built-in economic multipliers to estimate the temporal and spatial extent of the initial investment by sector of the economy, but also come with deficiencies outlined above.

Criterion 2. Environmental/Social Impact

Sub-Criterion 2.1: Air Quality

Air quality benefits consist of emissions savings or costs avoided and are a direct byproduct of fuel savings—the less fuel burned, the fewer emissions result. They are realized along the rail network due to reduced train travel time resulting from reduced or eliminated delay at rail-rail crossings, and at at-grade grade crossings due to reduced vehicular delay (resulting from reduced crossing closure time due to higher train speed) or due to eliminated delay (resulting from grade separation).

The air quality benefits are typically calculated by tons saved for various air pollutants, such as nitrogen oxides (NO_x), carbon monoxide (CO), volatile organic compounds or hydrocarbons (VOCs or HCs), particulate matter (PM), and carbon dioxide (CO_2). Calculation methods, data sources, and assumptions are rather standard for trucks and autos (see below) but can vary rather widely for locomotive emissions. Calculations are often performed by the partnering railroad and/or consultant with some degree of involvement by the lead public agency. The emission standards are frequently obtained from U.S. Environmental Protection Agency (EPA), but require conversion from EPA's grams/brake horsepower-hour (bhp-hr) to arrive at annual tons saved or avoided, which can be accomplished by a number of methods [2].

Emission savings from reduced or eliminated vehicular delay at rail crossings depend on the VMT or time delay reduction or avoidance that has already been calculated under mobility benefits. The VMT or time savings estimate is combined with the emission rates obtained from EPA's MOBILE6 or MOVES models [3] or other data by type of vehicle in grams/VMT or grams/hour for each pollutant. The total annual tons of each pollutant saved or avoided from rail crossing delay reduction or elimination are then calculated. Where monetization follows quantification, the monetary value per ton for each pollutant is prescribed or obtained independently from national sources—usually EPA—and shows little variation.

The reductions in emissions from rail projects have the potential to provide added benefit to the conformity process, which is a major concern in heavily populated metropolitan areas. They can provide some flexibility in the highway emissions budget allowing better accommodation of VMT and/or congestion growth.

Sub-Criterion 2.2: Energy Usage

Energy (fuel) savings or costs avoided are realized in the same situations as listed for air quality benefits. Most railroads use Berkeley Simulation's Rail Traffic Controller (RTC) planning model [4] outputs to calculate the savings in hours and miles. The output is combined with railroad-specific or the Association of American Railroads' (AAR) average values for train speed (mph) and fuel efficiency in ton-miles/gallon [5] incorporating additional fuel efficiency data from national agencies such as the EPA to calculate the total annual gallons of fuel saved from improved rail operations. Fuel savings from reduced or eliminated vehicular delay at rail crossings are calculated on the basis of the results of time delay reduction or avoidance calculations performed under congestion public benefits.

The VMT or time savings estimate is combined with vehicular fuel efficiency, obtained from EPA's MOBILE6 or MOVES model or the underlying national data, or other EPA data to calculate the total annual gallons of fuel saved or avoided. Some BCAs calculate the saved/avoided gallons of gasoline, diesel, and motor oil, as well as the gallons of crude oil (imported) according to the yield rate obtained from the Transportation Energy Data Book [6]. Others calculate the cost savings/avoided costs of vehicle operations that include fuel, time, and maintenance. The monetary value per gallon of fuel is almost always obtained from the Energy Information Administration [7].

Sub-Criterion 2.3: Natural Resources

Public benefits with respect to natural resources are usually defined in terms of avoidance of negative impacts to or preservation of water sources, plant and animal habitats, wetlands, and archaeological or historical sites—based on the premise that any and all human-induced actions impact nature negatively. If the project is expected to have negative impacts on natural impacts on natural resources, BCAs describe mitigation plans such as stream relocation and park landscaping or, as termed in one BCA, "creation of conservation corridors." Early BCAs have few comments on natural resource consideration; they are addressed in EIAs. When comparing addition to highway capacity vs. addition to rail capacity, right-of-way (ROW) acquisition for new highway lanes is more intrusive (and expensive) than adding a rail line within the existing rail ROW.

Sub-Criterion 2.4: Noise and Vibration

If a project has a positive impact or no impact it is explicitly stated in the BCAs. If it has a negative impact, mitigation plans are included in the documents. Projects involving highway-rail grade separations eliminate the need for a train to blow its horn when crossing. Projects involving rail-rail grade separations eliminate the need for train idling and noise production. Other projects involve construction of noise embankments or establishment of parks that are quiet zones in order to mitigate expected noise impacts. Less than a handful of the studied BCAs for projects involving highway-rail and rail-rail separations quantify noise public benefits and none attempt to monetize them. Quantification of noise benefits comparatively lags in terms of priorities, expectations, and requirements—hence so are official methodologies, data sources, and monetary values per unit of noise. BCAs that quantify noise benefits mostly address rail-induced noise and use the Federal Transit Administrations' (FTA) Transit Noise and Vibration Impact Assessment Manual [8] or project/state noise manuals based on the federal methodology. Typically noise levels are expressed in decibels of Type A (dBA), the frequency heard by the human ear. Other BCAs state that noise-related impacts due to changes in rail and highway operations are an output of FHWA's STEAM model, which is also used for calculation of other impacts. They are usually monetized directly and reported in dollars per year, with no available information on the quantification method.

Sub-Criterion 2.5: Disadvantaged Populations

Public benefits related to social equity are usually defined as improvements in the standard of living of special populations such as ethnic minorities, low-income population groups, the young and/or old, and mobility-constrained populations. Many BCAs reiterate job creation estimates prepared under the EIA in order to emphasize project benefits for low-income populations. BCAs of projects that effect rail passenger travel time improvements relate it to benefits for various special population groups, e.g., child school pick-up. In projects involving park development or street improvement, social equity benefits are sometimes merged with natural resource benefits.

Criterion 3. Asset Preservation

Sub-Criterion 3.1: Preservation of Rail Infrastructure

This performance indicator would assess the value of the project in preserving, revitalizing, or preventing abandonment of a rail corridor that is currently underutilized, negatively affects network performance, or is threatened with abandonment while it has available right-of-way or capacity for additional freight or passenger service. The indicator would also evaluate whether the proposed rail project will improve the rail system with sufficient routine maintenance and required improvements in order to keep the rail assets operating efficiently, extend their useful life, and delay the significant cost of reconstructing or replacing them. Asset preservation performance indicators that can be used are the number of track miles along rail corridors, or other rail infrastructure preserved, maintained, upgraded, revitalized, and/or saved from abandonment.

Sub-Criterion 3.2: Preservation of Highway Infrastructure

Preservation of highway infrastructure is typically considered to occur when the need for pavement maintenance is avoided. These benefits are typically a direct function of the potentially saved or avoided truck VMT if the rail project is realized. The truck VMT saved estimate is multiplied by a unit cost for pavement maintenance or damage (in dollars per truck VMT) to arrive at a total monetary value for the pavement maintenance/damage cost savings or costs avoided. The unit cost used in BCAs is usually the marginal pavement damage cost reported in the Highway Cost Allocation Study (HCAS) [11] or Virginia Department of Transportation's average pavement maintenance value ($0.07/VMT). The HCAS attributes pavement damage marginal costs (as well as congestion, crashes, air pollution, and noise) to trucks and autos (by weight class and/or area type) in terms of $/VMT. Costs are reported in 2000 dollars, which are converted to current year dollars in BCA comparisons. In the case of heavy trucks, the unit values are reported by truck Gross Vehicle Weight Rating (GVWR) of 60,000 and 80,000 lb, for both urban and rural highway VMT. The values range from $0.03/VMT for 60,000-rural to $0.41/VMT for 80,000-urban. The performance indicator for preservation of highway infrastructure can be truck VMT saved or avoided, lane-miles with avoided pavement maintenance/damage costs, or the pavement maintenance/damage savings.

CATEGORY: TRANSPORTATION

Criterion 4. Safety and Security

Safety and security benefits can be measured by reductions in crashes, fatalities, injuries, and property damage and specific credit is given to projects in distinctive areas, to projects that address the ability to handle transportation emergencies (such as those caused by natural disasters), to projects that improve on security concerns, and to projects that address specific needs such as hazardous materials transportation safety and security.

Sub-Criterion 4.1: Crashes, Fatalities, Injuries; and

Sub-Criterion 4.2: Property Damage

Safety savings consist of the reduction in the number and monetary value of crashes, fatalities, and injuries—often categorized by severity—along with property damage. Savings are realized on the basis of reduced exposure from reduced truck VMT (or avoidance of higher exposure from higher truck VMT) and eliminated exposure through grade separations. Emphasis should be placed on these criteria when a proposed project is located at or near a school, hospital, nursing home, church, or other such facility and the project generally has distinctive potential to improve safety with respect to a special population group.

Along highway links, crash rates may come in different forms, but they are typically converted to crashes, fatalities, injuries, and property damage per truck VMT, and then multiplied by the truck VMT estimate to obtain the expected crash reduction or avoidance. Grade crossing specific crash rates are obtained from databases of the Federal Railroad Administration's (FRA) [9] or the state. Grade crossing crash forecasts utilize FRA crash prediction equations. The national average monetary unit values for lives (fatalities), injuries, and property damage are usually used to estimate safety savings. The expected reduced or avoided fatalities, injuries, and property damage crashes are multiplied by the monetary unit values to calculate the total monetary value of the safety benefits.

If a grade crossing already has low accident prediction rates or little/no crash history the public benefits from a grade separation will be lower than if a grade crossing has high accident prediction rates or extensive crash history. Projects that only include grade separations at crossings with no prior crash history and no truck VMT savings or avoidance show up in the calculations as offering no public safety benefits, since there will be no change in the number of crashes under the "Build" scenario. However, BCAs note the levels of exposure or risk at those crossings in this case.

Sub-Criterion 4.3: Security;

Sub-Criterion 4.4: Natural Disasters; and

Sub-Criterion 4.5: Hazardous Materials

Public benefits related to safety (other than crashes) and security typically include implementation of improvements that address concerns with national security/terrorism, emergency vehicle access, hazardous materials (hazmat) movements, location of hazmat/dump sites, and natural disasters. If there are specific positive impacts associated with the project, BCAs provide descriptions. Examples include projects involving grade separations that would enhance emergency vehicle access, or rehabilitation or new construction of drainage structures.

Criterion 5. Connectivity

Connectivity improvement of the transportation network through the rail project is typically demonstrated qualitatively through discussions of the positive impact of the project, e.g., providing a critical connection with or between highways, transit, airports, bikeways, waterways, walkable areas, or other types of facilities, existing or planned. To the extent that such benefits can be effectively modeled by local/regional planning agencies, quantitative data may be used to evaluate the connectivity benefits of a given project.

Criterion 6. Congestion Relief

Sub-Criterion 6.1: Travel Time;

Sub-Criterion 6.2: Recurring Congestion (Bottlenecks); and

Sub-Criterion 6.3: Non-recurring Congestion

The performance indicators for these benefits are typically estimated through a single process to calculate the travel time reduction, increase in average train speed and reduced travel time variability.

Highway congestion relief/mobility benefits involve the calculation of the total before-and-after VMT and travel time on the highway network. VMT and travel time savings (or avoided increases) represent the difference between the before and after cases. The savings are realized along highway links and/or at at-grade grade crossings, depending on the project's characteristics.

In calculations for delay reduction or elimination at grade crossings, some BCAs use the FRA's GradeDec [10] methodology to calculate total time-in-queue (vehicle-hours) at each grade crossing to determine the before-and-after effect of the project. As with other categories, use of a variety of methods, data sources, and assumptions can often lead to comparisons that may not be equal across the board.

Analyses that do not involve grade crossing delay reductions or elimination often stay at the truck VMT calculation level and apply the marginal costs for congestion (in $/VMT) to each truck type to calculate total congestion monetary benefits. The marginal costs for congestion (as well as pavement, crashes, air pollution, and noise) attributed to trucks and autos (by weight class and/or area type) are reported in the HCAS [11] in 2000 dollars, which are converted to current year dollars for an evaluation.

Analyses that involve grade crossing delay reductions or elimination and rail passenger travel time savings proceed by calculating the travel time saved by motorists and/or rail passengers and applying dollar values per unit time to obtain the total monetary benefit of travel time saved or extra travel time avoided by the public. Sources for the value of time are generally stated to be federal [12] or state data, studies and models, which may recommend differing approaches or dollar values.

There is no official standard value for the value of time, but generally acceptable ranges are typically based on prevailing hourly wage rates. Thus travel time public benefits are sensitive to both truck VMT estimates and to the monetary value of unit time used in the calculation.

Criterion 7. System Capacity

Rail system capacity improvement can be evaluated through calculation of the additional number or weight of train cars, for example, that can be transported due to implementation of the rail project. This is typically performed by the operating railroad through the RTC model outlined above.

CATEGORY: IMPLEMENTATION

Criterion 8. Cost Effectiveness

Project performance with regard to cost effectiveness can be evaluated through estimation of the project's Net Present Value (NPV), which is the NPV of all monetized benefits minus the NPV of all monetized costs; the Benefit-Cost Ratio (BCR), which is the project's total monetized benefits divided by the total monetized costs; and Operation and Maintenance (O&M) costs. The level of complexity undertaken in BCAs and EIAs usually prescribes the extent to which the various project benefits are quantified and monetized.

Sub-Criterion 8.1: Net Present Value

The NPV of the project is the difference between the NPV of benefits and the NPV of costs, and it is a way to decide whether or not to invest in a rail project by looking at the projected cash inflows and outflows. If the value of NPV is positive, then the rail project is a go because it indicates that the project is profitable and worth the risk. If the value of NPV is negative, then the rail project is not worth the risk and is a no-go. In another words, TxDOT should pass on it. If the value of NPV is zero, it indicates that the project investment would neither gain nor lose value. Thus, the investment decision should consider additional criteria. Broadly speaking there are five steps for calculating the NPV: (1) select the discount rate; (2) identify the costs/benefits to be considered; (3) quantify and monetize those costs/benefits; (4) calculate NPV of each alternative; and (5) select the offer with the best NPV.

Sub-Criterion 8.2: Benefit-Cost Ratio

A BCR is an indicator used to identify the relationship between the costs and benefits of a proposed project. It is used in the formal discipline of benefit-cost analysis that attempt to summarize the overall value for money of a project. A BCR is calculated as the benefit of the project investment divided by the cost of the project investment. Benefits and costs are often expressed in money terms, and are adjusted for the time value of money, so that all flows of benefits and flows of project costs over time are expressed on a common basis in terms of their discounted present values.

Sub-Criterion 8.3: Operation and Maintenance Cost

O&M costs are the costs incurred for the purposes of the administration, supervision, operation, maintenance, and preservation of the project. They further consist of a number of cost components, including insurance, regular maintenance, repair, and administration over the lifetime of the project. They can be expressed as a lump sum over the lifetime of a proposed project or in terms of dollars per mile per year, for example. Sources for O&M costs can include state DOTs, railroads, and consultants-preparers of the analysis depending on experience and expertise to arrive at reliable estimates.

Criterion 9. Project Development

This is a qualitative indicator and considers the stage of development/readiness of the project based upon:

- Whether preliminary or final engineering plans are complete or underway.
- NEPA compliance documentation is complete or underway.
- If the project is only at the conceptual stage.

This analysis has to coordinate between inclusion of the project in a state or MPO 4-year Transportation Improvement Program (TIP) after funding becomes available and inclusion of the project in a state or MPO 4-year TIP before federal funds are used, as federal funds cannot be used otherwise.

The environmental clearance must be considered early in the process of project development, especially rail projects, and plan for the worst case scenario, i.e., the need to prepare a full-blown Environmental Impact Statement (EIS) even if it eventually turns out that only an Environmental Assessment (EA) is required (with a Finding of No significant Impact) or the project is granted a Categorical Exclusion (CE).

Criterion 10. Partnerships

This indicator is a qualitative one and involves discussion on the status and type of committed partnerships between the public and private sector; or between public agencies at various levels; or general levels of agency support; or level of public support.

Criterion 11. Innovation

This is a qualitative indicator that involves discussion on the implementation of institutional innovations, e.g., planning process, project delivery process; technological innovation such as cutting-edge safety and security improvements; or design innovations such as Leadership in Energy and Environmental Design (LEED) or other type of sustainable design.

TOOLS FOR CALCULATING INDICATORS OF FUTURE PERFORMANCE

This sub-section provides a short overview of the most widely used, off-the-shelf tools to calculate the indicators of future performance of rail projects according to the methodologies discussed above. There are a host of available tools that are typically corporate products and may differ in scope and other characteristics. A more elaborate and extensive discussion of an array of currently available tools, their requirements, issues, strengths, and limitations is provided in NCFRP Report 12 *Framework and Tools for Estimating Benefits of Specific Freight Network Investments* prepared by Cambridge Systematics, Inc. and published by the Transportation Research Board.

Regional Input-Output Modeling System (RIMS II) (Bureau of Economic Analysis)

IMPLAN (Minnesota IMPLAN Group Inc.)

REMI Policy Insight (Regional Economic Models Inc.)

IO models have limited application for transportation impact analysis. In the U.S., the two most widely used IO tools are IMPLAN and RIMS-II. Both are regional impact systems—built on the basis of the same national U.S. Department of Commerce accounting system—to trace how changes direct in the flow of purchases or sales of one industry lead to broader indirect and induced changes in purchases and sales (and ultimately jobs and income) in other industries in that region. That makes them very useful for estimating the local impact of industry openings, closings, expansions, and contractions.

As a result, both IMPLAN and RIMS-II are widely used to show the job and income impacts of operating or expanding transportation facilities. However, neither tool can estimate how the impact of changes in costs or market access, which are the two key impacts of most freight rail and highway projects. For such applications, it is necessary to utilize an external methodology or tool to translate changes in transport costs, or access characteristics into direct impacts on the behavior of transportation system users, before an IO model can be used to broader impacts.

In the U.S., the REMI Policy Insight model emerged during the 1980s as a structural simulation model for regional and statewide estimation of economic impacts. It shares many of the features of a spatial model, combining interindustry IO equations with transport price response and additional impacts on labor supply/demand and migration rates. To estimate impacts of transport projects or policies, there are REMI Policy Insight inputs, including generic transport cost and overall business operating cost by industry. Changes in "effective distance" between regions can also be used to calculate changes in generalized transportation costs by industry, which can then affect interregional trade. REMI Policy Insight is flexible and can be built for relatively small areas (counties) or for larger regions. In practice, REMI Policy Insight also needs a front-end tool to translate freight-related transportation impacts into economic model inputs.

RIMS, IMPLAN, and REMI are typically used to calculate indicators of future performance that relate to Economic Impacts (Criterion 1).

MOBILE6/MOVES (EPA)[1]

Developed by EPA's Office of Transportation and Air Quality (OTAQ), MOBILE6 is a currently approved but gradually phased-out model that generates emission factors for on-road motor vehicles (passenger cars to heavy-duty trucks) for use in transportation analyses at the state, region, or project level, in grams/VMT. In addition to criteria pollutants, such as hydrocarbons (HC), carbon monoxide (CO), oxides of nitrogen (NOx), and particulate matter (PM), and mobile source air toxics (MSAT), the model generates CO_2 (and other GHG) emission factors, which can be combined with VMT data to estimate CO_2 emissions. The CO_2 emission factors in only account for vehicle type and model year; they do not account for impacts of

[1] U.S. Environmental Protection Agency. Transportation and Air Quality Modeling and Inventories. http://www.epa.gov/otaq/models.htm. Accessed May 2011.

vehicle operating conditions (e.g., travel speeds) on CO_2 or expected changes in future vehicle fuel economy.

EPA's OTAQ developed the Motor Vehicle Emission Simulator (MOVES). This new emission modeling system estimates emissions for on-road mobile sources (cars, trucks, and motorcycles) covers a broad range of pollutants and allows multiple scale analysis, from fine-scale analysis to national inventory estimation. MOVES2010a incorporates new car and light truck energy and greenhouse gas rates and a number of other improvements. EPA plans to add the capability to model non-highway mobile sources in future releases.

When fully implemented, MOVES will serve as the replacement for MOBILE6 and NONROAD for all official analyses associated with regulatory development, compliance with statutory requirements, and national/regional inventory projections. MOVES2010 is approved for use in official SIP submissions and there is currently a two-year grace period before MOVES2010 is required to be used in new regional emissions analyses for transportation conformity determinations outside of California. EPA will be publishing a separate Notice of Availability to approve MOVES2010 for project-level transportation conformity hot-spot analyses when guidance is finalized.

MOVES and MOBILE6 are typically used to calculate indicators of future performance that relate to Environmental Impacts (Criterion 2) specifically Air Quality (Sub-Criterion 2.1) and Energy Usage (Sub-Criterion 2.2).

Rail Traffic Controller (Berkeley Simulation Software)

RTC belongs to a class of railroad operations tools which estimate how a given rail infrastructure improvement would change volumes, speeds, and reliability. These simulation systems are used by railroads to prioritize routing of trains through the network, identify conflicts, and measure effectiveness. The source data include specific track, siding and yard conditions, plus road, local and work train characteristics, and schedules that are proprietary to the railroads. Analysis is usually performed by the railroads and results are disclosed within the scope of public-private partnerships and other cooperative agreements.

RTC is typically used to calculate rail-specific indicators of future performance under Environmental Impacts (Criterion 2) more specifically Energy Usage (Sub-Criterion 2.2), and System Capacity (Criterion 7).

GradeDec.Net (FRA)

This tool, sponsored by the FRA, is a web-based system for evaluating the safety impacts and the benefit-cost of improvements to highway-rail grade crossings in a corridor or region. The tool is freely accessible over the Internet and requires no user-installed software besides a web browser. The tool has been used by DOTs, railroads, MPOs, and consultants for projects in dozens of jurisdictions. The benefits considered by GradeDec.Net include the array of highway user costs (travel time and vehicle operating costs), safety effects for highway and rail users, and environmental impacts.

From a freight planning perspective, it can be important to consider the fact that growth in railroad traffic near rail-highway intermodal facilities and large railroad traffic diversions due to system improvements often result in more frequently blocked crossings and blocks of longer duration, which are a focus of GradeDec.Net. Congestion and environmental effects due to queued vehicles at crossings are a major concern when considering rail system upgrades to accommodate increased flows of freight in the vicinity of metropolitan areas. GradeDec.Net includes a number of features for evaluating the benefit-cost of roadway capital improvements at crossings (i.e., grade separations, approach improvements); and traffic management mitigating measures (i.e., one-way restrictions, redirection of traffic to adjacent crossings, signal synchronization). The tool permits the specification of percentage of trucks in the traffic mix. GradeDec.Net allows for the evaluation of multiyear capital improvements in a corridor. It also has built-in risk analysis capabilities and benefit-cost, and intermediate results can be viewed in charts and reports as probabilistic ranges.

GradeDec.Net is typically used to calculate indicators of future performance that relate specifically to highway-rail grade crossings under Congestion Relief (Criterion 6).

Surface Transportation Efficiency Analysis Model (STEAM) (FHWA)

STEAM is a model designed to assess multimodal urban transportation investment and policy alternatives at the regional and corridor levels. Transportation system alternatives may include up to seven modes. Peak and off-peak periods and multiple trip purposes may be considered. The model is closely linked to outputs from the 4-step urban transportation modeling process. STEAM is used less often than other tools but is typically used to calculate indicators of future performance that relate to Noise and Vibration (Sub-Criterion 2.4) under Environmental/ Social Impacts (Criterion 2).

SECTION 3. RAIL PROJECT EVALUATION PROCESS

This section presents a systematic process and the associated tool that allows TxDOT to evaluate and prioritize its statewide investments in rail-related projects. A transparent methodology is recommended for evaluating proposed rail projects and establishing a process through which the methodology can be applied periodically to re-evaluate rail-related investments and compare them against one another in order to determine the most appropriate manner in which to utilize available public funds for freight and passenger rail projects.

TxDOT Strategic Goals

The project evaluation process developed is both transparent and linked to the TxDOT Strategic Plan goals—as emphasized by TxDOT. The goals under the newly adopted 2011–2015 TxDOT Strategic Plan are to:

- Develop an organizational structure and strategies designed to address the future multimodal transportation needs of all of Texas.
- Enhance safety for all Texas transportation system users.
- Maintain the existing Texas transportation system.
- Promote congestion relief strategies.
- Enhance system connectivity.
- Facilitate the development and exchange of comprehensive multimodal funding strategies with transportation program and project partners.

Evaluation Criteria

The list of 11 evaluation criteria shown in Table 1 have been identified that should be considered for all rail projects was developed to address the TxDOT strategic goal framework. The criteria were selected based upon an extensive review of other states' rail and/or multimodal planning methodologies, international rail project prioritization and funding activities, input from the TxDOT State Rail Plan Steering Committee, and criteria developed for recent federal infrastructure funding initiatives. These criteria are divided into the three broad categories of sustainability, transportation, and implementation that planning agencies should take into account when evaluating the overall utility of any rail project.

The sustainability category includes those criteria that weigh the economic, environmental, and social benefits of a project and its long-term ability to preserve existing transportation assets. The transportation category considers safety and security, connectivity, mobility, and capacity issues that are traditionally taken into account for transportation project evaluation. The implementation category encompasses those criteria that are related to the financial and/or technical features of a project that improve its ability to be realized more quickly. In addition, each of the criteria in Table 1 can be further broken down into multiple sub-criteria. Table 3 provides a short description of the scope of each criterion.

Evaluation Matrix

Table 4 shows an example rail project evaluation matrix based on the 11 evaluation criteria and the six goals of the 2011–2015 TxDOT Strategic Plan. To ensure that this rail project evaluation matrix better demonstrates the TxDOT strategic goals, each criterion is linked to the goal(s) it primarily addresses and the goal(s) it secondarily addresses. Descriptions and guidance on using this evaluation matrix, including the weighing and rating of criteria and the scoring methodologies are described in the following sections.

Table 3. Rail Project Evaluation Criteria Descriptions.

Sustainability	
1. Economic Impact	The economic impact criterion examines the economic value of the project. A variety of factors to consider include direct, indirect, and induced job creation; short- and long-term job creation, shipper savings, tax revenues that could be potentially generated, and long-term economic growth that could be attributed to the project. *Quantitative measures:* Job creation; Shipper savings; Tax revenues; Long-term economic growth *Qualitative measures:*
2. Environmental/ Social Impact	The environmental and social justice criterion evaluates the environmental and social impacts that are likely to accrue from the project. Examples of factors include air quality, energy use, impacts on natural resources, noise and vibration issues, and impact of the project on disadvantaged populations. *Quantitative measures:* Air quality; Energy usage *Qualitative measures:* Natural resources; Noise and vibration; Disadvantaged populations
3. Asset Preservation	The asset preservation criterion evaluates the ability of the project to assist in preserving existing TxDOT or other state assets with a particular emphasis on existing public sector transportation infrastructure (e.g., highways and associated rights of way) and/or privately-held transportation infrastructure (e.g., freight railroad infrastructure and rights of way). *Quantitative measures:* Preservation of rail infrastructure; Preservation of highway infrastructure *Qualitative measures:*

Transportation	
4. Safety and Security	The safety and security criterion evaluates the safety benefits and security enhancements that will accrue by implementation of the project. This takes into account crashes, fatalities, and injuries that may be prevented; property damage averted; and physical and operational security measures featured in the project. It may also give specific credit to projects that address the ability to handle transportation emergencies, such as those caused by natural disasters, to projects that address specific needs such hazardous materials transportation safety and security. *Quantitative measures:* Crashes, fatalities, and injuries; Property damage *Qualitative measures:* Security; Natural disasters; Hazardous materials
5. Connectivity	The connectivity criterion allows for project evaluation based upon its characteristics that relate to the ability to connect other existing and/or planned projects. Examples of a project attribute include the way in which a proposed intercity or commuter rail service connects with the urban transit services in urban areas or the way in which a proposed new freight rail line or urban bypass route serves existing freight distribution activity centers. *Quantitative measures:* *Qualitative measures:* Connectivity of transportation network
6. Congestion Relief	The congestion relief criterion accounts for travel time improvements, relief or removal of rail traffic and/or highway bottlenecks, and for alleviation of non-recurring congestion as the result of special events. Example projects include those making rail line improvements to allow improved freight/passenger rail travel times, rail-rail grade separation projects addressing rail congestion, or highway-rail grade separations that remove delay caused by train activity to motorists. *Quantitative measures:* Travel time; Recurring congestion (bottlenecks); Non-recurring congestion *Qualitative measures:*

7. System Capacity	The system capacity criterion evaluates the project as it relates to overall transportation system capacity needs. Examples of such a project might be rail infrastructure capacity improvement projects, such as adding sidings, double-tracking, or improving signaling in order to increase the daily throughput along a corridor. *Quantitative measures:* Throughput *Qualitative measures:*

Implementation	
8. Cost Effectiveness	The cost effectiveness criterion looks at the overall benefit derived from the investment applied to the project. It could encompass several methods of calculation (benefit-cost analysis, etc.) or be subjectively scored based on expected costs and outcomes depending on the level of project development at the time the projects are ranked. *Quantitative measures:* Net present value; Benefit-cost ratio; Operation and maintenance cost *Qualitative measures:*
9. Project Development	The project development criterion evaluates the stage of project development in relation to whether detailed engineering plans and environmental compliance (e.g., National Environmental Policy Act [NEPA] documents are complete or underway; and whether the project is part of a 4-year state or MPO TIP if not, federal funds cannot be used). Projects with major planning studies already completed would score higher than conceptualized projects. *Quantitative measures:* *Qualitative measures:* Stage of development
10. Partnerships	The partnership criterion allows for credit to be given to a project for maximizing the partnership features to produce a more readily implementable project. The partnerships may consist of public-private partnerships, partnerships between multiple government agencies, or other types of partnerships. *Quantitative measures:* *Qualitative measures:* Public-private partnerships; Public agency partnerships; Public support

11. Innovation	The innovation criterion provides an additional scoring opportunity for projects that exhibit technological and/or institutional innovation. This could refer to the technology proposed for implementation of a certain service or operation, or innovation related to creative funding methods from a variety of public and private sources. *Quantitative measures:* *Qualitative measures:* Technological innovation

Table 4. Rail Project Evaluation Matrix.

Criteria	Primary TxDOT Strategic Goal	Secondary TxDOT Strategic Goals	Rating	Weight (%)	Rating x Weight
Project Name:		**Project Type:**			
A. SUSTAINABILITY					
1. Economic Impact	**4**	**1,3,5**		10	0
Does the project provide for positive economic impacts on the community and/or state?			VH-H-M-L-N (10-7-5-3-0)		
2. Environmental/Social Impact	**4**	**1,3,5**		10	0
Does the project minimize/address environmental impacts?			VH-H-M-L-N (10-7-5-3-0)		
Does the project address community impacts?					
3. Asset Preservation	**3**	**1,4,5,6**		15	0
Does the project address the long-term preservation of the system?			VH-H-M-L-N (10-7-5-3-0)		
B. TRANSPORTATION					
4. Safety & Security	**2**	**1,3,4**		10	0
Does the project improve safety and security?			VH-H-M-L-N (10-7-5-3-0)		
5. Connectivity	**5**	**1,4,6**		10	0
Does the project improve/complete network linkages or connections?			VH-H-M-L-N (10-7-5-3-0)		
6. Congestion Relief	**5**	**1,2,3,4,6**		10	0
Does the project improve system operations?			VH-H-M-L-N (10-7-5-3-0)		
7. System Capacity	**5**	**1,2,3,4,6**		15	0
Does the project improve throughput?			VH-H-M-L-N (10-7-5-3-0)		
C. IMPLEMENTATION					
8. Cost Effectiveness	**6**	**1,3,4,5**		5	0
Does the project show positive economic value?			VH-H-M-L-N (10-7-5-3-0)		
Does the project have an identified funding source?					
9. Project Development	**6**	**1**		5	0
How developed is the project?			VH-H-M-L-N (10-7-5-3-0)		
Is the project part of an existing local or regional transportation plan?					
10. Partnerships	**6**	**1**		5	0
Does the project have committed partnerships?			VH-H-M-L-N (10-7-5-3-0)		
11. Innovation	**4**	**1,5,6**		5	0
Does the project involve innovative planning processes, technology, and/or financing?			VH-H-M-L-N (10-7-5-3-0)		
			(HAS TO EQUAL 100)	100	
			PROJECT COMPOSITE SCORE		**0**

Weighting of Criteria

In order to reflect a criterion's importance relative to other criteria and to the overall score of a proposed project a weight value is assigned. The weight is entered into the evaluation matrix as a percentage of the overall project evaluation—therefore, the total of the weight column must equal 100. TxDOT Rail Division has selected the scale shown in Table 5 as the standard weight scale that will be applied to all projects during the initial period of use of this prioritization methodology. Should a new competitive federal or other rail project funding source become available that emphasizes one or more of the criteria more heavily than this weight scale does, TxDOT Rail Division staff may seek official permission from the Transportation Commission to adjust the weighting scale and re-evaluate those projects that might be most appropriate for the specific funding program.

Table 5. Rail Project Criteria Weight Scale.

Category	Criterion	Weight
Sustainability	1. Economic Impact	10
	2. Environmental/Social Impact	10
	3. Asset Preservation	15
Transportation	4. Safety & Security	10
	5. Connectivity	10
	6. Congestion Relief	10
	7. System Capacity	15
Implementation	8. Cost Effectiveness	5
	9. Project Development	5
	10. Partnerships	5
	11. Innovation	5
		100

Project Rating

The rating of a project with respect to each criterion is based on a user-defined scale common to all criteria. The rating assigned to each criterion is then multiplied by its weight thus providing the composite score of the project with respect to that criterion. For each project that is evaluated a rating score using a scale from 0 to 10 will be assigned to each criterion, where in general 10 reflects the "highest positive outcome" and 0 reflects "no positive outcome."

The rating assigned to each criterion can be based on a qualitative assessment or the results of external quantitative analyses of a proposed project's *expected* performance toward each criterion. Quantification of several criteria takes place typically within external analyses such as Benefit-Cost Analyses and Economic Impact Analyses. Some criteria may lend themselves to direct quantification others may not partly because clear definitions and methodologies to do so have not been fully developed yet. For non-quantifiable or qualitative criteria the rating will be determined based on the professional experience and expertise of TxDOT staff and/or an advisory panel consisting of industry experts and members of the public the latter of whom might rate a project based on personal preferences.

The scope of this guidebook is the prioritization process for proposed rail projects, or the "before" stage. Therefore it focuses on and discusses a project's *expected* performance and the criteria and elements to consider in the prioritization process. These criteria and sub-criteria, even ones that are non-quantifiable before a project is built, can correspond to specific performance measures. Performance measurement by definition takes place after a project is implemented and performance measures are typically quantifiable. The most commonly employed methodologies and tools to develop indicators to forecast a proposed project's future performance (after implementation) at the "before" stage for purposes of supporting the rating and prioritization process were discussed in the previous section of this guidebook. Table 6 describes the criteria, sub-criteria, corresponding elements to consider, and the rating method in order to assist project evaluators in making a determination when rating a proposed project against each criterion.

Table 6. Project Criteria, Sub-Criteria, Considerations, and Rating Method.

Sustainability		
Criterion	**Considerations**	**Rating**
1. Economic Impact	Will the project have a positive economic impact on the community and/or state? *Elements to consider:* • Job creation. • Shipper savings. • Tax revenues. • Long-term economic growth.	10 = Yes – Exceptional 7 = Yes – Significant 5 = Yes – Moderate 3 = Yes – Minor 0 = No
2. Environmental/ Social Impact	Will the project reduce, minimize, or mitigate negative environmental impacts? Will it bring about positive environmental impacts? *Elements to consider:* • Air quality. • Natural resources, e.g., habitats, wetlands, national parks. • Energy usage. • Noise and vibration. • Visual aesthetics. Will the project reduce, minimize, or mitigate negative social impacts? Will it bring about positive social impacts? Elements to consider: • Neighborhood cohesiveness. • Disadvantaged populations, e.g., minorities, low-income, old, young, disabled.	10 = Yes – Exceptionally 7 = Yes – Significantly 5 = Yes – Moderately 3 = Yes – Slightly 0 = No

3. Asset Preservation	Will the project positively impact the long-term preservation or improvement of the system? *Elements to consider:* • Preservation of rail corridors. • Preservation of highway corridors.	10 = Yes – Exceptionally 7 = Yes – Significantly 5 = Yes – Moderately 3 = Yes – Slightly 0 = No
Transportation		
Criterion	**Description**	**Rating**
4. Safety and Security	Will the project completely remove or reduce risks associated with safety and security? *Elements to consider:* • Total number of crashes. • Number of fatalities. • Number of injuries. • Property damage costs. • Security. • Natural disasters. • Hazardous materials.	10 = Yes – Complete removal 7 = Yes – Significant reduction 5 = Yes – Moderate reduction 3 = Yes – Minor reduction 0 = No reduction
5. Connectivity	Will the project complete or improve critical network links or connections on/between existing or planned facilities? *Elements to consider:* • Connectivity, e.g., along a major road/rail network link and/or intermodal connector, between two or more road/rail network links and/or intermodal connectors, etc.	10 = Yes – Exceptionally (critical link) 7 = Yes – Significantly 5 = Yes – Moderately 3 = Yes – Slightly 0 = No

6. Congestion Relief	Will the project improve systemwide mobility (traffic flow)? *Elements to consider:* • Travel Time. • Travel Speed. • Recurring congestion points (bottlenecks). • Non-recurring congestion.	10 = Yes – Exceptionally 7 = Yes – Significantly 5 = Yes – Moderately 3 = Yes – Slightly 0 = No
7. System Capacity	Will the project create additional capacity or otherwise improve system throughput? *Elements to consider:* • Throughput.	10 = Yes – Exceptional 7 = Yes – Significant 5 = Yes – Moderate 3 = Yes – Minor 0 = No
Implementation		
Criterion	**Description**	**Rating**
8. Cost Effectiveness	Will the project show positive economic value? *Elements to consider:* • Benefit-Cost Ratio. • Net Present Value. • Internal Rate of Return. • Identified funding source. • Operation and Maintenance cost.	10 = Yes – Exceptional 7 = Yes – Significant 5 = Yes – Moderate 3 = Yes – Minor 0 = No
9. Project Development	What stage of development are project plans currently at? *Elements to consider:* • Engineering design (preliminary and final). • Environmental documents (NEPA compliance). • Is the project part of a 4-year state or MPO TIP? (if not, federal funds cannot be used)	10 = Full development 7 = Significant 5 = Moderate 3 = Concept stage 0 = Proposal stage

10. Partnerships	What is the level of committed partnerships to the project? What is the level of general support for the project? *Elements to consider:* • Public-private partnerships. • Partnerships between local/regional/state public agencies. • General level of support from local/regional/private entities and the general public.	10 = Exceptional 7 = Significant 5 = Important 3 = Minor 0 = None
11. Innovation	Will the project involve implementation of innovative practices? *Elements to consider:* • Planning processes. • Technology implementation. • Funding/financing mechanisms. • Other.	10 = Yes – Exceptional 7 = Yes – Significant 5 = Yes – Moderate 3 = Yes – Minor 0 = No

Composite Score

When the rating and weight are multiplied, a score for each criterion is calculated. The sum of the criteria composite scores provides a final overall composite score, for which the maximum is equal to the maximum in the chosen rating scale (10) multiplied by 100. Thus the maximum composite score for any project would be 1,000 points. Individual projects could also be compared on the basis of their score in individual criteria if a more specific objective such as connectivity was of primary importance. The development of less discrete rating scales (for example 7 rating levels instead of 5 for each criterion) could also refine the precision of the evaluation. The output (total score) from each project's matrix evaluation would then be used to populate a table, which would allow for direct cross comparison of the projects to one another. Table 7 provides an example of how such a table would be formatted.

Once all projects are evaluated using the methodology described, a list of scored projects from which subsets of projects meeting the criteria of specific funding programs or projects addressing specific future TxDOT priorities can be selected. The use of this should allow the flexibility to respond quickly to emerging funding opportunities and, at the same time, ensure the stability provided by a transparent, well-defined process for prioritizing rail project decisions. As stated previously, this process will be refined by TxDOT during its Short Term Rail Program as described in the Texas Rail Plan and can be altered by Transportation Commission action.

Table 7. Project Cross Comparison.

		Sustainability			Transportation				Implementation				
		1	2	3	4	5	6	7	8	9	10	11	Composite Score
Project Name	Project Type	EI	ES	AP	SS	CO	CR	SC	CE	PD	PA	IN	
	Criteria Weight (Total=100%)	10	10	15	10	10	10	15	5	5	5	5	Max = 1000
	Measure	VH-H-M-L-N	VH-H-M-L-N	VH-H-M-L-N	VH-H-M-L-N	VH-H-M-L-N	VH-H-M-L-N	VH-H-M-L-N	VH-H-M-L-N	VH-H-M-L-N	VH-H-M-L-N	VH-H-M-L-N	
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Rating Scale	
Exceptional (VH)	10
Significant (H)	7
Moderate/Important (M)	5
Minor (L)	3
None (N)	0

Criteria		
Sustainability	**Transportation**	**Implementation**
Economic Impacts (EI)	Safety & Security (SS)	Cost Effectiveness (CE)
Environmental/Social Impact (ES)	Connectivity (CO)	Project Development (PD)
Asset Preservation (AP)	Congestion Relief (CR))	Partnerships (PA)
	System Capacity (SC)	Innovation (IN)

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