ITTS FREIGHT INVESTMENT PERFORMANCE MONITORING GUIDEBOOK

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ITTS Freight Investment Performance Monitoring Guidebook

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List of Acronyms

AADT	Annual Average Daily Traffic
BCA	Benefit-Cost Analysis
BUILD	Better Utilizing Investments to Leverage Development
BTS	Bureau of Transportation Statistics
CCTV	Closed-Circuit Television
CDA	Comprehensive Development Agreement
CFS	Commodity Flow Survey
DART	Dallas Area Rapid Transit
DBFOM	Design-Build-Finance-Operate-Maintain
DOT	Department of Transportation
EMFAC	EMission FACtor
FAF	Freight Analysis Framework
FAST	Fixing America's Surface Transportation
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FTEIK	Freight Transportation Economic Impact Kit
GIS	Geographic Information System
GPS	Global Positioning System
HOV	High-Occupancy Vehicle
INFRA	Infrastructure for Rebuilding America
IRI	International Roughness Index
ITS	Intelligent Transportation System
ITTI	Institute for Trade and Transportation Studies
LBJIG	LBJ Infrastructure Group LLC

LOS	Level of Service
LOTTR	Level of Travel Time Reliability
MAP-21	Moving Ahead for Progress in the 21st Century
MARAD	Maritime Administration
MDOT	Maryland Department of Transportation
MMUCC	Model Minimum Uniform Crash Criteria
MOVES	MOtor Vehicle Emissions Simulator
MPA	Maryland Port Administration
MPO	Metropolitan Planning Organization
NAFTA	North American Free Trade Agreement
NCTCOG	North Central Texas Council of Governments
NEPA	National Environmental Protection Act
NHFP	National Highway Freight Program
NHS	National Highway System
NOFO	Notice of Funding Opportunity
NPMRDS	National Performance Management Research Data Set
NS	Norfolk Southern
OEM	Original Equipment Manufacturer
P3	Public-Private Partnership
PAC	Ports America Chesapeake, LLC
PBPP	Performance Based Planning and Programming
RAISE	Rebuilding American Infrastructure with Sustainability and Equity
RoRo	Roll On/Roll Off
RTC	Regional Transportation Council
SCDOT	South Carolina Department of Transportation

SCIP	South Carolina Inland Port
SCPA	South Carolina Ports Authority
SFP	Statewide Freight Plan
SMART	Specific, Measurable, Agreed-upon, Realistic, Time-bound
SOV	Single-Occupancy Vehicle
STB	Surface Transportation Board
STIP	Statewide Transportation Improvement Program
TEU	Twenty-Foot Equivalent Unit
TFMP	Texas Freight Mobility Plan
TIP	Transportation Improvement Program
TPM	Transportation Performance Management
TTTR	Truck Travel Time Reliability
TxDOT	Texas Department of Transportation
USACE	U.S. Army Corps of Engineers
USDOT	U.S. Department of Transportation
USMCA	United States-Mexico-Canada Agreement
VHT	Vehicle Hours Traveled
VMT	Vehicle Miles Traveled

1.0 Introduction

Freight investment performance monitoring includes the process of identifying the appropriate performance measures for gauging the effectiveness of a freight system investment and tracking how performance changes over time. By understanding how a specific investment has impacted freight performance at a corridor, sub-regional, or broader level, decision-makers are better able to allocate resources towards meeting performance targets. Freight investment performance monitoring fits within the broader transportation performance management (TPM) framework as a key focus of the TPM framework is to help decision-makers understand the consequences of investment decisions.[1]To be successful, performance monitoring must be aligned with an agency's goals and objectives and must use of targets to gauge the effectiveness of projects, programs, and policies.[2]

This guidebook introduces a framework for conducting freight investment performance monitoring. The development and use of this framework promotes transparency, accountability, and transferability for freight investment performance monitoring. It promotes transparency by providing a documented process to measure and track performance. It promotes accountability by helping agencies set targets, determine if those targets are met, and (if not) assess what must be changed to achieve the targets. Lastly, the framework promotes transferability through its application to various types of freight investments across modes.

The freight investment performance monitoring framework fits within the broader TPM framework, reflecting many of TPM's principles. Furthermore, the freight investment monitoring framework borrows elements of the Performance Based Planning and Programming (PBPP) framework.[3] While the PBPP framework is the application of TPM principles within planning and programming processes, the freight investment performance monitoring framework is the application of TPM principles within an investment's pre- and post-implementation phases.

[1] https://www.fhwa.dot.gov/tpm/about/tpm.cfm.

[2] https://www.tpmtools.org/#diagram.

[3] *Performance Based Planning and Programming Guidebook*, September 2013, FHWA-HEP-13-041, https://www.fhwa.dot.gov/planning/performance_based_planning/pbpp_guidebook/pbppguidebook.pdf.

2.0 What Is Freight Investment Performance Monitoring?

2.1 Why Measure Freight Investment Performance?

Freight investment performance measurement and monitoring is important for several reasons.[4, 5] Freight performance measures provide quantitative evidence of how well the freight system is performing. This allows the identification and tracking of challenges faced by the freight transportation system and an understanding of the underlying drivers. Addressing these challenges and assessing the improvement, or deterioration of the freight system, relies on monitoring performance relative to established targets. These targets help determine the impact and success of freight investments and initiatives. This is not possible without performance measures. Finally, given that freight investments are constrained by funding limitations, agencies must prioritize strategies and investments and make tradeoffs between achievements within different goal areas. For example, funding a highway capacity expansion may help a freight mobility goal area but hinder a state of good repair goal area as it would reduce funds available for maintenance. Effectively prioritizing projects and investment decisions requires objective measures of freight system performance.

The remainder of this section of the guidebook focuses on topics related to freight performance measurement. It discusses the federal requirements for performance measurement and monitoring including freight; summarizes the federal freight planning requirements for using National Highway Freight Program (NHFP) funds; discusses how freight performance measurement supports achieving agency (as informed by stakeholders) goals and objectives for freight; and discusses the benefits of measuring freight investment performance monitoring to transportation decision-making.

2.1.1 Federal Requirements for Performance Measurement and Freight Planning

Federal Requirements for Performance Measurement

In 2012, President Obama signed into law the Moving Ahead for Progress in the 21st Century Act (MAP-21) which provided funding for surface transportation programs and identified a policy and programmatic framework for investments to guide growth and development of the country's vital transportation infrastructure.[6] MAP-21 established national performance goals for purposes of enhancing the performance of the transportation network. In 2015, the efforts of MAP-21 were advanced by the Fixing America's Surface Transportation (FAST) Act.[7] The FAST Act required the Secretary of Transportation to implement the performance management framework established in MAP-21 by developing performance measures to assess the condition and performance of the highway system. These measures were established by rulemaking and are summarized in Table 2.1.

[4] Southworth, F., and J. Gillett, *Trucking in Georgia: Freight Performance Measures*, Georgia Transportation Institute University Transportation Center, Report 10-16, October 2011.

[5] BouMjahed, L., and J. L. Schofer, Freight Performance Measurement in FAST Act-Mandated State Freight Plans, Transportation Research Record, 1-15, 2019.

[6] Moving Ahead for Progress in the 21st Century Act, https://www.fhwa.dot.gov/map21/summaryinfo.cfm.

[7] FHWA, Overview of Highway Provisions in the FAST Act, https://www.fhwa.dot.gov/fastact/presentations.cfm.

Table 2.1 Federally Mandated Performance Measures

Rulemaking	Performance Measure	Description
Safety	Number of fatalities	The total number of persons suffering fatal injuries in a motor vehicle traffic crash during a calendar year.
	Rate of fatalities	The ratio of the total number of fatalities to the number of vehicle miles traveled (VMT) (expressed in 100 million VMT) in a calendar year.
	Number of serious injuries	The total number of persons suffering at least one serious injury for each separate motor vehicle traffic crash during a calendar year where the crash involves a motor vehicle traveling on a public road, and the injury status is “suspected serious injury (A)” as described in Model Minimum Uniform Crash Criteria (MMUCC).
	Rate of serious injuries	The ratio of the total number of serious injuries to the number of VMT (expressed in 100 million VMT) in a calendar year.
	Number of non-motorized fatalities	The total number of fatalities where the person suffering a fatal injury is a pedestrian or a bicyclist.
	Number of non-motorized serious injuries	The total number of serious injuries where the injured person is a pedestrian or a bicyclist.
Infrastructure (State of Good Repair)	Percentage of pavements of the Interstate System in Good condition	The percentage of pavements on the Interstate System with an overall rating of Good based on three conditions (International Roughness Index [IRI], cracking, and rutting or faulting).
	Percentage of pavements of the Interstate System in Poor condition	The percentage of pavements on the Interstate System with an overall rating of Poor based on three conditions (IRI, cracking, and rutting or faulting).
	Percentage of pavements of the non-Interstate National Highway System (NHS) in Good condition	The percentage of pavements on the non-Interstate NHS with an overall rating of Good based on three conditions (IRI, cracking, and rutting or faulting).
	Percentage of pavements of the non-Interstate NHS in Poor condition	The percentage of pavements on the non-Interstate NHS with an overall rating of Poor based on three conditions (IRI, cracking, and rutting or faulting).
	Percentage of NHS bridges classified as in Good condition	The percentage of bridges on the NHS with a Good rating based on deck, superstructure, and substructure conditions.
	Percentage of NHS bridges classified as in Poor condition	The percentage of bridges on the NHS with a Poor rating based on deck, superstructure, and substructure conditions.
System Performance	Percent of the person-miles traveled on the Interstate that are reliable	The percent of person-miles traveled on the Interstate System that exhibit a Level of Travel Time Reliability (LOTTR) below 1.50 during all required time periods.
	Percent of the person-miles traveled on the non-Interstate NHS that are reliable	The percent of person-miles traveled on the non-Interstate NHS that exhibit an LOTTR below 1.50 during all required time periods.
	Truck Travel Time Reliability (TTTR) Index	The length-weighted average of the maximum Truck Travel Time Reliability on Interstate System segments during all required time periods.

Rulemaking	Performance Measure	Description
	Annual Hours of Peak Hour Excessive Delay Per Capita	The cumulative hours of excessive delay (i.e., the additional amount of time to traverse a roadway segment as compared to the time needed when traveling at a threshold speed) experienced by people during peak hours in the urbanized area.
	Percent of Non-Single-Occupancy Vehicle (SOV) travel	The percentage of travel that is not occurring by driving alone in a motorized vehicle.
	Total Emissions Reduction	The cumulative reduction in emissions over 2 and 4 federal fiscal years.

Source: 23 CFR Part 490; Federal Highway Administration, https://www.fhwa.dot.gov/tpm/about/regulations.cfm, Accessed September 28, 2020.

The only freight-specific measure required by federal mandate is the TTTR Index. Higher values of the TTTR Index indicate less reliable truck travel while lower values indicate more reliable truck travel. Though not specific to freight, other federally mandated performance measures have implications for freight mobility. For example, traffic incidents are a major cause of nonrecurring congestion and associated delay for freight operations. The federally mandated infrastructure performance measures characterize the conditions of pavements and bridges, which have important implications for freight. For example, poor pavement conditions can result in higher vehicle operating costs in the form of decreased fuel efficiency and increased vehicle maintenance needs. For bridges, certain structural and functional deficiencies could result in load limits that hinder freight movement resulting is less efficient, more circuitous routes.

Federal Requirements for Freight Planning

The FAST Act included a provision that requires each state receiving funding under the National Highway Freight Program (NHFP) to develop a State Freight Plan (SFP). This plan must address the state's immediate and long-range freight planning activities and investments. The SFP may be developed separate from or incorporated into the required Long-Range Statewide Transportation Plan.

SFPs must meet a number of federal requirements for freight planning,[8] including:

- Identification of significant freight system trends, needs, and issues.
- A description of the freight policies, strategies, and performance measures that will guide the state's freight-related transportation investment decisions.
- When applicable, a listing of:
  - Multimodal critical rural freight facilities and corridors designated within the state under Section 70103 of Title 49 (National Multimodal Freight Network).
  - Critical rural and urban freight corridors designated within the state under Section 167 of Title 23 (NHFP).

[8] 49 U.S.C. 70202.

- A description of how the plan will improve the ability of the state to meet the national multimodal freight policy goals described in Section 70101(b) of Title 49, United States Code and the NHFP goals described in Section 167 of Title 23.
- A description of how innovative technologies and operational strategies, including freight intelligent transportation systems, that improve the safety and efficiency of the freight movement, were considered.
- In the case of roadways on which travel by heavy vehicles (including mining, agricultural, energy cargo or equipment, and timber vehicles) is projected to substantially deteriorate the condition of the roadways, a description of improvements that may be required to reduce or impede the deterioration.
- An inventory of facilities with freight mobility issues, such as bottlenecks, within the state, and for those facilities that are state owned or operated, a description of the strategies the state is employing to address those freight mobility issues.
- Consideration of any significant congestion or delay caused by freight movements and any strategies to mitigate that congestion or delay.
- A freight investment plan that, subject to 49 U.S.C. 70202(c), includes a list of priority projects and describes how funds made available to carry out 23 U.S.C. 167 would be invested and matched.
- Consultation with the State Freight Advisory Committee, if applicable.

In addition to the required elements, the U.S. Department of Transportation (USDOT) recommended multiple optional elements be considered for inclusion in SFPs. Though not required for compliance with the FAST Act, these elements enhance SFPs, especially in regard to freight performance measurement. Optional SFP elements that are relevant for this guidebook include the following:

- **20-Year or More Planning Horizon—**Though SFPs must address a 5-year forecast period, USDOT recommended an outlook of two decades or more. USDOT noted that a freight plan horizon of only 5 years would not enable states to do more than list present problems and projects already in the development pipeline, providing no preparation or planning for longer-term trends and new technologies.
- **Economic Trends and Forecasts Impacting Freight—**SFPs are required to identify freight system trends, but there is no requirement that states examine any specific trend. USDOT recommended that states examine the following trends: economic conditions at the global, national, regional, and local levels; population growth and location; income and employment by industry sector; freight attributes of industry sectors; the value, quantity, and type of foreign trade; industrial and agricultural forecasts; and forecasts of freight movements by commodity type and location.
- **Freight System Condition and Performance—**USDOT encouraged states to describe the condition and performance of their multimodal freight systems to help identify needs for future investments within states.
- **Freight System Performance—**USDOT recommended that states explain how they will measure the success of their strategies, policies, and objectives of their freight plans. Preferably, such measurements would be quantifiable and consistent with the measures used by states to describe the condition and performance of their multimodal freight system, and in other state planning documents and federal grant requests. This would allow states to determine if they are achieving their objectives and to quantify and assess outputs and outcomes relative to expectations.

2.1.2 Support for Achieving Goals and Objectives

Goals reflect an agency's vision and address key desired outcomes while objectives play a key role in determining investment priorities by providing specific measurable statements that support the achievement of goals. Together, they comprise a strategic direction for an agency that defines the desires of its multimodal freight system. Freight investment performance monitoring supports the achievement of goals and objectives by providing a formal process by which progress towards freight goals are assessed at the individual investment level. Monitoring performance over time after implementing a freight investment helps determine the effectiveness of the investment. While this type of before-and-after analysis has been common to safety (e.g., changes in crash rates), transit (e.g., changes in ridership), and other transportation investments, it has not been common for freight investments. Even with the freight performance management requirements included in the FAST Act, there is no requirement to examine the impact of any individual investment on the federal freight performance measure.

2.1.3 Support for Transportation Decision-Making

Freight investment performance monitoring also supports transportation decision-making. It allows decision-makers to better understand the consequences of an investment in terms of its impact to performance. By understanding how a specific investment has impacted freight performance, agencies are better able to identify the types of projects that will benefit the freight system and to develop projects in a manner that maximizes those benefits. Ultimately, freight investment monitoring enables decision-makers to more effectively allocate resources towards meeting performance targets.

2.2 How Does Freight Investment Performance Relate to Transportation Performance Management?

Freight investment performance monitoring can be viewed as a transportation performance management (TPM) practice. This section of the guidebook discusses TPM, PBPP, and how freight investment performance monitoring is a TPM practice.

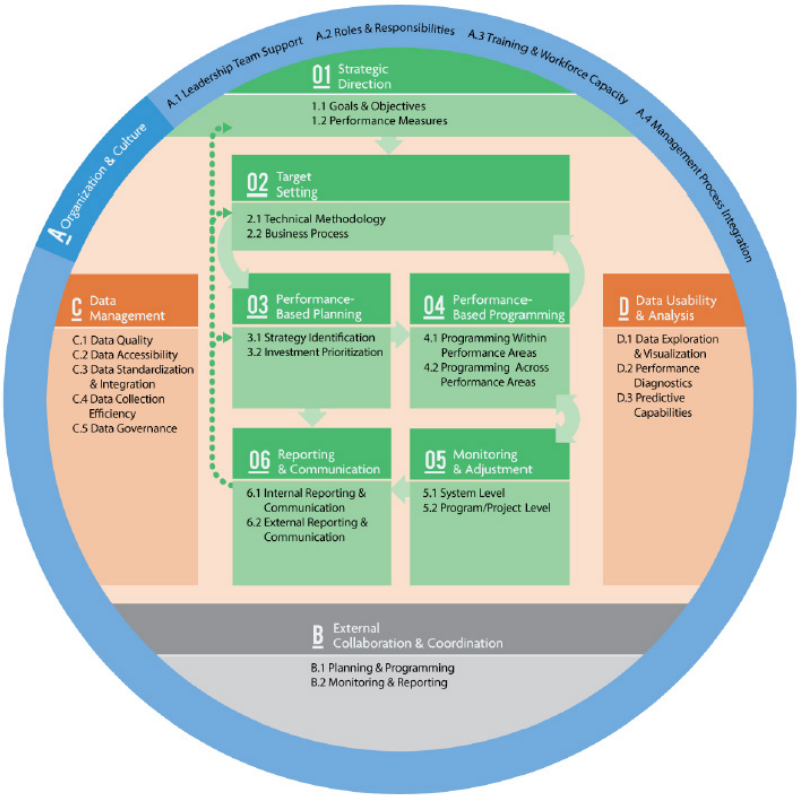
2.2.1 Overview of Transportation Performance Management

Transportation performance management (TPM) is a strategic approach that uses system performance information to make investment and policy decisions to achieve national performance goals.[9] When fully implemented, TPM leads directly to improved transportation system performance. TPM achieves this by helping transportation agencies determine what results (strategic goals) are to be pursued, then guiding investments to achieve those results using information from past performance levels and forecasted conditions to select the best investments. Progress made towards the strategic goals is routinely measured and used to make adjustments in planned expenditures to more effectively allocate available resources to meet the adopted performance goals. TPM is grounded in sound data management, usability, and analysis as well as in effective communication and collaboration with internal and external stakeholders.

[9] Federal Highway Administration, TPM Guidebook, https://www.tpmtools.org/guidebook/.

There are 10 distinct components to TPM as shown in Figure 2.1. These include the following:

Figure 2.1 TPM Framework



Source: Federal Highway Administration, TPM Guidebook, https://www.tpmtools.org/guidebook/.

1. **Strategic Direction—**Establishes an agency's direction through well-defined goals and objectives and enables assessment of the agency's progress towards meeting goals by defining a set of aligned performance measures.
2. **Target Setting—**Uses baseline data, information on possible strategies, resource constraints, and forecasting tools to collaboratively establish a quantifiable level of performance the agency wants to achieve within a specific time frame.
3. **Performance-Based Planning—**Uses agency goals and objectives and performance trends to drive development of strategies and priorities in the long-range transportation plan and other performance-based plans and processes.
4. **Performance-Based Programming—**Uses strategies and priorities to guide the allocation of resources to projects that are selected to achieve goals, objectives, and targets.
5. **Monitoring and Adjustment—**The active use of information gained from monitoring performance data to obtain key insights into the effectiveness of decisions and identify where adjustments in programming need to be made.
6. **Reporting and Communication—**The use of products, techniques, and processes to communicate performance information to different audiences for maximum impact.
7. **Organization and Culture—**The institutionalization of a transportation performance management culture within an agency.
8. **External Collaboration and Coordination—**The established processes to collaborate and coordinate with agency partners and stakeholders on planning/visioning, target setting, programming, data sharing, and reporting.
9. **Data Management—**A set of coordinated activities that collects, organizes, and makes available data for an organization for the purpose of maximizing value to the organization.

10. **Data Usability and Analysis—**Ensures that data are accessible and usable by the staff and stakeholders that need them, that those individuals have the required analysis capabilities available to support performance measurement, and the analytical tools needed to describe the value of alternative projects, plans, and strategies that are under consideration for achieving the desired strategic goals.

2.2.2 Overview of Performance-Based Planning and Programming (PBPP)

Performance-Based Planning and Programming (PBPP) is the application of performance management principles within the transportation planning and programming processes in order to achieve desired performance outcomes for the transportation system. The term performance-based planning and programming simply refers to how the overall objective of TPM is implemented, in part, through the planning process. PBPP helps transportation agencies to make infrastructure investment decisions based on the ability of those investments to meet performance goals. PBPP is a key element of the overall TPM framework and the critical process from federal transportation legislation that makes TPM possible.

Figure 2.2 shows that PBPP has three main components:

1. Planning.
2. Programming.
3. Implementation.

These components are discussed in greater detail in the following sections.

Figure 2.2 Performance-Based Planning and Programming Framework

Source: Federal Highway Administration, Performance-Based Planning and Programming Guidebook, September 2013.

Planning

In the context of PBPP, the planning process is designed to ask two basic questions: “where do we want to go?” and “how are we going to get there?” These questions are answered by first determining the direction a community wants its transportation system to go and then by establishing quantifiable measures by which progress can be assessed.

Where Do We Want to Go?

This question is answered by defining the vision that a state or a region has for its transportation system as described through goals, objectives, and measures—a strategic direction. The strategic direction defines the trajectory a community wants its multimodal transportation system to take by shaping decisions about policies and investments. This area must incorporate national goals, but goes beyond those in order to reflect and be responsive to local issues, priorities, and values. A strategic direction includes:

- **Goals and Objectives—**In the context of PBPP, a goal is a broad statement that describes a desired end state. An objective is a specific, measurable statement that supports achievement of a goal. Goals address key desired outcomes and supporting objectives play a key role in shaping planning priorities.

- **Performance Measures—**Performance measures support objectives and serve as a basis for comparing alternative improvement strategies and for tracking performance over time.

In order to answer “where we want to go” and set the direction and targets for the transportation program, transportation agencies must navigate multiple, often competing, goals, including not just transportation system use and performance, but current and desired land uses, environmental quality and sustainability, social equity, and fiscal reality. These competing priorities are the reason why external collaboration and cooperation are so important to TPM and PBPP as well as key pieces of information needed when agencies ask the next question, “how are we going to get there?”

How Are We Going to Get There?

“How are we going to get there” is the crux of the long-range planning process. It is answered by identifying the specific strategies an agency can take to improve performance, and the projects that it will undertake to implement those strategies. As part of picking those projects, the project identification, planning, and analysis processes need to consider how the potential projects being evaluated help the agency reach the performance targets defined by the strategic goals. The project identification, evaluation, selection, and prioritization processes drive this planning analysis.

The planning analysis component of PBPP identifies achievable targets and investment priorities, including operating strategies that can be carried forward into programming. It includes:

- **Identify Trends and Targets—**Preferred trends or targets are established for each measure to provide a basis for comparing alternative packages of strategies and measuring actual progress, by tracking current conditions against the desired trend. This step starts with an initial baseline of system performance. It then computes a trend line of historical performance so that the agency understands where it stands now, and where current trends are taking performance in the future under no action conditions. The agency then sets desired target values for future performance, considering the current performance trend, forecasts of future performance given expected population and economic growth, information on possible strategies and their impacts on performance, available funding, other constraints,

and knowledge of the desired level of performance the public would like to see achieved. While PBPP recognizes the utility of aspirational targets, such as "zero traffic fatalities," to signal the broader societal importance of an issue, it also stresses that agencies should set realistic targets based on data in order to make material improvements in performance.

- **Identify Strategies and Analyze Alternatives—**Performance measures are then used to assess specific strategies and to prioritize options for system improvements. Scenario analysis may be used to assess alternative packages of strategies, to consider alternative funding levels, or to explore what level of funding would be required to achieve a certain level of performance.

- **Develop Investment Priorities—**Based on the results of the analyses performed above, the next step involves prioritizing strategies and investments and making tradeoffs between achievements within different goal areas. Final decisions on what projects to invest in are then made within the context of the system-level changes in performance which occur from any given mix of investments in specific technology, geographic, and modal areas. This step requires prioritizing what performance outcomes are most important to the agency, which should be reflected in the answers the agency provided to the initial question of "where do we want to go?"

Programming

The Programming component of PBPP addresses the question: "what are the schedule and budget details of the plan". The programming component starts with the prioritized list of projects selected in the planning process, and provides the details required to implement those projects. This often requires adjustments to the initial list of prioritized projects. It sets the schedule for when specific projects are implemented, and ensures funding sources exist and are available when required. This includes ensuring that funds for projects supplied or built by partner agencies are also available and appropriately scheduled.

What Are the Schedule and Budget Details of the Plan?

"What are the schedule and budget details of the plan" is answered by considering tradeoffs across different programs and goals, developing long-range investment plans and short-range improvement programs (i.e., transportation improvement program or statewide transportation improvement program), leading to a fiscally constrained set of projects. The estimated impacts of these projects define the expected level of system performance over time based on expected trends, leading to the desired target for system performance. This relates to the target setting element of TPM, and specifically, to determine if the improvements help to achieve or exceed the defined performance targets. This information is presented to the agency's decision makers in the next round of Strategic Decision-Making.

The Programming task also defines resource allocation for the agency, with the resource allocation plan often tied to the resource allocation plans of other agencies in the region.

The programming component of PBPP should produce:

- **Investment Plan—**An investment plan details a set of strategies or projects that have not yet been programmed into a transportation improvement program (TIP) or a statewide transportation improvement program (STIP). It may be developed to cover a mid-range (e.g., 10 years) outlook in order to bridge long-range planning efforts (e.g., 20 or more years) to a short-term investment program.

Projects developed with traditional public funding sources as well as those developed as public-private partnerships (P3s) would be included in this part of the process. Though funded in a non-traditional manner, P3s are still a part of a state and/or region's overall investment plan. Furthermore, if a P3 receives federal funds it must be included in the TIP/STIP.

- **Resource Allocation/Program of Projects—**Project prioritization or selection criteria are used to identify specific investments or strategies for a capital plan or TIP/STIP. Projects included in the TIP/STIP are selected on the basis of expected performance and show a clear link to meeting performance objectives.

Implementation and Evaluation

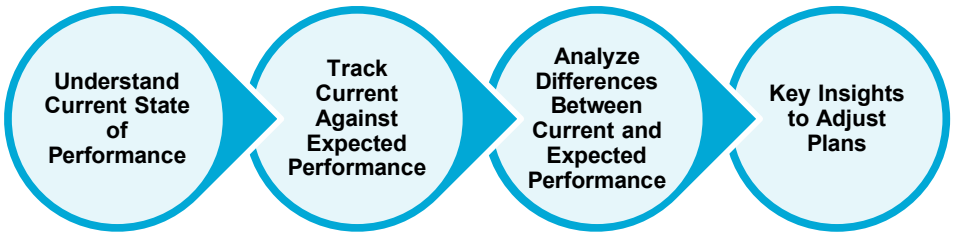
In PBPP, in addition to simply implementing the programmed projects, the performance of the system post-implementation is monitored and reported. The outcome of this performance review is then used to: 1) adjust the plan, if needed, in order to achieve the performance targets more effectively, and 2) refine the techniques used to forecast system performance to better reflect the impacts achieved from the deployment of specific techniques and strategies. Thus, the implementation phase of PBPP not only implements the projects, but it also asks and answers the question: "**how did we do**?" as a result of implementation.

Consequently, after executing the selected set of strategies or projects, it is important for the agency to assess how those strategies or projects actually contributed towards the progress required to meet the goals set in the Strategic Decision-making effort, which are reflected in the adopted performance targets.

How Did We Do?

"How did we do" addresses the reporting and evaluation process, so that future plans and programs can make use of the lessons learned from previous iterations. PBPP makes heavy use of the reporting, accountability, and transparency elements of TPM during this stage. Implementation and evaluation activities occur continuously and include:

- Monitoring.
- Evaluation.
- Reporting.



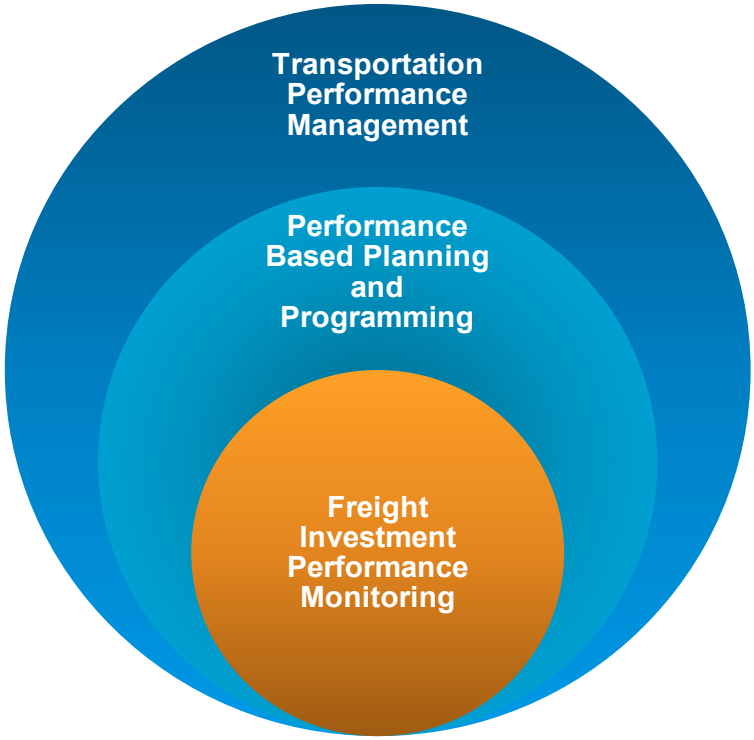
These TPM tasks ensure that decision makers and stakeholders can understand the system's current performance and track it against expectations. This further allows decision makers and stakeholders to analyze differences between current and expected performance. With that information, plans can be adjusted as needed.

2.2.3 Relationship Between Freight Investment Performance Monitoring, TPM, and PBPP

Figure 2.3 shows the relationship between freight investment performance monitoring, TPM, and PBPP. Freight investment performance monitoring is viewed as a TPM practice. A central tenet of TPM is the use of

targets to gauge the effectiveness of projects, programs, and policies. The freight investment performance monitoring framework is a direct implementation of this tenet as it is a step-by-step process by which an agency may gauge how a specific freight investment has impacted performance levels and contributed to transportation goals and objectives.

Figure 2.3 Relationship Between Freight Investment Performance Monitoring, TPM, and PBPP



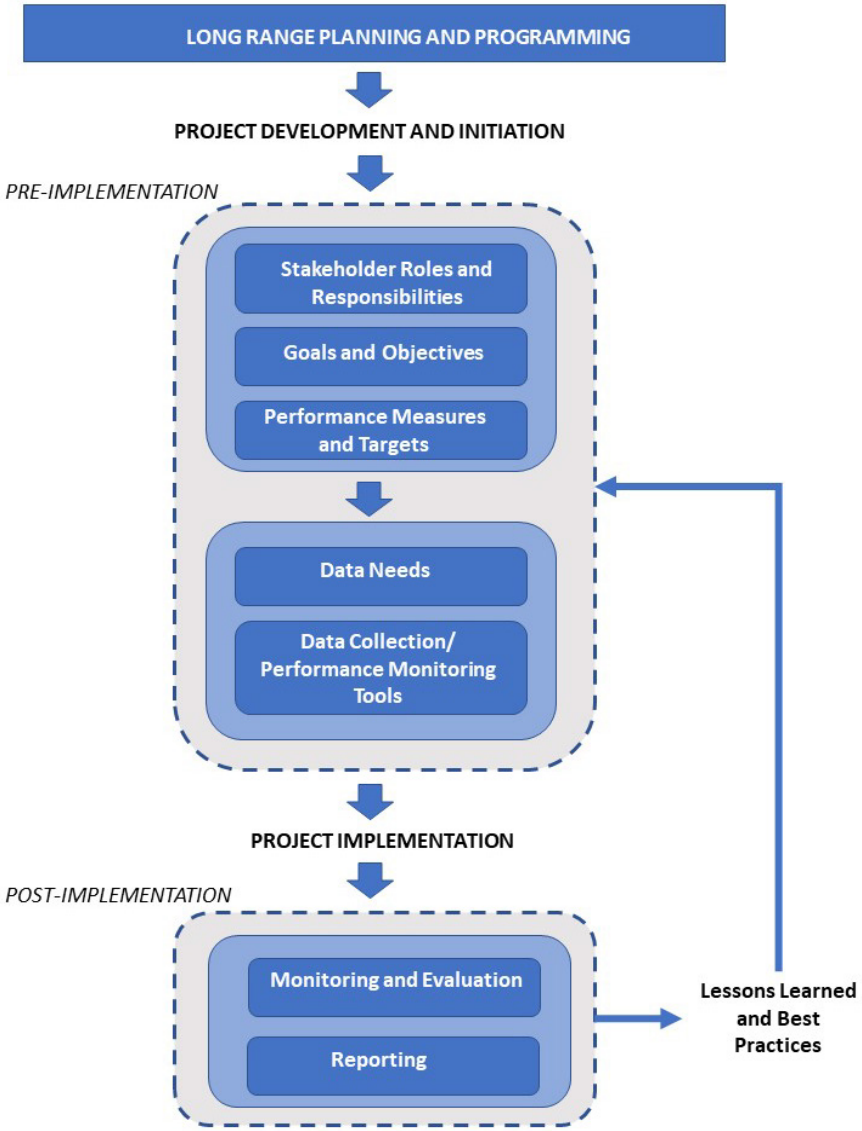
Source: Cambridge Systematics, Inc.

Furthermore, the freight investment performance monitoring framework may also be viewed as a subset of PBPP. PBPP is also a TPM practice as it applies performance management principles within the planning and programming processes of transportation agencies. While PBPP is applied at the planning and programming levels, the freight investment performance monitoring framework is applied at the project level. As a result, there is significant overlap between the two frameworks as they are both applications of TPM principles and draw on its fundamental concepts of performance measurement, target-setting, and performance monitoring.

3.0 The ITTS Freight Investment Performance Monitoring Framework

This section of the guidebook provides a high-level overview of the freight investment performance monitoring framework. As shown in Figure 3.1, the freight investment performance monitoring framework provides a procedure that can be generally applied across types of investment for measuring and monitoring the performance of a freight system investment. It is comprised of seven distinct elements: Stakeholder Roles and Responsibilities; Goals and Objectives; Performance Measures and Targets; Data Needs; Data Collection/Performance Monitoring Tools; Monitoring and Evaluation; and Reporting. These elements are divided into pre- and post-implementation phases. The framework should be carried out within the broader performance management framework created by an agency.

Figure 3.1 Freight Investment Performance Monitoring Framework



Source: Cambridge Systematics, Inc.

Below is a high-level overview of the elements of the freight investment performance monitoring framework. These elements are described in greater detail in Section 5:

- **Stakeholder Roles and Responsibilities.** Stakeholder engagement is fundamental to any transportation investment, freight or otherwise. Thus, the first step in the freight investment performance monitoring framework is to determine the relevant stakeholders and to define their roles and responsibilities. Some level of stakeholder engagement would have already taken place as part of the long-range planning process in which the investment was conceived, and as part of the project development and initiation process in which the concept was refined. Stakeholder engagement at this level is more focused on identifying the parties that will make the decisions for key steps that follow in the process, including determining the appropriate performance measures and targets for monitoring performance, assessing data needs, and determining the relevant tools for performance monitoring.

- **Goals and Objectives.** A goal is a broad, socially driven aim that guides overall decision-making and describes a desired end state, while an objective is a specific aim that supports the attainment of a broader goal and can be quantified to measure progress. Federal surface transportation law sets national goals for transportation, as described in Section 2.1, and agencies may also set their own goals. In the context of freight investment performance monitoring, ideally an investment would have already been aligned with relevant state and (if applicable) regional goals and objectives as part of the long-range planning process. As a result, as included in the framework this step may simply require an agency to identify the relevant objectives and targets from those already established as part of their long-range freight plan. It may also focus more on articulating in greater detail specifically how an investment supports existing goals and objectives and the specific target to be achieved.

  As an example, if the Texas Department of Transportation (TxDOT) was considering an investment in signal coordination and timing on a major arterial that carries large volumes of truck traffic, they may identify the mobility and reliability goal of the Texas Freight Mobility Plan (TFMP) as the most relevant (i.e., "Reduce congestion and improve system efficiency and performance."). Multiple objectives in the TFMP support this goal, but TxDOT may determine that the most appropriate objectives for this particular investment are to: 1) reduce the number of Texas Highway Freight Network miles at unacceptable congestion levels (level-of-service D or worse); and 2) improve travel time reliability on the Texas Highway Freight Network. With the most relevant goals and objectives identified, at this step in the freight investment performance monitoring framework, TxDOT also may determine that two targets are appropriate for the investment: 1) reduce travel time delay for trucks by 20 percent and 2) reduce the buffer time index by 10 percentage points.

- **Performance Measures and Targets.** This step determines the performance measures needed to assess progress towards achieving the targets and objectives identified in the previous step. In the context of the freight investment performance monitoring framework, freight performance is broadly defined in terms of the characteristics and quality of freight system condition, utilization, operations, and economic outcomes. While freight performance may be more narrowly defined as the outcome of utilization under particular physical conditions,[10] a broader definition is applied to reflect the scope of state freight programs that tend to collect data and report on a larger dimension of metrics.

[10] BouMjahed, L., and J. Schofer, "Freight Performance Measurement in FAST Act-Mandated State Freight Plans," Transportation Research Record, Volume 2673, Issue 4, 2019.

The selection of performance measures for freight investment performance monitoring should focus on direct outcomes of investments that can be represented in terms of measurable data points. For example, a highway freight investment that decreases the variability in travel time along a corridor or a freight rail investment that allows for an increase in rail tonnage. In addition, specific performance measures may have already been established as part of a long-range plan that can be applied to the investment.

For example, the South Carolina Department of Transportation's (SCDOT) Freight Plan established level of service (LOS) as a performance measure for its highway freight network. So, if the SCDOT were planning an investment on the highway freight network they could choose to apply the existing measure as opposed to identifying an alternative measure. For any selected performance measure, the data needed to support the measure must be readily available or can be collected.

- **Data Needs.** Identifying the data to be used for performance monitoring is an important step in the freight investment process. Once the performance measures have been selected, agencies should determine what data is needed to support those measures. For example, a highway investment meant to improve travel times would require speed data gathered from cameras, loop detectors, or global positioning system (GPS) enabled devices. A deep-water port investment intended to increase throughput would require data on container volumes over time. For data controlled by private entities, early engagement and coordination is critical to obtain the data needed to support performance measurement. In cases where a private entity is unwilling to share data, agencies should explore alternative measures that can be supported by available data. Without an assessment of the data needed to support the chosen performance measures, agencies will be unable to gauge the true impact of an investment in the freight system.

- **Data Collection/Performance Monitoring Tools.** Once an agency has selected performance measures and assessed the data needs to support those measures, they must determine what tools are needed to collect the data and monitor the performance of the investment. Having the right tools to measure and monitor performance is essential to the freight investment performance monitoring framework. Tools for data collection and performance monitoring can vary across investment types. In addition, while performance monitoring for some freight investments may be a relatively straightforward process using simple tools and/or data analysis processes, others may be more complicated. For example, an investment to increase the volume of goods transported through an air cargo or port terminal would simply require those facilities to report data they already collect as part of existing operational processes. On the other hand, an investment to improve truck turn times at those same facilities would potentially require tools to track the position and speed of trucks within a pre-defined catchment area, such as GPS-enabled devices or an intelligent transportation system (ITS). Furthermore, an investment may impact performance across multiple modes that an agency desires to measure (e.g., a substantial increase in rail capacity that impacts highway performance). In either scenario, simple or complex, agencies must consider the tools necessary to collect the data and monitor the performance of the investment.

- **Monitoring and Evaluation.** While the previous step focused on identifying and acquiring the tools needed to collect data and monitor performance, this step is the actual implementation of the monitoring and evaluation tasks. In addition, while the previous steps in the framework all occur within the pre-implementation phase of the investment (i.e., before the investment is actually made), this step begins the set of activities that must occur in the post-implementation phase. Monitoring refers to the gathering of information on actual performance of the infrastructure post-investment (e.g., travel times, freight volumes, crash rates, etc.). Evaluation refers to analysis of the gathered information to calculate the effectiveness of the investment.

Monitoring and evaluation activities put into practice all of the decisions made during previous steps in the framework. Stakeholders have decided how performance will be measured, what data and tools are needed for monitoring, and who will be responsible for performing the various performance monitoring activities and the ultimate evaluation of the results.

- **Reporting.** The final step in the freight investment performance monitoring framework is reporting. Reporting refers to the communication of investment performance and effectiveness information to policymakers, stakeholders, and the public. As agencies must communicate results to a number of different audiences, the method of communication is important and can have significant implications for support for similar investments in the future. In the case of reporting results to the public and policymakers, simple graphics and visuals may be the most effective methods, rather than reporting highly detailed technical data. No matter the audience, the reporting of performance findings should be done in a clear and concise manner. This step in the framework also includes a feedback loop to the pre-implementation phase. The purpose of this loop is to incorporate lessons learned for future investments.

4.0 Making Freight Investment Performance Monitoring Work for My Freight Program

Selecting performance measures, identifying data needs, developing relationships with stakeholders, and monitoring and evaluating investments—these activities take time, energy, and resources to implement. As an agency sets up its freight investment performance monitoring program it must consider the resources available. Given the range of resources available across states, there is not a one-size-fits-all solution. This section outlines guidelines to help states implement a sustainable freight investment performance monitoring program.

4.1 Resource Requirements

To begin, the resources needed to implement a freight investment performance monitoring program include staff; data and tools; and agency coordination. These elements should serve as a solid start to a freight investment performance monitoring program.

4.1.1 Intra-Agency Coordination

For many state Departments of Transportation (DOT), performance monitoring is conducted outside of Freight Divisions or Branches. Also, investment decisions and analysis (e.g., prioritization, programming, investment performance monitoring) typically involve multiple divisions or branches within an agency (e.g., groups focused on finance, planning, programming, etc.). In addition, the data to support both performance monitoring and project programming may reside in different places within an agency. This subsection discusses the needs related to intra-agency coordination to support freight investment performance monitoring.

4.1.2 Staff Resources

The staff needed to support the implementation of the freight investment performance monitoring framework typically overlap with those needed for transportation performance management in general. Thus, guidance on the necessary staff resources can be drawn from other TPM practices implemented by an agency. For instance, the Federal Highway Administration (FHWA) Transportation Alternatives Program Management Guidebook identified some key competencies for staff that support performance management activities. Many of those core competencies align with the elements of the freight investment performance monitoring framework:

- **Performance Measurement Staff.** Within the context of the framework, performance measurement staff are those staff that effectively develop/identify relevant performance measures, support the technical components of target setting, and can assist in performance reporting. Performance measurement staff lead data collection and support the monitoring and evaluation components of the framework. Key competencies include proficiency in data analysis tools and techniques, developing and maintaining various types of databases (e.g., geospatial, relational, etc.), coordinating interagency performance data access, and performing quality assurance/quality control of data. Performance measurement staff should also have the ability to research best practices for performance measurement. They may also develop internal and external interfaces to explain data to decisionmakers and the public. These staff are critical to support the data collection/performance monitoring tools, and monitoring and evaluation components of the freight investment performance monitoring framework.

- **Stakeholder Outreach and Engagement Staff.** These staff would lead the stakeholder outreach and engagement elements of the framework. Key competencies include the ability to effectively communicate with and engage the broader public and freight system stakeholders. Generally, the framework outlines a process for measuring the success (or lack thereof) of a freight investment. Thus, stakeholder outreach must be led by someone with freight experience and/or experience interacting with the freight community and an understanding of their needs. Those relationships and an understanding of those needs is what distinguishes the stakeholder outreach role for a freight versus non-freight investment. Furthermore, relationships with the freight community will also allow these staff to help guide partnerships between agencies and commercial entities for sharing data, professional knowledge, and other resources.

- **Economic Analysis and Transportation Performance Evaluation Staff.** These staff have key competencies that are central to evaluating the impact of a freight investment, including the ability to perform before-and-after transportation economic impact analyses (e.g., benefit-cost, return on investment, etc.) and performance analyses (e.g., crash reduction, travel time reduction, etc.).

At some agencies, these roles may already wholly exist within a freight division or branch. In that scenario, an agency must only identify those staff and define their specific roles within the framework. However, most agencies will have these core competencies distributed over multiple divisions or branches within the agency. In those cases, agencies must coordinate internally and share resources across a multi-disciplinary team to implement the framework.

4.1.3 Data and Tools

Agencies also must rely on multiple data sources and tools to support implementation of the freight investment performance monitoring framework. While there always is room for improvement in freight data sources and tools, agencies have several existing data sources and tools that are useful (depending on the specific type of freight investment) for implementing the framework. These data sources and tools are discussed further below.

Data

Many agencies are already collecting data on an ongoing basis that may be used to support freight investment performance monitoring. These ongoing data collection efforts may be due to other reporting requirements or to feed into other work activities, such as transportation safety programs. Examples of the types of data that would be used to implement the framework are listed below. This is not an exhaustive list, but rather a sample of relevant data types. More detailed information on freight data sources is included in Appendix C.6.

- **Condition and Usage Data**—State DOTs routinely collect data on the condition and usage of freight assets that may be used to implement freight investment performance monitoring. These include traffic counts, bridge condition ratings, and pavement condition ratings.

- **Commodity Flow Data**—These data provide information on the origins and destinations of goods as summarized by their commodity classification. The Commodity Flow Survey (CFS) is collected by the U.S. Census Bureau in partnership with the USDOT Bureau of Transportation Statistics (BTS). It is the primary source of data on U.S. domestic freight shipped by establishments in the mining, manufacturing, wholesale, auxiliaries, and selected retail and services trade industries. The Freight Analysis Framework (FAF) is produced through a partnership between the BTS and FHWA. Using the CFS as its foundation, the FAF

integrates data from a variety of sources to create a comprehensive picture of freight movement among states and major metropolitan areas by all modes of transportation. In addition to these public sources, proprietary commodity flow data may also be acquired from private entities.

- **Travel Time Data**—Travel time data may be used to measure performance in terms of speed, reliability, delay, and other travel time-based measures. It is derived from navigation systems, mobile phones, electronic logging devices, and other devices enabled with global positioning systems (GPS). Agencies may derive travel time data from several sources including Bluetooth readers, toll-tag readers, electronic license plate readers, road tubes, and vehicle probe data from commercial sources. The National Performance Management Research Data Set (NPMRDS) is a public source of vehicle probe data made available by the FHWA's Office of Freight Management and Operations. The public version of this data is limited to Interstate highways and the NHS.

- **Port Data**—Data is available on tonnage, numbers of containers, vessel calls, accidents, commodity types, and more at deep-water and river ports. This information can come directly from port authorities and also from the U.S. Army Corps of Engineers (USACE) and the Maritime Administration (MARAD).

- **Rail Data**—Train volumes by segment, densities of rail traffic, levels of service, and other rail performance data that could be used to implement the framework may be estimated using the Surface Transportation Board (STB) Rail Waybill Sample. The Rail Waybill Sample is a stratified sample of carload waybills for all U.S. rail traffic submitted by rail carriers terminating 4,500 or more revenue carloads annually. The Federal Railroad Administration (FRA), as well as state DOTs, maintain data on highway-rail crossings. These data include number of trains, average train speeds, incident history, and other rail performance data that can be used in the freight investment performance monitoring framework.

- **Air Cargo Data—**The BTS provides landing weight data for cargo-bearing airports throughout the U.S. Data on air cargo tonnages are also typically available directly from airports.

Tools

Agencies also already have a number of tools available to them to help implement the freight investment performance monitoring framework. Many of these tools are regularly used as part of agencies' planning, programming, and engineering work. Examples of the types of tools that would be used to implement the framework are listed below. This is not an exhaustive list, but rather a sample of some relevant tools. It should be noted that measuring and monitoring the performance of most investments will require the use of multiple tools.

- **Environmental Impacts Models**—Environmental impacts models—such as the MOtor Vehicle Emissions Simulator (MOVES) model and the EMission FACtor (EMFAC) model—can be used to assess emissions-related impacts of freight investments. In particular, they can be paired with travel demand and traffic simulation models to gauge the environmental impacts of projects such as those that reduce freight vehicle travel times or divert freight from one mode to another.

- **Economic Analysis Tools**—There are multiple tools that may be used to measure the economic impacts of a freight investment. Economic impacts include changes to employment, gross domestic product, and user costs. Generally, these tools take improvements in vehicle miles traveled (VMT), vehicle hours traveled (VHT), and other first order performance measures (i.e., performance outcomes that are a direct result of the investment) and estimate their indirect economic impacts. The Florida Freight Transportation Economic Impact Kit (FTEIK) is an example along with multiple commercial tools,

such as the suite of tools produced by Regional Economic Models Inc. (REMI) or Transportation Economic Development Impact System (TREDIS). Within the context of the freight investment performance monitoring framework, these can be used to assess the before-and-after economic impacts of an investment within a pre-defined catchment area.

- **Traffic Monitoring Tools**—State DOTs, county and city DOTs, and county and city public works departments routinely use various tools to monitor traffic volumes and conditions. These include loop detectors, closed-circuit television cameras (CCTV), video vehicle detection, and other devices for determining traffic volume, speed, and vehicle occupancy. These tools support real-time monitoring at Traffic Management Centers (TMCs) and can also be used to establish performance trends over time. These types of tools are central to the monitoring and evaluation components of the framework.

- **Other Data Collection, Data Analysis, and Monitoring Tools**—In addition to transportation-specific tools, such as those highlighted earlier, there are many other tools for general data collection, data analysis, and monitoring that may be used to implement the framework. For example, tools for maintaining relational databases (e.g., SQL and Access) and analyzing large data sets (e.g., the Python and R programming languages) could support the implementation of the framework for any type of investment. Tools such as Tableau and Power BI may prove to be useful for visualizing data, especially in an interactive format like on a dedicated project website.

While the discussion has focused on the types of tools that may be used to measure and monitor the performance of a freight investment, it should be noted that stakeholder coordination is key to this process as well. Stakeholders will be relied upon to share data and tools with each other, especially where those items are not accessible to parties outside of their respective organizations or are not available in a timely fashion. For example, if an agency made an investment intended to divert freight traffic from a congested highway corridor to a nearby railroad corridor, the agency would need data on daily train volumes on the impacted railroad segments in order to implement the framework effectively. Obtaining this level of information would not be possible without cooperation from the operating railroad. Thus, stakeholder coordination is a key tool for measuring and monitoring performance.

4.2 Building on Existing Practices

This portion of the guidebook discusses how states can build on existing practices at their agencies and within their freight planning programs in order to implement freight investment performance monitoring. Examples of existing practices that are relevant for freight investment performance monitoring include data collection initiatives, agency-wide performance management practices, and project selection and prioritization tools and/or methodologies.

- **Coordinate with existing performance management practices.** One of the first key steps to implement the freight investment performance monitoring framework is to assess current agency practices for performance management so that the framework can be coordinated with those efforts. For some agencies, performance management may be divided across multiple divisions or branches. This can pose a challenge for implementation as accessing data, tools, and key staff may be limited by organizational silos. In this case, steps must be taken to gather resources within what equates to a program-specific process (i.e., freight investment performance monitoring).

  For other agencies, performance management may be centralized across the agency with program-specific processes under a single performance management umbrella. In this case, steps must be taken

to integrate freight investment performance monitoring as a new program. A key step in the process to integrate freight investment performance monitoring will be to determine the magnitude of the program. Conceivably, there will be numerous projects that an agency considers to be freight investments. Resources may not be adequate to implement the framework for every investment made. As a result, agencies would need to determine an appropriate size for the program (e.g., number of projects to be evaluated, monetary thresholds for freight investment monitoring, funding program used).

- **Use and build on existing performance measures.** Agencies are already using performance measures and/or metrics that may be applied to the freight investment performance monitoring framework. For example, states are required to calculate the Truck Travel Time Reliability (TTTR) metric on Interstate highways as part of federal performance reporting. Calculation of this metric may be extended to a larger portion of an agency's highway network and used as a performance measure within the framework.

  In addition to the federally required freight performance measure, states and metropolitan areas routinely use several freight performance measures in the development of state and regional freight plans. These include measures of network utilization (e.g., average annual daily truck traffic, average annual number of trains per segment, annual landed weight of air cargo operations), infrastructure condition (e.g., pavement condition ratings, number of posted bridges), travel time and congestion (e.g., delay, buffer time index), and safety (e.g., truck crash rates, number of highway-rail crashes). Existing performance measures used in other freight planning and operational initiatives at an agency should be used within the freight investment performance monitoring framework, wherever appropriate. Where possible, they should also be strengthened (such as through improved data collection) to increase their utility to the framework and ultimately, decision-makers.

- **Build on existing data collection efforts.** Agencies already collect multiple types of data on an ongoing basis due to other reporting requirements, or to feed into other work activities. For example, almost all state DOTs have robust crash and traffic count data collection programs. Efforts that improve data collection, coordination, and data sharing among agencies would greatly enhance implementation of the freight investment performance monitoring framework. For example, a roadway that carries a high share of truck traffic but has a relatively low total volume of traffic may not receive the same level of attention for data collection efforts as a higher volume roadway. Shifting some of the data collection efforts onto the critical freight corridors would help to supply the data needed to implement the framework effectively.

- **Incorporate recommended practices for competitive federal grants.** Competitive discretionary federal grant programs also feature notable practices that are useful for informing the development of a framework for gauging the effectiveness of freight investments. The Rebuilding American Infrastructure with Sustainability and Equity (RAISE) (formerly Better Utilizing Investments to Leverage Development [BUILD]) and Infrastructure for Rebuilding America (INFRA) grant programs both require performance monitoring for the specific performance measures established in the grant agreement.[11] Grant applicants are required to establish two to four meaningful performance measures most relevant to the project and applicable to the primary long-term objectives of the programs. To support the requirement for gauging the effectiveness of a project towards the agreed upon performance measures, the RAISE and INFRA grant programs require a performance measurement plan, pre-project report to establish performance measure baselines, and progress reports throughout the project. A performance measurement plan

[11] "TIGER/BUILD Performance Measures Guidance—Appendix A," https://www.transportation.gov/administrations/office-policy/tigerbuild-performance-measures-guidance-appendix.

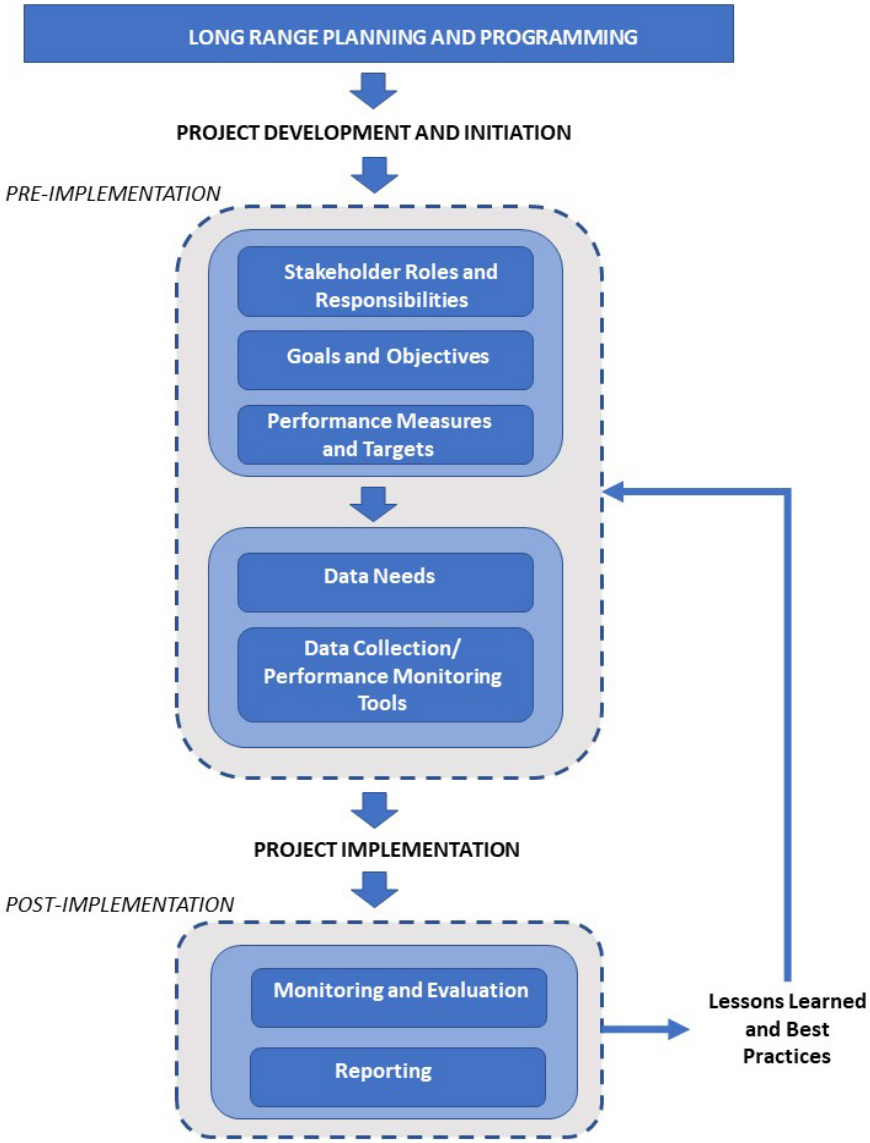
establishes which data will be collected, the methodology for data collection, the project study area, the collection period, and the reporting period and frequency. Performance reporting is required to be submitted at regular intervals either quarterly or annually depending on the measures selected.

- **Build on existing tools for freight-specific investments.** The Florida DOT uses the Florida Freight Transportation Economic Impact Kit (FTEIK) to measure the economic impact of freight and other transportation investments. The FTEIK combines a regional economic input-output model with the freight component of the State's travel demand model (i.e., Freight Supply-chain Intermodal Model or FreightSIM). Outputs from FreightSIM, including changes in freight vehicle miles traveled and vehicle hours traveled, are converted into monetary values that are used as the inputs for the regional economic input-output model. The input-output model is then used to estimate economic impacts by industry sector.

5.0 How Do I Monitor Performance for My Freight Investment?

This section of the guidebook outlines the steps needed to apply the freight investment performance monitoring framework as described in Section 3 (see Figure 5.1). Its purpose is to make the framework actionable and practice ready. In outlining the process for implementation, this section identifies the relevant framework elements to be applied, inputs and outputs, necessary tools and/or methodologies, and any associated actions or resources that may be needed. A series of case studies of successful investments that exemplify many of the elements of the freight investment performance monitoring framework are included in Appendix A while a step-by-step example of this framework in use by a state DOT is outlined in Appendix B. Appendix C provides an inventory of some useful freight performance measures and freight data sources.

Figure 5.1 Freight Investment Performance Monitoring Framework



Source: Cambridge Systematics, Inc.

5.1 Identify Stakeholders Involved in the Process

The first step to implement the framework is to identify the stakeholders likely to be impacted by the freight investment so that they may be involved in the setting of its foundational elements (i.e., vision, goals, objectives, and performance measures) and contribute to the decisions in the key steps that follow in the process. At this step in the framework the roles and responsibilities of the stakeholders are also defined. In the context of freight investment performance monitoring, this step answers the questions:

Identifying Stakeholders

Some key questions to ask in order to identify stakeholders:

- *Who will own the investment? Who will be responsible for maintaining it?*
- *Who will benefit from the investment? Who might be adversely impacted?*
- *Who will pay for the investment?*
- *Who must approve the investment?*

- Who will collect the data needed for performance measurement?
- Who will measure performance over the evaluation period?
- Who will monitor the results and performance trends?
- Once the evaluation period is ended, who will evaluate the investment's progress towards reaching goals and targets?
- Who will report results to the broader public and stakeholders?

Depending on the investment, one or more of these responsibilities may be carried out by a single entity. Multiple responsibilities may also be carried out by a single entity but assigned to different groups within that entity. For example, it is common for state DOTs to have specific groups responsible for traffic data collection, data analysis and performance measurement, and public engagement.

In many instances, the planning process that conceived of and funded the investment will have already defined the key stakeholders and the foundational elements that will guide the project. Therefore, when implementing this portion of the framework, this first step often focuses on refining, as necessary, any of these foundational elements and possibly revisiting the key stakeholders, as the project moves from planning to implementation. As the project advances, key stakeholders may include groups such as:

- Local and regional transportation practitioners.
- State and regional freight advisory committees.
- Local business groups, chambers of commerce, and business improvement districts with a transportation focus.
- Civic groups with a transportation focus including pedestrian and bicycle interest groups.
- Advocates for groups traditionally underserved by existing transportation systems.

Once the relevant stakeholders are identified, they must be brought on-board to support implementation of the investment. This may be achieved through a series of one-on-one meetings with each stakeholder in

which they are made aware of the motivation for the investment, any pertinent background information, and what the agency intends to achieve moving forward. Upon completion of the series of one-on-one meetings, all stakeholders may be brought together as part of an advisory committee to help implement the framework for the duration of the investment. See this in practice in the example in Appendix B.

5.1.1 Define Roles and Responsibilities

In addition to refining the goals and objectives of the investment, this step also focuses on defining the roles and responsibilities of stakeholders. This is an important step because it provides all stakeholders a clear understanding of what they need to do so successfully implement the framework. Depending on the investment, one or more of these responsibilities may be carried out by a single stakeholder. Specific roles and responsibilities defined during this step should include:

- **Data Collection and Performance Monitoring—**A stakeholder should be assigned to lead the data collection activities needed to support the performance measures; this should also include monitoring the results over time to establish performance trends.

- **Performance Measurement—**A stakeholder should be assigned the responsibility to measure the performance of the investment over the defined evaluation period. This includes all the technical steps necessary to calculate the selected performance measures. Depending on the number and complexity of the selected performance measures, this role may be combined with the Data Collection and Performance Monitoring role.

- **Investment Evaluation—**A stakeholder should be assigned the responsibility of evaluating the investment. Evaluation refers to the analysis of the gathered information and data to understand the effectiveness of the investment. This stakeholder will likely need to be proficient in economic evaluations (e.g., benefit-cost, return on investment) as well as those more focused on transportation performance (e.g., crash reduction, changes to travel times).

- **Stakeholder Coordination and Engagement—**A stakeholder should be identified to ensure coordination among all partners and be responsible for reporting results to the broader public and external stakeholders. This should be coordinated with an agency's public information officer.

Lessons Learned from the Port of Baltimore

As part of the Maryland Port Administration's (MPA) public-private partnership (P3) with Ports America Chesapeake (PAC) to modernize the Seagirt Marine Terminal, the MPA found that defining clear roles and responsibilities for stakeholders and having frequent communication were critical components of the investment's success. By virtue of the P3 arrangement, PAC is "fighting fires every day," while MPA is a level removed and resolves issues as they arise. MPA sees its role akin to a "shock absorber" or "customer service appendage" to PAC that performs "damage control," which gives PAC the room to focus on moving containers through Seagirt Marine Terminal. The high level of communication between MPA and PAC allows each stakeholder to transparently report performance against specific metrics and regularly discuss opportunities and challenges related to the performance of Seagirt Marine Terminal.

Stakeholders will carry out these roles and responsibilities through the duration of the time period over which the framework is being implemented for the investment. Progress on these tasks should be provided through regular update meetings to the entire advisory committee. Appendix B provides an example of defining the roles and responsibilities.

5.2 Set Goals and Objectives

Once stakeholders have been identified and their roles and responsibilities defined, the next step is to set performance goals and objectives for the freight investment. A goal reflects the overarching values and mission of an agency. An objective is a specific aim that supports the attainment of a broader goal and can be quantified to measure progress. The stakeholders identified in the first step of the framework should set a limited number of goals for the investment. In setting goals for the investment, the stakeholders should refer back to goals that have been set as part of statewide and regional freight planning initiatives to ensure that the investment's goals reflect state and local priorities.

After goals have been identified, the next component in this step of the framework is to set objectives. While goals focus on the desired end result that reflects an overarching mission and values, objectives are specific and measurable and provide a level of specificity needed to actually achieve the desired end result articulated by the set of goals. A good objective should directly inform an associated performance measure and target. Objectives that accomplish this are commonly referred to as "SMART" (specific, measurable, agreed-upon, realistic, time-bound). In setting objectives for the investment, the stakeholders identified in the first step of the framework should refer back to objectives that have been set as part of statewide and regional freight planning initiatives.

An investment may have already been aligned with relevant state and (if applicable) regional goals and objectives as part of the long- and/or mid-range planning process. As a result, this step may focus more on refining the existing goals and objectives and, where appropriate, adding more detail. While this is not envisioned to be a lengthy step in the framework, it is important to ensure relevant performance measures are identified, and that the data needed to support them is available.

It is also critical to ensure the selected goals and objectives reflect performance areas that can be impacted by the investment. As the selected performance measures and targets are derived from goals and objectives, care must be taken to select goals and objectives with underlying factors that may be influenced by the investment (i.e., traffic volumes, toll rates, average speeds). Stakeholders must also recognize that performance may be influenced by multiple external factors beyond the control of an agency or the intent of the freight investment. More information on setting goals and objectives is provided in the example in Appendix B.

Refining Existing Goals and Objectives for Implementation in the Framework

As an example, consider a freight intelligent transportation system (ITS) project that was originally developed as part of a long-range plan. As a project conceived as part of that process, it was aligned with multiple regional goals and objectives defined as part of the long-range plan. For instance, the goal and objectives may have been:

- *Goal: Improve mobility, safety, and traffic conditions.*
- *Objective #1: Reduce congestion.*
- *Objective #2: Reduce the number and severity of crashes.*

However, the specific motivation for the freight ITS project was to alleviate truck queueing at blocked at-grade rail crossings near a rail intermodal terminal gate. At this step in the framework, stakeholders would refine those goals and objectives to focus on the specific motivating factors of the project while maintaining fidelity to the broader goals and objectives of the long-range plan.

- *Refined Goal: Improve mobility, safety, and traffic conditions for passengers and freight operating near the rail intermodal terminal.*
- *Refined Objective #1: Reduce congestion due to blocked rail crossings and truck queueing.*
- *Refined Objective #2: Reduce the number and severity of crashes associated with queued trucks.*

5.3 Select Performance Measures, Identify Data Sources, and Set Targets

5.3.1 Select Performance Measures and Identify Data Sources

Performance measures must be selected with consideration of data and analysis methods available to calculate the measures. A measure will be of no value to the agency if reliable data cannot be consistently obtained to compute the measure. Below are some criteria to consider when selecting performance measures for the freight investment performance monitoring framework.

- **Performance measures should have a clear relationship to the investment's goals and objectives.** A performance measure should allow stakeholders to readily see how an investment contributes to progress toward goals and targets. For example, if an investment's goal is to help alleviate a truck bottleneck, a relevant performance measure may be the change in travel time delay and/or reliability. Well defined measures have the additional use as project selection criteria as demonstrated in the California Trade Corridor Enhancement Program in Appendix A.4.

- **Performance measures should be relevant to the public and decision-makers.** Performance measures should reflect the primary concerns of external stakeholders and the public, granting them the ability to help drive the public discourse on transportation issues. To this end, measures that are easy to understand may be preferred to those that are more nuanced but complicated.

- **Performance measures should have data that are readily available, reliable, and of high quality.** The selection of performance measures should, in part, depend on what data is needed to support those measures. Performance measures must be supported by consistent, high-quality data. When considering performance measures and their associated data needs, agencies should focus on a few key factors: meaningfulness, availability, timeliness, and accuracy. Data are meaningful in that they provide a necessary input to the calculation of the performance measure. To be available, agencies must be able to access the data with relative ease and be able to do so consistently. To be timely, data must be available within a timeframe that enables near-time evaluation of the investment. Lastly, data are accurate when they are of high-quality and have been vetted through a quality assurance/quality control process.

Agencies should consider measures already being used as part of other programs and initiatives. The practice of performance management and the use of performance measures is now prevalent throughout all levels of transportation planning (i.e., local, regional, state, and federal). As a result, existing measures that may be applied to investments within the context of the framework can be found in the freight planning and programming documents of the agencies that cover the jurisdiction(s) in which the investment is located. Potential measures may also be found in federal planning documents.

As previously discussed, there are multiple challenges involving freight data including those related to: meaningfulness, timeliness, availability, and accuracy. Agencies must take steps to overcome the data limitations and challenges that impact the ability to use the defined performance measures. This may require new data collection activities or adjustments to existing activities to resolve and overcome the challenges. If the issues cannot be resolved, agencies must consider alternative performance measures that do not rely on these data items. Some questions that stakeholders may ask to aid in the identification of data sources include:

- Does the lead agency, or a partner stakeholder, have complete control over the data or is the data controlled by an external entity?

- Is the data significantly impacted by external forces beyond a state DOT's or metropolitan planning organization's (MPO) control?
- Are the data and the associated performance measure(s) being considered because they are useful, or just because they are available?
- How much time will be required to collect, analyze, and report the data?
- What is the cost of collecting, analyzing, and reporting the data?

The FHWA Transportation Alternatives Program Performance Management Guidebook developed a worksheet that is useful for assessing data needs that can be applied to the freight investment performance monitoring framework. Table 5.1 contains an adaptation of the worksheet that has been modified for use in this framework. Implementing a data assessment worksheet into the freight investment performance monitoring framework can help agencies avoid common pitfalls, such as selecting measures that require too many data sources to develop or rely upon data sources that are not dependable and or consistently available.

Table 5.1 Performance Measure Resource and Data Assessment

Performance Measure Under Consideration				
Data Source				
Where can we get the data, internally or externally?	If the data is only available externally, are there limitations on the use and reporting of the data?	Does the agency already collect this data internally?	If the data is not already collected by the agency, what is the level of effort to begin collection? What is the cost?	Is funding for this data consistent?
Data Availability and Data Quality				
How far back is the data available? Is it sufficient to cover the baseline period?	How often is the data made available?	Is reporting consistent, or has there been variation in collection and/or calculation methods over time? Would this variation make data incomparable over time?	Is the reported data considered an estimate or is the data actual?	How reliable is this data source? If the source were to discontinue, is there a backup source?
Data Analysis—Level of Effort				
What is the level of effort to analyze this data for the purpose of estimating past performance over the baseline period and forecasting future performance over the evaluation period?	What is the level of effort to analyze this data for reporting?	Does this data need to be assessed by using a transportation model?	Does this data need to be assessed using a geographic information system (GIS)?	How complex would the method of calculation be? Describe the method.
Data Usefulness to Performance Reporting				
How directly does the data address stated goals and objectives?	How directly does the data support the associated performance measure(s)?	Would changes in the data be a direct result of the investment?	What is the likeliness that changes in the data are due to external factors outside beyond the investment?	

Source: FHWA Transportation Alternatives Program Performance Management Guidebook, March 2016, Report No. FHWA-HEP-16-026.

5.3.2 Set Targets

Once the performance measures have been selected, the next step is to set targets that quantify the desired trends. Desired trends may be to reduce, increase, or maintain the level of a selected performance measure. Specific numerical figures for targets may also be established for each performance measure. There are three types of targets that are commonly used in transportation planning: directional, aspirational, and realistic. Targets carry additional significance when they directly relate to operations as demonstrated in the Lyndon B. Johnson TEXpress Lanes case study in Appendix A.1.

- Directional targets do not define a specific numerical target, but rather indicate the direction an agency would like to see a trend move in.
- Aspirational targets are an ideal and describe the result that an agency would like to achieve. They do not demonstrate an achievable target within a short- or often long-term timeframe given resource constraints and other factors, such as required modification of human behavior.
- Realistic targets are numerical targets that are set within the context of constraints such as available funding, staff resources, current trends, and other factors.

Methods for Setting Performance Targets

- *Extrapolate historical performance trend.*
- *Determine what is achievable.*
- *Base on policy considerations and desired outcome.*
- *Predict performance depending on funding level.*
- *Revise project evaluation and prioritization criteria to reflect performance objectives.*
- *Establish data collection and monitoring process.*
- *Report on progress towards meeting targets.*
- *Adjust projections and targets if needed based on experience.*

Source: FHWA Transportation Alternatives Program Performance Management Guidebook.

Within the freight investment performance monitoring framework, targets may be directional or realistic. To develop targets, the following process should be followed:

1. **Analyze data to recognize past trends.** This will provide an understanding of how a freight asset's performance has changed over time. It may also provide insight into external factors, beyond an agency's control, that have impacted performance which will allow an agency to manage expectations for the investment's impact.
2. **Extrapolate historical performance trends through the monitoring period to see how performance might look without intervention.** This provides an upper, or lower bound depending on the measure, on performance levels.
3. **Forecast performance through the monitoring period to estimate performance levels with the investment.** Again, this provides an upper or lower bound on performance depending on the measure.
4. **Calculate the difference between performance levels using the extrapolated historical trend and the forecasted trend with the investment.** Based on this analysis, which may be supplemented with a review of targets and achievements in other similar areas, stakeholders can determine what is achievable based on funding levels. This will also inform the decision on use of a directional versus a realistic target for the investment.

An example of selecting performance measures, identifying data sources, and setting targets is provided in Appendix B.

5.4 Identify Performance Measurement and Monitoring Tools

Once the performance measures have been selected and the data needs identified, the next step is to identify the tools needed to collect and compute performance data. Agencies have a number of tools available to them for collecting and computing performance data. Many of these tools are regularly used as part of agencies' planning, programming, and engineering activities. As summarized in Section 4.1.3, these include traffic monitoring tools, travel demand and traffic simulation models, environmental impacts models, and economic analysis tools.

To implement this step of the framework, agencies should use the performance measure resource and data assessment worksheet presented in Table 5.1 (or a similar approach) to help identify the necessary tools for the specific investment under consideration. Many of the tools needed for implementing the framework will be identified as part of the process of answering the questions in the worksheet. For example, the data source component of the worksheet asks questions that will help agencies identify the data collection and monitoring tools needed for implementing the framework for a specific investment:

- Where can we get the data, internally or externally?
- If the data is not already collected by the agency, what is the level of effort to begin collection? What is the cost?

In answering these questions, an agency may determine that it must install video vehicle detection along a corridor to collect data on changes in traffic volumes and/or travel times as a result of the investment. Or the agency may determine that they need a data sharing agreement with a railroad along with a secure file-sharing site for transmitting data on changes in rail activity. These are just a few examples of how discussions generated through completion of the worksheet can help identify data collection needs and monitoring tools.

The data analysis component of the worksheet asks questions that will help agencies identify tools needed to measure performance and/or evaluate the investment. Specifically, the data analysis component of the worksheet asks:

- Does this data need to be assessed by using a transportation model?
- Does this data need to be assessed using a geographic information system (GIS)?
- How complex would the method of calculation be? Describe the method.

Answering these questions reveals the specific tools an agency needs. Agencies are likely to determine that multiple performance measurement tools are needed, ranging from simple spreadsheets to more complicated models of traffic impacts. See how this is used in practice in the example in Appendix B.

5.5 Evaluate and Report Performance Results

The final step in the freight investment performance monitoring framework is to perform the evaluation and report the results. Evaluation refers to analysis of the gathered information to understand to what extent the

investment has been effective. During this step, an agency should determine the time periods for the baseline analysis and the performance monitoring of the investment. Establishing a baseline is important for being able to gauge the true impact of a project. Without knowing the level of performance of a facility beforehand, it is not possible to determine if an investment has had the intended positive impact on achieving defined performance targets. As such, the collection of pre-investment performance data (and an analysis of that data) is a key component of this step of the framework. The adequacy of the length of the baseline period may vary by type of investment. For example, for safety investments it is typical to examine five or more years of crash data in order to effectively evaluate the impact of an investment.

Just as establishing a baseline period is important for freight investment performance monitoring, so too is determining an adequate period for monitoring post-investment performance. Both are needed to effectively gauge the impact of a freight system investment. For modest investments (such as deploying freight signal priority on a major truck corridor or other operational improvements), a ten- to fifteen-year monitoring period may be adequate. For major freight projects (e.g., highway capacity expansions, highway-rail grade separations), a much longer monitoring period would be needed.

The specific evaluation methodology, and the tools used to execute that methodology, will vary across investment types and performance measures. However, an analysis of conditions over a baseline period using historical data, an analysis of conditions over a pre-determined post-investment evaluation period, and an estimation of the impact of the investment based on a comparison of conditions between the two periods will be features of any methodology.

5.5.1 Evaluate Performance

Analyze Baseline Conditions

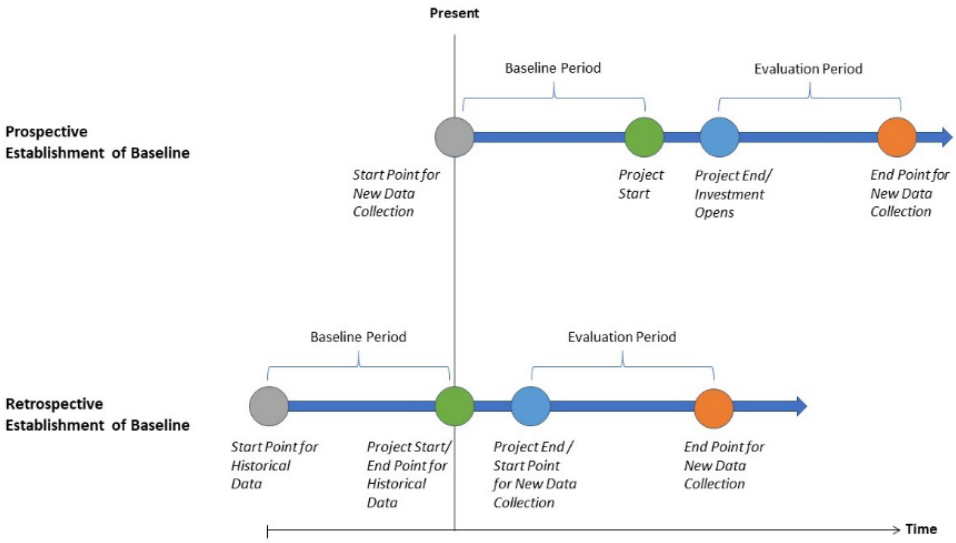
The first step in conducting the performance evaluation is to analyze baseline conditions using historical data. Establishing a baseline allows agencies to gauge the true impact of a project. Without knowing the level of performance for a facility beforehand, it is not possible to determine if an investment has had a positive impact on achieving performance targets. A baseline can be established either retrospectively or prospectively depending on the availability of historical data. To establish a baseline retrospectively, historical data must be available. Agencies can use that information to

Freight Performance Measure Approaches for Bottlenecks, Arterials, and Linking Volumes to Congestion Report

The FHWA Freight Performance Measure Approaches for Bottlenecks, Arterials, and Linking Volumes to Congestion Report was developed to: 1) provide best practices and approaches on several key areas of freight performance measurement; and 2) develop practical guidance in analyzing truck freight bottlenecks to state DOTs and MPOs. Its step-by-step process to develop performance measures for freight bottlenecks provides an example of how a baseline analysis could be conducted. An abbreviated version of the process is included here:

1. ***Adjust the Range of Influence—****For each of the entry routes into the highway freight bottleneck, determine and refine the range of influence by determining the range of queuing. Speeds are used as the indicator of queuing. The idea is to identify a string of* ***contiguous segments*** *that meet the queuing threshold (e.g., 15 miles per hour).*
   a. *Calculate the queue length by summing up the segment lengths found to experience queuing.*
   b. *Calculate the 95th percentile queue length. The segments encompassed by the 95th percentile queue length are used as the highway distance over which performance measures are computed.*
2. ***Calculate Reference Speed—****Determine the free-flow or reference speed for the highway.*
3. ***Calculate Performance Measures for each Bottleneck—****Calculate the pre-determined performance measure(s) (e.g., delay, queue length) for the bottleneck.*
4. ***Rank Bottlenecks by Impacts—****Rank bottlenecks using total truck delay or other measures.*

"look back" at performance levels over the pre-defined period and effectively establish a baseline. If historical data are not available, then agencies must establish a baseline prospectively. With this method, agencies would select a future date to begin data collection and another future date to begin the initiation of investment. The interim period between the start of data collection and project initiation would serve as the baseline period.



With either method for establishing a baseline, the primary components to this step in the framework are to gather and analyze the pre-investment performance data for the pre-determined baseline analysis period using the tools identified in the previous step. For an investment aimed at improving a highway freight bottleneck, this may include pre-investment data on queue lengths, travel times, speeds, and other performance measures. For an air cargo or port terminal investment, pre-investment data on terminal throughput or truck turn times may be needed. Regardless of the performance measures selected for the analysis in earlier steps, pre-investment performance data must be gathered and analyzed to establish a baseline.

It should also be noted that the adequacy of the length of the baseline period may vary by type of investment. For example, for highway safety investments it is typical to examine five or more years of crash data in order to effectively evaluate the impact of an investment. Other investments may not require as lengthy of a pre-investment baseline analysis period. In general, however, a longer baseline analysis period provides greater opportunity to control fluctuations in performance that may not be indicative of typical conditions.

Monitor Performance and Analyze Post-Investment Conditions

The second step in conducting the performance evaluation is to monitor performance and analyze post-investment conditions using the newly collected performance data. The monitoring component of this step consists of using the loop detectors, CCTVs, spreadsheets, relational databases, file sharing sites, and other various tools previously identified to collect new data and monitor performance. These tools will be deployed over the entirety of the post-investment monitoring period. Like the analysis of baseline conditions, it is important to select an adequate period to monitor post-investment performance to effectively gauge the impact of a freight system investment.

The analysis component of this step uses the travel demand models, traffic simulation tools, spreadsheets, and other analysis tools to gauge post-investment performance using the previously selected measures. The same tools and methods used to conduct the baseline analysis should be used for the post-investment analysis.

Evaluate the Performance of the Investment

Evaluation refers to analysis of the gathered performance data, pre-and post-investment, to understand to what extent the investment has been effective. In order to communicate the benefits of the freight investment to as large an audience as possible, both a transportation performance and an economic impact evaluation are recommended as part of the framework.

- **Transportation Performance Evaluation.** The transportation performance evaluation assesses the first order performance outcomes of the freight investment. First order performance outcomes emerge as a direct result of the investment (e.g., changes in crash rates and travel times, traffic and/or cargo volumes, number of rail intermodal lifts). The transportation performance evaluation may take one of two forms depending on the nature of the freight system investment: 1) a traditional before-and-after evaluation or 2) a build versus no-build evaluation.

  - **Before-and-After Evaluation.** A traditional before-and-after evaluation would examine performance conditions before and after the investment was made and then use a statistical test to determine if observed changes in performance can be attributed to the investment. For example, a freight ITS investment meant to improve truck turn times at a port terminal might calculate mean turn times before (e.g., μ_1) and after the deployment of the system (e.g., μ_2). A statistical hypothesis test could then be conducted with the null hypothesis that the post-investment mean truck turn time is lower than the pre-investment mean truck turn time (e.g., $H_0: \mu_1 - \mu_2 \geq 0$) and the alternative hypothesis that the post-investment mean is not lower than the pre-investment mean (e.g., $H_a: \mu_1 - \mu_2 < 0$). The failure to reject the null hypothesis would indicate that the freight ITS investment did actually improve truck turn times at the port.

  - **Build versus No Build Evaluation.** For some freight assets, it may be unrealistic to expect a sustained improvement in performance over the current state. In some instances, an investment may help to maintain current performance levels in the face of increasing demand, thereby preventing further degradation. For example, consider a highway investment to support a rapidly growing cluster of industrial and freight-intensive businesses within a metropolitan area. As more and more firms locate to the cluster, the increase in traffic volumes from employees and freight may quickly consume any added capacity from an expansion and/or operational improvement. In these cases, a build versus no build evaluation-type procedure might be more appropriate as it would consider the difference between the performance level achieved with the investment and the performance level that would have been realized had no investment been made.

  The specific evaluation method used by an agency must depend on the nature of the freight investment and the overall goals of the investment.

  It should be noted that when conducting the evaluation of the freight investment, especially those related to safety (e.g., crash reduction, crash rate reduction), that regression to the mean should be accounted for. Regression to the mean is a statistical phenomenon that can make natural variation in repeated data look like real change.[12] For investments motivated by improving transportation safety, agencies should consider that the number of crashes at a site will randomly fluctuate up and down from year to year. Over time, this random fluctuation will balance out to what can be considered the long-term expected average

[12] https://pubmed.ncbi.nlm.nih.gov/15333621/.

number of crashes at the site.[13] The long-term expected average number of crashes should be used as the basis of the evaluation as it reduces the influence of regression to the mean.

- **Economic Impact Evaluation.** The economic impact evaluation assesses the second order performance outcomes of the investment. Second order performance outcomes are those that emerge as a result of the first order outcomes and may be used to estimate the broader impacts of the deficiency that the freight investment is meant to address and the benefits of eliminating, or mitigating, that deficiency (e.g., changes to employment, productivity, user costs). Delay cost is an example of a second order performance outcome. It is the monetized cost of delay and for freight vehicles is calculated as:

$$Annual\ Freight\ Vehicle\ Delay\ Cost\ = \\ Annual\ Freight\ Vehicle\ Hours\ of\ Delay\ \times Value\ of\ Freight\ Vehicle\ Time$$

  Benefit-cost, return on investment, and other analytical methodologies may be used to conduct the economic impact evaluation. Like the transportation performance evaluation, the specific methods used for the economic impact evaluation will depend on the nature and overall goals of the investment.

5.5.2 Report Results

The final step in the framework is to report results. Reporting refers to the communication of information about investment performance and its effectiveness to policymakers, stakeholders, and the public. As agencies must communicate results to a number of different audiences, the method of communication is important and can have significant implications for support for similar investments in the future, as demonstrated by the Inland Port Greer case study in Appendix A.2.

- **Project Websites.** Project websites are an effective tool for communicating information about the status of an in-progress investment. They may be maintained over the evaluation period of the investment so that stakeholders may be updated on current performance levels and ultimately the results of the evaluation. Project websites may also incorporate online dashboards in order to better visualize performance results.

- **Online Dashboards.** Dashboards are visualization tools that provide information in an easily understood format that is similar in appearance to automobile dashboards. Often, dashboards are designed so that users may navigate to greater levels of detail for performance areas that are important to them. Performance results for specific freight investments may have their own dashboard as part of a project website or be folded into a broader dashboard already maintained by the agency.

- **Performance Report Cards and Scorecards.** Performance report cards and scorecards condense information into easily comprehensible graphics and assessments. They use a combination of colors and symbols to convey performance results and to demonstrate how those results relate back to investment goals and objectives.

Learn more about evaluating performance and reporting results in Appendix B.

[13] https://safety.fhwa.dot.gov/tsp/fhwasa15089/appd.cfm.

Appendix A. Case Studies

A series of case studies were developed to provide examples of successful investments that exemplify many of the elements of the freight investment performance monitoring framework. These case studies are not direct implementations of the framework, but instead illustrate the commonality of the components of the framework across a diverse range of investment types. Specifically, case studies were developed for investments including policy and programmatic, highways, ports, and inland port/rail as described below:

- **Policy and Programmatic—**Competitive grant programs, loan programs, infrastructure banks, and other policies and/or programs with a specific focus on funding, prioritizing, and monitoring freight projects.
- **Highway—**Projects that address truck bottlenecks as Institute for Trade and Transportation Studies (ITTS) member states are primarily responsible for freight performance on the highway system as opposed to other modes.
- **Port—**Projects that improve on-dock freight operations and/or landside access for truck and rail.
- **Inland Port and Rail—**Projects that created and/or enhanced an inland port facility as these investments reflect the multimodal nature of freight and its importance for economic development.

The remainder of Appendix A presents case studies for the following projects: Lyndon B. Johnson TEXpress Lanes (Highway), Inland Port Greer (Inland Port and Rail), Port of Baltimore Modernization (Port), and California Trade Corridor Enhancement Program (Policy and Programmatic).

A.1 Lyndon B. Johnson TEXpress Lanes

A.1.1 Introduction

This case study considers the impacts of the LBJ TEXpress Lanes in Dallas County, Texas. These 13.3 miles of I-635 are a public-private partnership consisting of tolled and general-purpose lanes. The project included a decades-long planning process with considerable public involvement to improve corridor roadway performance for commuters and commercial vehicles. Interviews with staff from the Texas Department of Transportation (TxDOT), North Central Texas Council of Governments (NCTCOG), and the LBJ Infrastructure Group LLC (LBJIG) regarding the project were conducted as part of the case study.

A.1.2 Overview of the Region

With access to major interstates, airports, and rail lines, the Dallas-Fort Worth (DFW) region is an integral player in the freight arena, both for Texas and the nation. NCTCOG, 98 percent of the U.S. population is accessible by truck from the DFW region within 48 hours. The region is considered one of the largest inland ports in the United States.[14] Nearly 77 percent of the goods coming into North Texas arrive by truck.[15]

[14] North Central Texas Council of Governments. Freight. https://www.nctcog.org/trans/plan/freight (accessed on September 17, 2020).

[15] North Central Texas Council of Governments. Freight Movement: More Than Just Trucks Fact Sheet, June 2016. https://www.nctcog.org/nctcg/media/Transportation/DocsMaps/Plan/Freight/Freight_June16.pdf (accessed September 17, 2020).

The region has four significant interstates that carry large amounts of freight for the State and the nation: I-20, I-30, I-35E and I-35W, and I-45. I-35 is a major interstate for freight transportation in Texas, and since 1995 has served as the United States-Mexico-Canada Agreement (USMCA) (formerly the North American Free Trade Agreement [NAFTA]) corridor.[16] NCTCOG has completed many freight-related studies highlighting the importance of freight to the region and the nation along with freight challenges and possible solutions, including:

- Freight North Texas: North Central Texas Regional Freight System Inventory,[17] in May 2013, which assessed the freight network capacity.
- The Freight Congestion and Delay Study Final Report,[18] in March 2016, which highlighted congestion in the region.
- The Truck Parking Study,[19] in April 2018, which inventoried available truck parking in the region.

Figure A.1 shows the major freight facilities located within the NCTCOG metropolitan boundary.

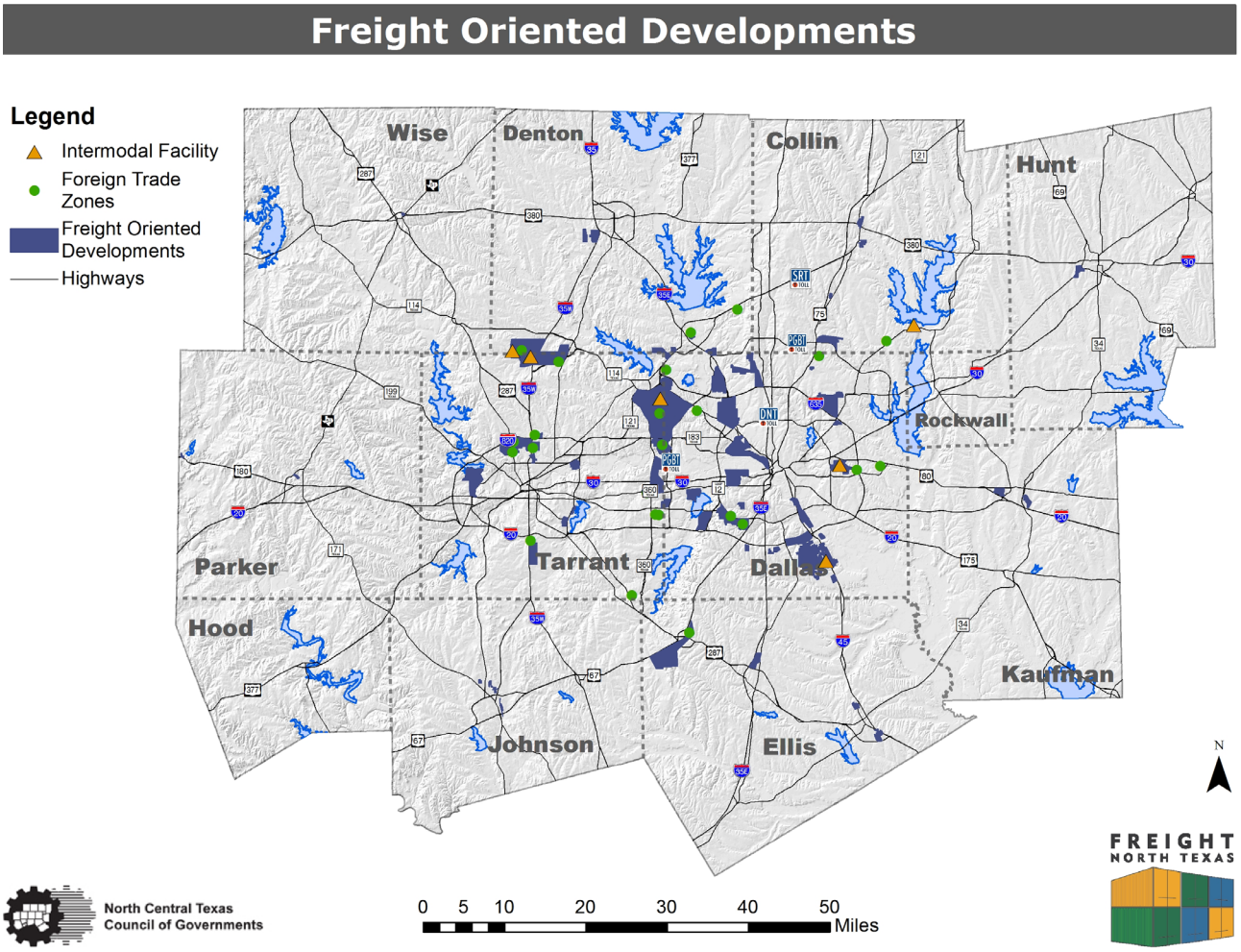
[16] North Central Texas Council of Governments. Truck Parking Study: A Freight North Texas Study, April 2018. https://www.nctcog.org/getmedia/b5a888c4-1be5-426d-a193-b91e93bdb1b5/TPS-Master-Updated-2018_FINAL2_1.aspx (accessed September 17, 2020).

[17] North Central Texas Council of Governments. Freight North Texas: The North Central Texas Regional Freight System Inventory, May 2013. https://www.nctcog.org/nctcg/media/Transportation/DocsMaps/Plan/Freight/FreightNorthTexas2013_1.pdf (accessed September 17, 2020).

[18] North Central Texas Council of Governments. Freight Congestion and Delay Study Final Report, March 2016. https://www.nctcog.org/nctcg/media/Transportation/DocsMaps/Plan/Freight/fcds20150507MJ_3-14-16.pdf (accessed September 17, 2020).

[19] North Central Texas Council of Governments. Truck Parking Study: A Freight North Texas Study, April 2018. https://www.nctcog.org/getmedia/b5a888c4-1be5-426d-a193-b91e93bdb1b5/TPS-Master-Updated-2018_FINAL2_1.aspx (accessed September 17, 2020).

Figure A.1 North Central Texas Major Freight Facilities
2016



Source: North Central Texas Council of Governments.

A.1.3 Overview of the Freight Investment

The LBJ Freeway, which was part of the original outer loop in Dallas, opened in 1969 and was designed with a daily capacity of 180,000 vehicles. By the early 1980s, the area around the LBJ corridor developed, and the roadway became heavily congested, leading TxDOT to begin considering options for additional improvements. As discussions and planning occurred throughout the 1990s, congestion continued to increase. By 2008, the freeway was one of the most congested roadways in the U.S., and nearly 270,000 vehicles used it each day.[20] The increased traffic and congestion led TxDOT and other vital stakeholders to search for options, where available, to mitigate the high traffic and congestion.

TxDOT initially considered widening the existing LBJ Freeway, which would have resulted in the removal of homes and businesses. The community opposed this plan, and they quickly took action to prevent the proposed design. Determined to avoid a “wider and higher” configuration, the community hired independent

[20] LBJ TEXpress. LBJ Express FAQs. https://www.lbjtexpress.com/faq-page (accessed September 17, 2020).

engineers, planners, and lawyers to represent their interests. Working with the community and key stakeholders, TxDOT began looking at a tunnel option. TxDOT created a dedicated office for the LBJ Express project, reflecting their commitment to design and build within the local context. TxDOT staff were then located within the area and could gain first-hand knowledge of the issues and concerns of the roadway design. NCTCOG was instrumental in completing traffic studies and holding public meetings. One success from the project was the public education aspect. NCTCOG held numerous meetings to explain the purpose of the project and the need for specific requirements. They developed a running list of project tradeoffs that helped the community and design planners to design a project that fit the transportation needs and addressed community concerns. The partnership created between the community, TxDOT, NCTCOG, and LBJIG was crucial to the project's success.

In the early 2000s, TxDOT began looking into innovative funding strategies for the project because funding was limited. In 2003, legislation was passed allowing public-private partnerships (P3) for Texas roadways. At the time, there was a former Dallas Area Rapid Transit (DART) board member and city council member that was integral to securing the necessary caveats for a successful P3 within the State legislation. In 2006, the Regional Transportation Council, the governing body of the NCTCOG, created a managed lanes policy to provide oversight of tolling in North Texas.[21]

TxDOT pursued a Comprehensive Development Agreement (CDA), the first of its kind in Texas, and selected LBJIG to design, finance, and build the LBJ Express project in 2009. A CDA is a legal agreement between a public and private agency to build needed infrastructure when state and federal funding is limited. The private agency helps to cover the costs of building the infrastructure project in turn for the ability to collect tolls on a facility. The State maintains ownership.[22] At the time, the agreement was the largest P3 in the U.S. and remains the largest in the southwestern U.S. While TxDOT maintains ownership of the roadway, LBJIG leases the LBJ TEXpress Lanes and manages the tolling, operations, and maintenance of the facilities, including the general-use lanes and frontage roads, for the 52-year life of the lease.[23]

The final project was designed to encompass continuous frontage roads, general-purpose lanes, and tolled lanes with variable pricing, called TEXpress Lanes. The following is a breakdown of the project design on I-635:

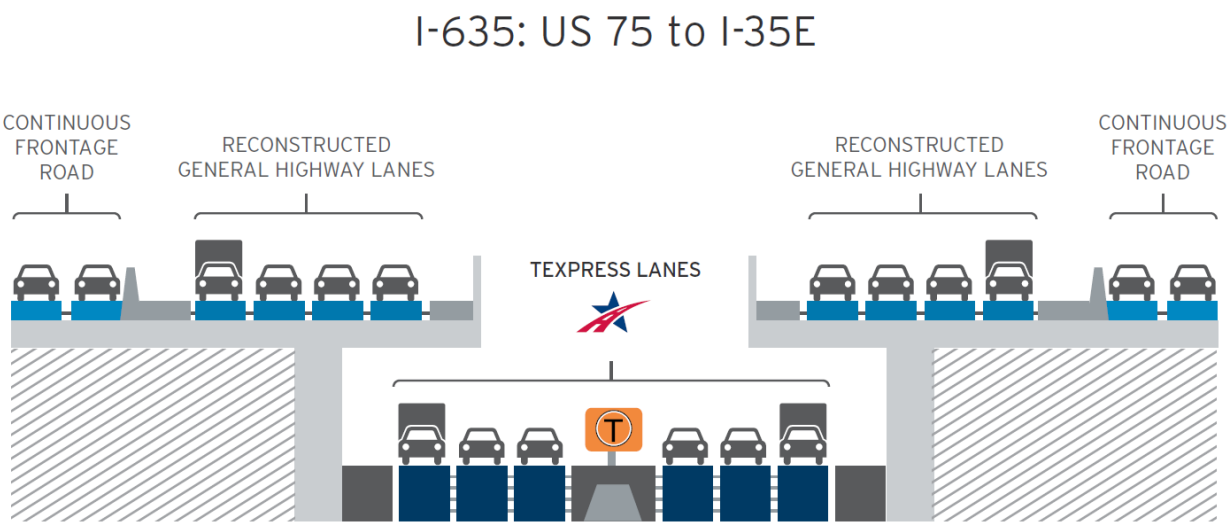
- Continuous frontage roads.
- Four general-purpose lanes in each direction.
- Up to three depressed TEXpress Lanes, in each direction, from Luna Road to Greenville Avenue (see Figure A.2).
- Four elevated TEXpress Lanes, two in each direction, on I-35E from I-635 south to the I-35E/Loop 12 split and from I-635 north to just before Valley View Lane (see Figure A.3).

[21] U.S. Department of Transportation. Build America Bureau. I-635/LBJ Freeway Managed Lanes, Dallas-Fort Worth, TX. https://cms8.dot.gov/buildamerica/projects/project-highlights/i-635-lbj-freeway-managed-lanes-dallas-fort-worth-tx (accessed September 17, 2020).

[22] LBJ TEXpress. LBJ Express FAQs. https://www.lbjtexpress.com/faq-page (accessed September 17, 2020).

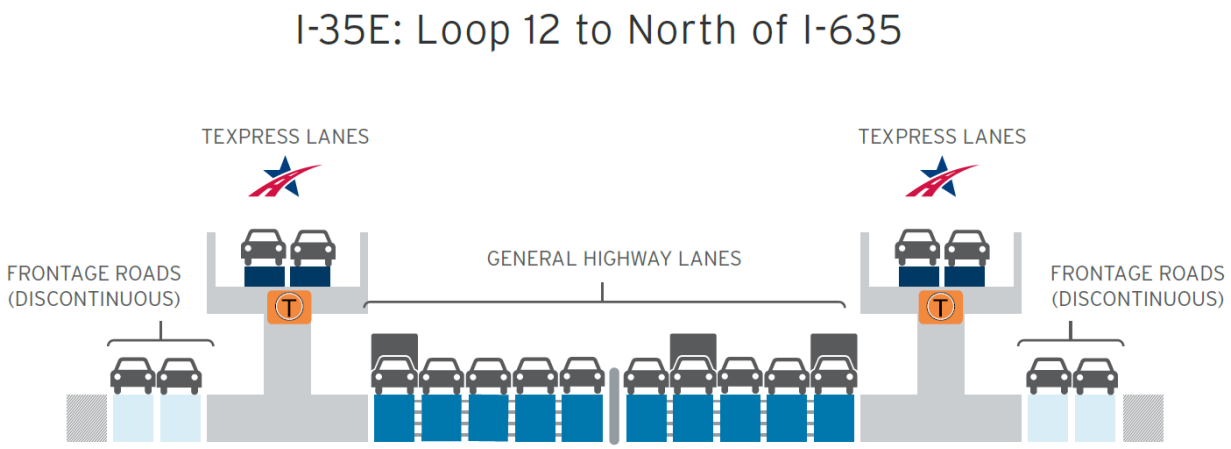
[23] LBJ TEXpress. LBJ Express FAQs. https://www.lbjtexpress.com/faq-page (accessed September 17, 2020).

Figure A.2 Cross-Section Image of Depressed TEXpress Lanes on I-635



Source: LBJ Infrastructure Group LLC.

Figure A.3 Cross-Section Image of Elevated TEXpress Lanes on I-35E



Source: LBJ Infrastructure Group LLC.

The first phase opened in December 2013, and the final phase opened in September 2015.[24] As part of the project, LBJIG completely rebuilt the general-purpose lanes and the frontage roads to make them compliant with the current federal and state requirements. As a result, both the lanes and shoulders are wider in both

[24] LBJ TEXpress. LBJ Express Traffic and Revenue Summary for Q3 2016, October 28, 2016. https://www.lbjtexpress.com/sites/lbjtexpresslanes.com/files/lbj_texpress_lanes_q3_2016_traffic-revenue_results_10_28_16.pdf (accessed September 17, 2020).

directions.[25] The tolled lanes are depressed below the general-purpose lanes, which are cantilevered above, partially covering the tolled lanes.[26]

The TEXpress Lanes have designated entrance and exit ramps with signage to indicate the toll price. The tolls on the lanes are managed to induce demand to maintain a speed of at least 50 mph on the TEXpress Lanes. The speed limit on the general-purpose lanes is 70 mph, while the TEXpress Lanes is 75 mph. Real-time traffic conditions are continuously monitored by intelligent transportation systems (ITS) to adjust the tolling prices.[27] As more vehicles enter the TEXpress lanes and the speed drops, the price to use the lanes increases. Drivers have the choice to pay a toll and have a more reliable travel time, or they can use the general lanes or frontage roads without paying a toll. As prices rise, travelers must decide how much they are willing to pay to use the more reliable service. The increased speed limit and lack of congestion is an incentive for drivers to pay to use the facility.

The LBJ TEXpress Lanes are unique in that toll prices are determined by the dimensions of the vehicle (see Figure A.4), rather than the number of axles or weight. However, permitted overweight vehicles are not allowed on the TEXpress Lanes. Trucks pay anywhere from three to five times the base rate. There are currently no motor carrier discounts or formalized relationships with any motor carrier companies. There is anecdotal evidence that Texas Instruments (located along the corridor) uses the express lanes for freight movement. The real-time tolls for large trucks are not advertised on the dynamic signs before entering the managed lanes. Commercial drivers can find the multiplier for their configuration on the tollway website.

During the planning process, TxDOT considered a tunnel design. However, there were concerns about hazardous materials loads in the tunnel, which resulted in the open cantilever design. Trucks carrying hazardous materials may use the lanes. These freight-focused considerations impacted the design process, but general mobility was the primary objective of the project. Still, the LBJ TEXpress Lanes have benefited freight movement, as documented below.

[25] LBJ TEXpress. LBJ Express FAQs. https://www.lbjtexpress.com/faq-page (accessed September 17, 2020).

[26] U.S. Department of Transportation. Build America Bureau. I-635/LBJ Freeway Managed Lanes, Dallas-Fort Worth, TX. https://cms8.dot.gov/buildamerica/projects/project-highlights/i-635-lbj-freeway-managed-lanes-dallas-fort-worth-tx (accessed September 17, 2020).

[27] LBJ TEXpress. LBJ Express FAQs. https://www.lbjtexpress.com/faq-page (accessed September 17, 2020).

Figure A.4 Toll Pricing by Vehicle Type

Shape Examples	Vehicles and Users	Info	Size	Price
	Exempt Vehicles			0.0
	Class 12 HOV and Motorcycles registered through GoCarma	Applies only during weekday peak periods 6:30 a.m. to 9 a.m., and 3 p.m. to 6:30 p.m., Monday through Friday HOV drivers (with a minimum of one additional passenger) and motorcycles with valid TollTags, TxTags or EZ TAGs who have registered online via GoCarma for HOV discounts.		Base Toll Rate x 0.5 (50% off)
	Class 12 Single Occupant Vehicles: Passenger Car Pickup Truck Small Van SUV Motorcycle	Includes HOV and motorcycles during non-peak periods	Not larger than: 7 feet high, or 20 feet long, or 8.5 feet wide	Base Toll Rate x 1
	Class 13 Single Occupant Vehicles + 1 or More Trailers	A Single Occupant Vehicle pulling a trailer	Combined dimensions do not exceed: 14 feet in height, or 73.5 feet in length, or 8.5 feet in width	Base Toll Rate x 2
	Class 14 Large Trucks	Larger than a Single Occupant Vehicle and includes: Buses Recreational Vehicles	Not larger than: 14 feet high, or 46 feet long, or 8.5 feet wide	Base Toll Rate x 3
	Class 15 Extra-Large Trucks	Larger than a Large Truck but not larger than a Special Permit Vehicle	Dimensions do not exceed: 14 feet in height, or 73.5 feet in length, or 8.5 feet in width	Base Toll Rate x 4
	Class 16 Large or Extra-Large Trucks + 1 Trailer	A Large or Extra-Large Truck pulling a trailer	Dimensions do not exceed: 14 feet in height, or 73.5 feet in length, or 8.5 feet in width	Base Toll Rate x 4
	Class 17 Large Trucks or Extra-Large Trucks + More Than 1 Trailer	A Large or Extra-Large Truck pulling more than one trailer	Combined dimensions do not exceed: 14 feet in height, or 73 feet in length, or 8.5 feet in width	Base Toll Rate x 5

Source: Texas Department of Transportation, https://www.lbjtexpress.com/pricing/vehicle-classification-shapes.

A.1.4 Measuring and Monitoring the Impact of the Investment

The LBJ Express project was estimated to cost $2.7 billion, including maintenance and operations. The construction itself was estimated to cost $2.1 billion. LBJIG provided $2.21 billion of the needed $2.7 billion. Estimated costs for maintenance and operations throughout the 52-year lease were $800 million.[28] Without private financing, it would not have been possible for TxDOT to undergo the project in the timeframe that it did.

[28] LBJ TEXpress. LBJ Express FAQs. https://www.lbjtexpress.com/faq-page (accessed September 17, 2020).

There are three separate tolling segments on the LBJ TEXpress Lanes (see Figure A.5):

- Segment 1 begins at Josey Lane, bypassing the I-35E/I-635 interchange and runs south to the I-35/ Loop 12 split and runs north on I-35E to Valley View Lane.
- Segment 2 runs from Luna Road to the Dallas North Tollway.
- Segment 3 runs from the Dallas North Tollway to Greenville Avenue.

Figure A.5 Map of LBJ TEXpress Lane Toll Segments

Source: LBJ Infrastructure Group LLC.

The variable tolling on the TEXpress Lanes did not begin until June 2014, six months after completing the construction for Phase 1. This period allowed for LBJIG to simulate demand-based tolling by implementing higher charges during peak travel periods, and then evaluating the process.[29]

Regional Transportation Council (RTC), the governing body of the NCTCOG, sets the toll pricing policy based on the impacts of the traffic conditions, shape and size of the vehicle, and the number of passengers. Real-time congestion levels determine the variable tolling throughout the day. Average toll prices for a vehicle typically range from 15-35 cents per mile with light traffic and from 45-90 cents per mile with congested traffic. A cap for the base toll rate is 90 cents per mile and is adjusted each year based on a percentage equal to the Consumer Price Index from the previous year. The cap has only been hit one time since the TEXpress Lanes opened. If traffic speeds drop below 50 mph, the price increases to encourage

[29] LBJ TEXpress. LBJ Express FAQs. https://www.lbjtexpress.com/faq-page (accessed September 17, 2020).

travelers to use the general-purpose lanes, therefore, maintaining a minimum speed on the toll lanes. As the vehicle size increases, so too does the toll price. High-occupancy vehicles (HOV) may apply to receive a discount on the toll price.

A market-driven pricing plan determines truck tolls, a multiplier based on vehicle size. Tolls are typically higher during rush-hour periods, and less expensive for off-peak and overnight travel. Drivers may look up their vehicles' multiplier and calculate their toll based on the current displayed prices. Drivers may choose to use the general lanes or pay the toll to get to their destinations faster based on their price tolerance.

Another aspect that led to the success in keeping freight moving is that the concessionaire maintains highway speeds of 50 mph. This threshold helps drivers understand that even if prices increase, driver times can be fairly reliable as they will travel at higher speeds than the general-purpose lanes. The pricing structure and minimum speed requirement have helped make the project a success.

State and federal authorities cap the toll price and LBJIG follows a strict managed lanes policy set by the RTC. If the speed drops below 50 mph longer than fifteen minutes, or if the volume exceeds the maximum car-per-lane threshold, the toll rate increases every five minutes. TxDOT may fine LBJIG as defined in the CDA for not implementing the price increase to maintain a congestion-free roadway. The fines increase if the speed on the roadway segment continues to decline.[30]

The 50-mph speed threshold has proven to be successful on the TEXpress project. If traffic speeds decrease to below the threshold, the concessionaire may be penalized as defined in the contract, and they may face tighter pricing regulations. A price cap, or maximum base rate, is used to prevent the toll lanes from becoming prohibitively expensive. These two mechanisms work in tandem to balance speed and price. The concessionaire may charge any rate below the cap while maintaining a minimum speed. The algorithm that determines the price based on volumes and speeds, however, is proprietary and may be adjusted by the concessionaire.

As an example, early on in the TEXpress project, prices spiked above the cap even as traffic speeds returned to normal. The algorithm did not adjust prices to normal as quickly as would be expected. This event ultimately led to decreased revenue that could have been collected by the concessionaire. From this real-world experience, the concessionaire adjusted the algorithm.

LBJIG is responsible for maintaining the roadway, including the general-purpose and frontage roads, and there are specific performance requirements for the managed lanes. Penalties are written into the contract, increasing with inflation, if certain minimal conditions are not met. When the lease ends, LBJIG is required to return the roadway to TxDOT in a state of good repair.[31]

LJBIG reported 10.1 million transactions totaling $20.4 million in revenue for the third quarter of 2016. During that time, the average toll rate was approximately $0.32 per mile.[32] In the fourth quarter of 2019, there were 12.8 million transactions that amounted to $40.2 million, an increase of 12.5 percent compared to the

[30] LBJ TEXpress. LBJ Express FAQs. https://www.lbjtexpress.com/faq-page (accessed September 17, 2020).

[31] Ibid.

[32] LBJ TEXpress. LBJ Express Traffic and Revenue Summary for Q3 2016, October 28, 2016. https://www.lbjtexpress.com/sites/lbjtexpresslanes.com/files/lbj_texpress_lanes_q3_2016_traffic-revenue_results_10_28_16.pdf (accessed September 17, 2020).

previous year.[33] The most recent traffic and revenue information available was published on August 10, 2020. In the second quarter of 2020, there were only 4.95 million transactions that amounted to $16.6 million in revenue for LJBIG, a decrease of 58.5 percent compared to the previous year. COVID-19 had significant impacts on traffic levels, as fewer cars were on the roads and congestion decreased.

A.1.5 Corridor Freight Mobility

Since 2009, TxDOT has produced an annual ranking of the most congested roadways in the State. The Texas 100 Most Congested Roadways List ranks congestion levels by the number of extra hours of travel time (also called "delay") experienced by travelers on each section of road analyzed for all vehicles (cars and trucks) in the traffic stream. Because roadway sections are of varied lengths, roadways are ranked by the performance measure of delay per mile. Because of the significant delay values in the most congested corridors, and the slow nature of solution implementation to address a congested roadway, the overall list changes little from year to year. The ranked list allows stakeholders and decisionmakers to see the relative rank of a corridor compared to others around the state. To consider the unique aspects of commercial vehicles, TxDOT also ranks corridors specifically measuring truck delay on a per mile basis.

The LBJ TEXpress project was not designed with freight mobility in mind, but mobility in general. In the design stages, planners anticipated a low level of freight traffic, but truck volumes have far exceeded the expectations. The predictable reliability that trucks find on the TEXpress lanes allows trucks to pay a market-based price to get where they need to go quickly. Even if the toll prices increase, trucks continue to be willing to pay for the added benefit of getting to their destinations quickly. The TEXpress lanes have been an instrumental success, most notably for just-in-time deliveries that need to arrive at a designated time. At any point that a truck is stuck in traffic, they are losing money and could even face penalties for being late with deliveries. Even though freight was not considered in the project planning, ultimately, it was the general success of the project that also made it a success for freight.

The LBJ corridor from 1-35E to US 77 was ranked number 7 statewide in 2014 (for both "all vehicle" delay per mile, and for truck delay per mile). This initial ranking was during the first phase of construction. In 2019, this section dropped in congestion ranking to number 15 with construction continuing in the adjacent segment for "all vehicle" delay per mile, and it dropped to number 28 in truck delay per mile.[34]

Truck delay improved because more trucks were willing to use the toll lanes and pay to get to their destinations faster. Planners in other states should be aware that even if they do not anticipate freight to travel on their managed lanes, if the pricing structure is fair and trucks can be assured they can travel through quickly to get to their destinations, then they will use the toll lanes. For trucks, the ultimate driver can often be time, and many would be willing to pay in order to guarantee that reliability.

Given these reductions in delay, the trucking community is also clearly reaping the benefits of the TEXpress Lanes. The corridor experiences much more freight traffic on the TEXpress Lanes than was anticipated. Freight companies have demonstrated they are willing to pay tolls to receive a predictable and reliable travel time through the corridor. TxDOT believes the higher-than-expected freight demand is related to just-in-time

[33] LBJ TEXpress. LBJ Express Traffic and Revenue Summary for Q4 2019, March 12, 2020. https://www.lbjtexpress.com/sites/lbjtexpresslanes.com/files/lbj_q4_2019_results.pdf (accessed September 17, 2020).

[34] Texas' Most Congested Roadways—2019, https://mobility.tamu.edu/texas-most-congested-roadways/ (accessed September 28, 2020).

deliveries. The data show that truck drivers tend not to use the managed lanes during peak periods when toll prices are highest.

Another lesson learned is the strategic selection of delay per mile (and truck delay per mile) as the primary performance measure for the rankings. In general, delay measures are advantageous because they capture the full extent of the congestion problem because they are computed for every hour for every day throughout the year ("24/7/365"). Delay-based measures can identify the biggest problem areas because they combine the performance of the roadway segment (speed data) with how many travelers are impacted by those speed conditions (traffic volume data). Normalizing (dividing) the total delay for a segment by the segment length allows for the ranking of roadway segments that are of different lengths. Index measures such as the Texas congestion index (equivalent to the travel time index) (mobility measure) or planning time index (reliability measure), while valuable, are typically computed for the peak-period(s) only. In highly congested locations, it can be difficult to "move the needle" with congestion projects on these index measures that focus only on the peaks. Delay measures, on the other hand, allow for the measurement of congestion outside the peak periods where congestion mitigation improvements can have an impact.

The computation of truck delay per mile requires four data inputs: 1) actual travel speed, 2) free-flow travel speed, 3) vehicle volume (total vehicles and truck only), and 4) vehicle occupancy (persons per vehicle) to calculate person-hours of travel delay. TxDOT obtains crowd-sourced speed data from a vendor through a competitive bid (most recently from INRIX). INRIX provides an annual average speed for each 15-minute period of each day. TTI uses those speeds to compute a free-flow travel speed (or reference speed or "uncongested speed") for use in the calculation of delay. The free-flow travel speed is computed as the 85th percentile of the weeknight speeds between 10:00 pm and 6:00 am.

TxDOT roadway inventory data include daily traffic volumes ("all vehicles" and truck AADTs). The traffic data are obtained from their annual count program. Seasonal factors and time-of-day profiles from local continuous count locations are used to estimate 15-minute traffic volumes ("all vehicles" and trucks) by functional classification for each daily traffic volume. The interested reader can review the full methodology to review detailed steps, including the average vehicle occupancy assumptions (https://mobility.tamu.edu/texas-most-congested-roadways/).

There are many valuable lessons learned for other states related to freight bottlenecks. First of all, the delay measures are most effective for capturing the full extent of the congestion problem, beyond just the peak periods. The methodology provides sound, replicable, and defensible results for planning purposes, allowing public agencies to review segment congestion trends over time. The methodology allows for the identification of freight bottleneck locations with the truck delay per mile measure, and highlights highway sections where location-specific freight bottleneck improvements can be further investigated. Another lesson is that the entire suite of performance measures is valuable (including the peak-period indices) because they tell a compelling, collective story.

A.1.6 Lessons Learned and Notable Practices

The LBJ Express project successfully maintains minimum speeds in the managed lanes and demonstrates the potential of 3Ps for improving freight mobility and innovative community engagement. Below are the lessons learned from the project:

- The project was successful in reducing the delay on the corridor, thus resulting in a better statewide ranking in both "all vehicle" delay and truck delay. The ongoing performance measurement activities of

the TxDOT 100 Most Congested Roadways List demonstrate an effective performance measurement process and measures for ongoing highway performance measurement.

- More trucks have used the TEXpress Lanes than was anticipated. Travel time reliability has created a favorable environment for just-in-time delivery and for companies looking to get shipments delivered more quickly. This may be attributed to latent demand, which was unable to use the roadway before the infrastructure and operational improvements.

- Partnerships among all stakeholders, flexibility, and relationship building are critical to the success of projects. Engaging the community to create a full understanding of project goals can lead to meaningful conversations that lead to projects that provide the best solutions for everyone.

- Planners should also seek to require a speed threshold and a price cap. These mechanisms balance the demands of mobility and accessibility for travelers. The combination allows for free market drivers and public policy to work in tandem.

- While freight was not a main consideration for the TEXpress project, freight has benefited. Planners should consider and understand freight demand of the existing infrastructure and the potential demand generated by an improved system. As long as the prices are truly market-driven and the pricing structure is fair for all roadway users, freight will take advantage of the benefits of toll roads.

A.2 Inland Port Greer

A.2.1 Introduction

This case study addresses the Inland Port Greer (previously known as the South Carolina Inland Port, or SCIP) at Greer, South Carolina. It considers the general perspective of facility origins, functions, and growth over time, and then addresses the specifics of a federal discretionary grant application (known as the "Upstate Express" project) to expand the facility.

A.2.2 Overview of the Region

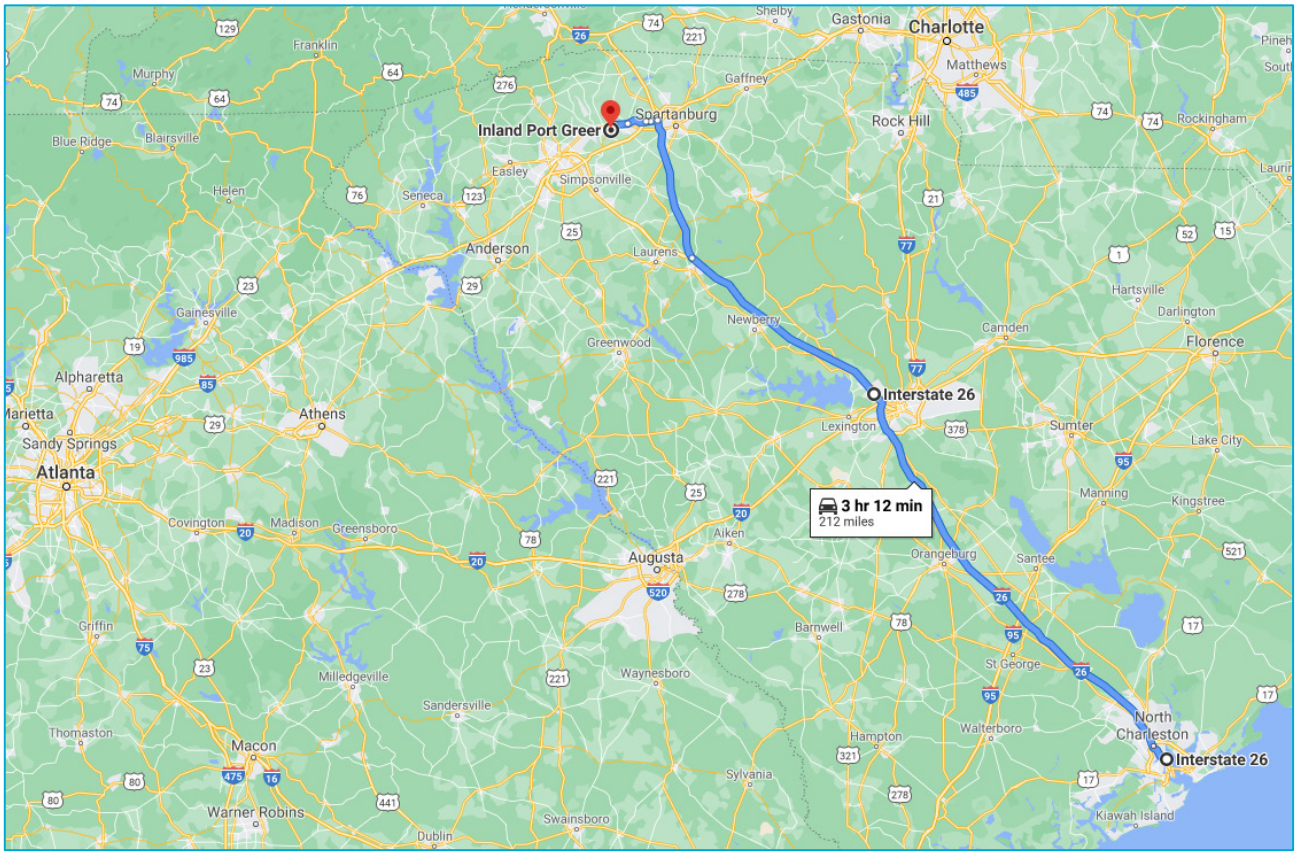
Freight in the "Upstate" Region

Greer is located in the northwestern corner of South Carolina, immediately directly between Greenville SC and Spartanburg SC, and generally between Charlotte NC and Atlanta GA. The area is served by I-85 (with Atlanta GA to the southwest and Charlotte NC to the northeast), and by I-385/I-26 (connecting to Charleston, approximately 212 miles southeast). Inland Port Greer has a rail connection (via the Norfolk Southern Railroad) to Charleston, South Carolina and the South Carolina Ports Authority terminals located in Charleston and North Charleston; Charleston is located on South Carolina's southeastern seacoast; the rail route distance is approximately 234 miles (see Figure A.6 and Figure A.7).

Functionally, the Inland Port Greer provides freight service for the fact-growing Greenville-Spartanburg area, the Port of Charleston, and all of South Carolina, and its location allows easy access to and from the Charlotte NC and Athens GA/Atlanta GA markets. Historically, South Carolina has been a very important state for freight movement, starting with imports through the Port of Charleston and domestic production and export of agricultural products. In recent years, and especially over the past decade, South Carolina's importance as an international gateway has intensified. The state has seen dramatic growth in

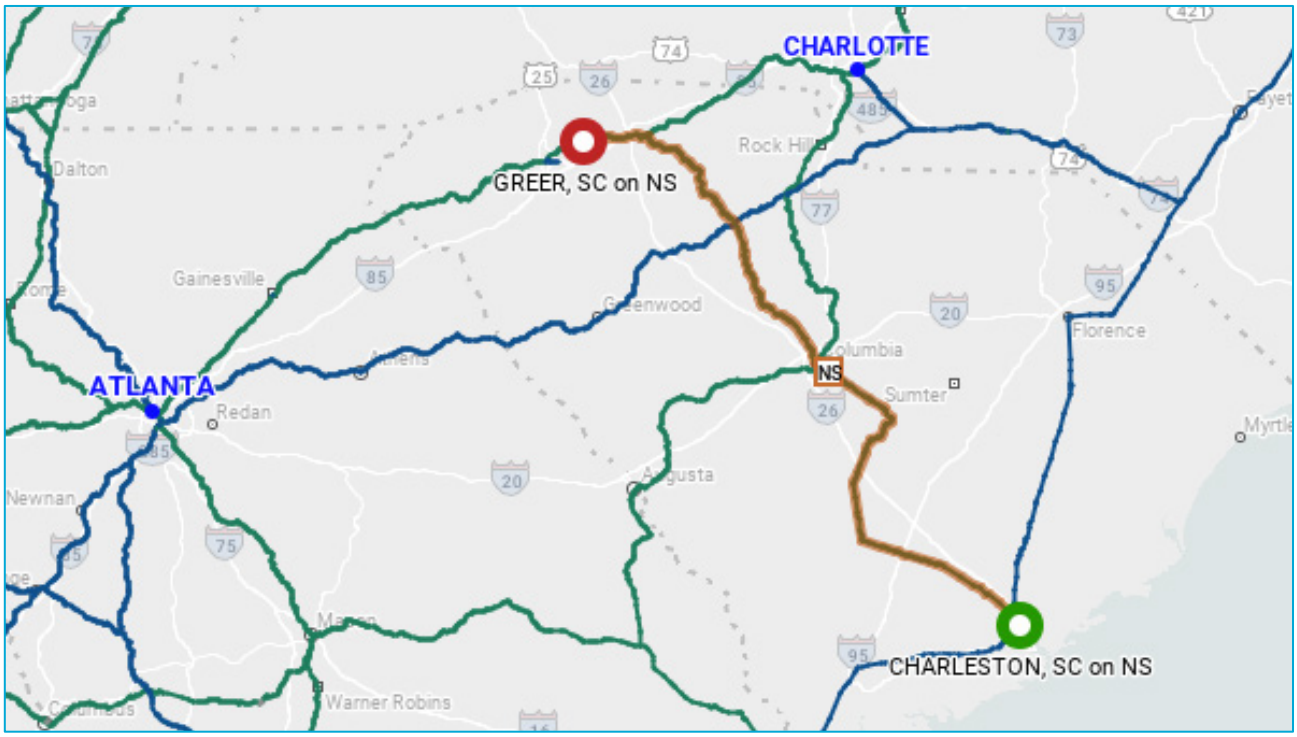
manufacturing—including aerospace, automobiles/original equipment manufacturer (OEM) auto parts, and high-tech fabrication—as well as new logistics and distribution activity driven by industrial development and consumer population growth.

Figure A.6 Highway Routing between Greer and Charleston



Source: Google Maps.

Figure A.7 Rail Routing between Greer and Charleston via Norfolk Southern



Source: PC Miler Rail.

The Greenville-Spartanburg area, and the City of Greer specifically, is a major hub for freight-generating and freight-dependent industries in South Carolina. Although Greer has a population around just 34,000, it hosts a major BMW automotive manufacturing plant with roughly 11,000 employees (see Figure A.8). The facility has been open for 25 years and is "the BMW Group producer of the BMW X3, X3 M, X5, X5 M and X7 Sports Activity Vehicles and X4, X4 M, X6 and X6 M Sports Activity Coupes." The plant produces more than 1,500 vehicles per day, and around 70 percent of its production are exported to 125 different world markets.[35] The BMW plant is supplied by a complex network of domestic and international materials and parts manufacturers, including a large community of nearby OEM suppliers. It is served directly by truck and rail, and given its sales market and sourcing requirements, it is also highly dependent on efficient international ocean transportation.

[35] See https://www.bmwgroup-werke.com/spartanburg/en.html.

Figure A.8 BMW Group Plant in Greer

Source: https://www.bmwgroup-werke.com/spartanburg/en/our-plant/site-infos.html.

Other major freight-intensive employers in Greer include Benore Logistics Systems, Mitsubishi Polymer Film, Honeywell Aerospace, Yorker Packaging/Jarden Plastic Solutions, Syncreon America (automotive logistics services for BMW). Minghua USA (OEM auto parts), Magna Closures and Mirrors (OEM auto parts), Service Transport Inc., and other automotive parts/engineered materials/packaging companies. Other major freight-intensive employers in the Greenville-Spartanburg area include Michelin North America (tires), GE Power (turbines), Sealed Air Corp (Cryovac), Lockheed Martin Aeronautics (aircraft components), Wal-Mart (retail), Milliken and Company (textiles, flooring, materials), ZF Transmissions, AFL (electronic components), DAA Draexlmaier Automotive (OEM parts), Eaton Corp (power distribution and transformers), Electrolux (appliances), Freightliner (RV and van chassis), Nestle (frozen foods), Techtronic Industries (hand tools), Timken (ball and roller bearings), and many others.[36]

A.2.3 Freight in South Carolina

The recently updated (2020) South Carolina Statewide Freight Plan (SFP) provides an overview of goods movement in the state. The movement of goods is critical to the economic health of South Carolina, which has access to major ocean ports, regional airports, inland ports, rail lines and highways. The objective of South Carolina's Statewide Freight Plan (SFP) is to respond to the recognition policymakers in South Carolina have made of the critical role of transportation infrastructure and freight movement to the state's economy.

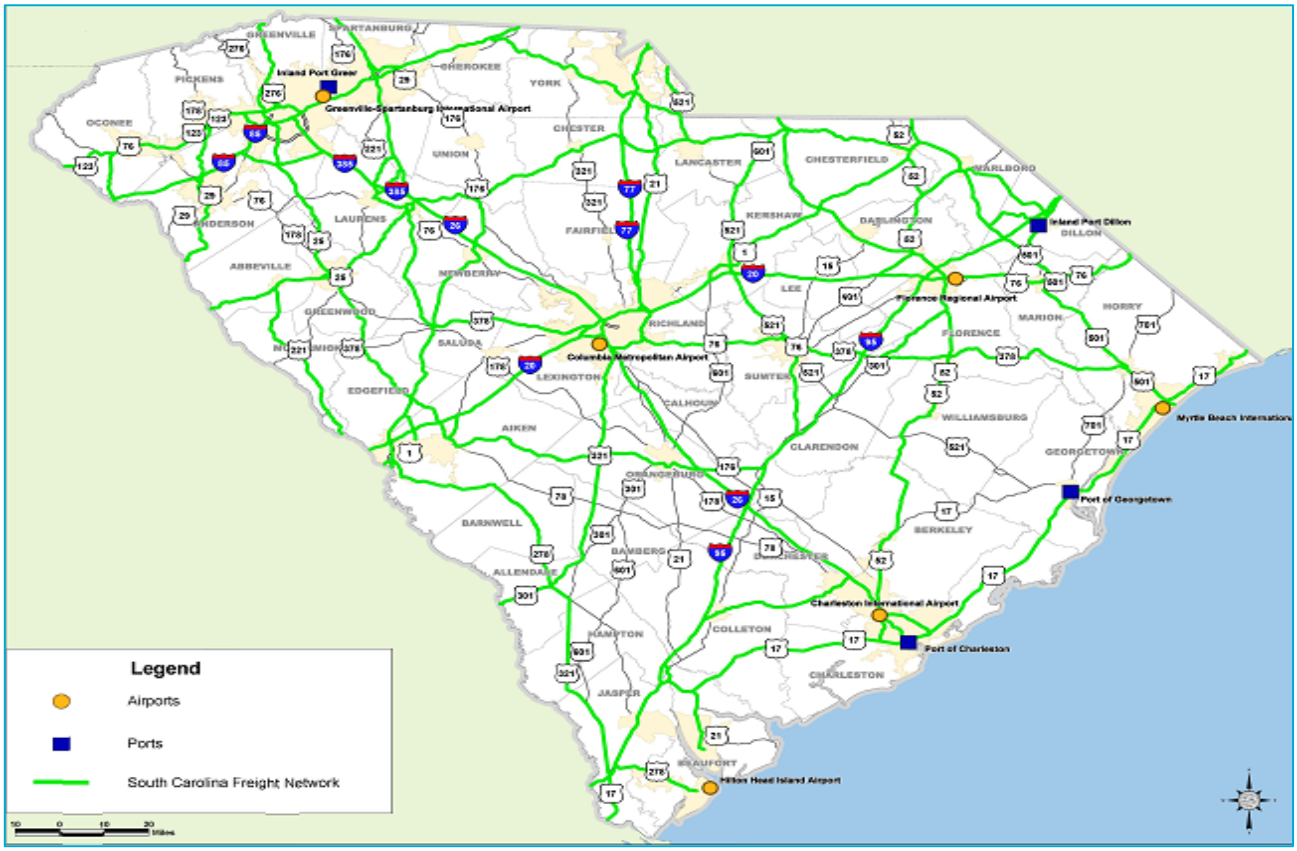
The SFP includes an inventory of transportation assets that contribute to the movement of goods in South Carolina, including all modes of transportation, regardless of asset ownership. The inventory also includes an overview of freight generators, businesses and geographic areas contributing to freight movements. A profile of goods movement was developed for South Carolina, summarizing the tonnages and commodities for both historical years and forecast years, aligning data analyses for the 2040 Multimodal Transportation Plan and the SFP.

[36] See https://greerdevelopment.com/wp-content/uploads/2019/07/Greer_Largest_Employers.pdf and https://www.upstatescalliance.com/data-resources/major-employers/.

- Over 465 million tons of freight, valued at nearly $739 billion, moved across South Carolina's freight network in 2016.
- Trucking accounts for the largest modal share: 375.1 million tons (81 percent) valued at $611.8 billion (83 percent).
- Rail comprises the second largest modal share at 63.2 million tons (14 percent) and $93.6 billion (13 percent).
- Major truck and rail tonnage movements are followed by pipeline, water, and air, respectively.
- Tonnage across the South Carolina freight network is forecast to grow 65 percent from 2016 to 2040.
- While rail yields the fastest tonnage growth rate (69 percent), truck growth is nearly as rapid (60 percent) and is much greater in terms of volume (224.6-million-ton increase).
- Truck tonnage is forecast to grow from 375.1 million tons in 2016 to 599.6 million in 2040.

The state is served by several important interstate highway corridors (including I-85, I-95, I-77, I-26, and I-20) and two Class I freight railroads (Norfolk Southern and CSX). In 2019 the Port of Charleston handled more than $75 billion in international trade value to rank eighth among all US ports. Locations of the Port of Charleston, Inland Port Greer, major truck routes, freight rail terminals, and cargo airports are shown in Figure A.9.

Figure A.9 South Carolina's Strategic Freight Network



Source: South Carolina Statewide Freight Plan, 2020.

Industrial growth and diversification have been major opportunities for South Carolina. Though logging and agriculture are historically two of the state's biggest industries, new manufacturing and distribution center development has been transformational to South Carolina due to BMW, Amazon, Walmart, Harbor Freight, Volvo, Mercedes, Boeing, OEM manufacturing, and others. The state envisions continued growth and diversification, and with it the need for facilities to accommodate growth.

As a result of the continued growth in freight-intensive industries throughout South Carolina, state and regional planning is increasingly attentive to freight. SCDOT recently refreshed its state freight plan and anticipates a "complete rebuild" for the next version, responding to the state's rapidly changing business environment. The Upstate region and Berkeley-Charleston-Dorchester Council of Governments are also conducting freight plans. The South Carolina Council on Competitiveness, an arm of the state's Department of Commerce, has a freight and logistics subcommittee that includes industries and associations, multimodal transportation carriers, and other logistics professionals, and has proven valuable in guiding freight planning efforts.

South Carolina has two main freight hubs—the Port of Charleston and Inland Port Greer—along with a network of smaller hubs and corridors. Connections between Charleston and Greer are especially critical, along with access to these hubs from user markets. The state is working to establish a third hub—an Inland Port at Dillon, SC. Harbor Freight is the anchor for Dillon and rail service is provided by CSX. Growth near the Port of Charleston has been substantial, including new Volvo and Walmart facilities; growth in the Greenville-Spartanburg area has also been substantial for both consumer and industrial uses, and is seeing "freight sprawl" effects; growth in Dillon has been slower as that area is relatively undeveloped, but has potential for long-term development and intensification.

Important recent freight and logistics improvements include the deepening of Charleston harbor to 52 feet and deepening the entrance channel to 54 feet. The additional depth will permit post-Panamax vessels to utilize the Port of Charleston 24 hours a day regardless of tides. Additionally, the SC Port Authority is expected to open the Hugh K. Leatherman terminal in 2021. The new terminal's first phase will have a 1,400-foot berth, 25 hybrid rubber-tired gantry cranes, and five new ship-to-shore cranes with 169 feet of lift height and 228 feet of outreach. The first phase will add about 700,000 twenty-foot equivalent units (TEU) of capacity to SC Ports; when fully built, the 280-acre, three-berth terminal will double existing port capacity. It can be anticipated that the deepening activities and capacity increases will result in greater freight activity for the state as a whole, and for Inland Port Greer.

A.2.4 Overview of the Freight Investment

Inland Port Greer

Inland Port Greer is a rail intermodal terminal located 212 miles inland from the Port of Charleston. It was opened in 2013 to provide BMW (initially) and other customers (over time) nearby intermodal transfer and scheduled 'express' rail service to and from the Port of Charleston, improving their access to international ocean transportation services. Inland Port Greer is owned and operated by the South Carolina Ports Authority (SCPA). Figure A.10 and Figure A.11 contain the reference sheet published by the SCPA describing operations at Inland Port Greer.

Figure A.10 Inland Port Greer "Quick Reference Sheet" Page 1

INLAND PORT GREER SOUTH CAROLINA PORTS SIGN-UP FOR OUR E-NEWSLETTER AT WWW.SCSPA.COM

Meet Inland Port Greer – an innovative new intermodal facility 212 miles inland. Now you can move containers inland with speed and reliability, while simultaneously lowering your carbon footprint.

Address: 100 International Commerce Blvd., Greer, SC 29651. Located on US Highway 29, Exit 58 off of Interstate 85.

Operations: Owned and operated by the SC Ports Authority.

Operating Hours: Open for receipt/delivery of containers 24-hours/day, 7-days/week.

Terminal Manager: Will Angelich / 864-968-7902.

Office FAX: 864-877-2041.

Driver's Assistance: 864-968-7901

Rail Service: Provided exclusively by Norfolk Southern.

Train Schedule: Overnight express shuttle service between the Port of Charleston and Greer, SC six days per week. *See chart below for full details.*

Chassis and M&R: Chassis pool on-site with maintenance provided. Pool chassis are not compulsory, so OFBT is permitted.

Trackage: Initial rail infrastructure consists of 2x2,600' working tracks and 3x2,600' storage tracks.

Payment: All expenses are billed to the account of the ocean carrier. Cargo owners must request rates from their ocean carriers. Ramp rates will include the lift to/from rail on both ends, NS CHS in-gate/out-gate charges, and drayage between NS Seven Mile Yard and Port of Charleston marine terminals.

Port of Entry: Located in the Greenville-Spartanburg (GSP) port of entry. Cargo may move under the ocean carrier's bond to Greer where it remains until a subsequent transaction. Per CBP, certain exams and inspections will continue to be performed in Charleston and also at bonded facilities in GSP. Ocean carriers or agents wishing to prevent delivery of equipment at Inland Port Greer may place holds in Orion. A separate summary of systems is available for ocean carriers. The Inland Port Greer FIRMS code is M682.

Trucking: The requirements and processes for motor carriers doing business at Inland Port Greer are essentially the same as in Charleston, except TWICs are not required. Draymen must have an SCPA Orion motor carrier code, which can be obtained from the SCPA's Solutions Center at 843-579-4433.

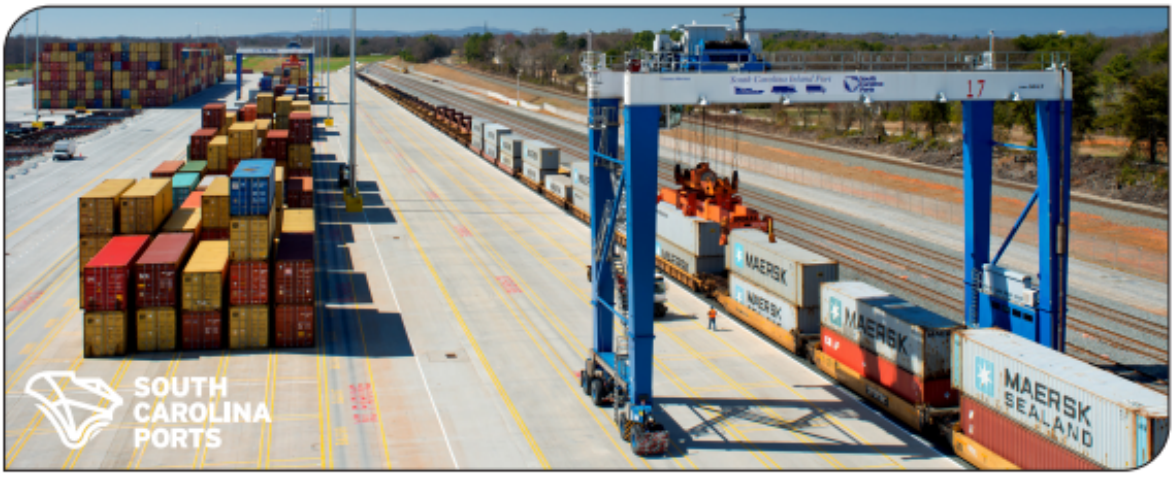
Drayage To/From Marine Terminals In Charleston: Provided by SCPA RapidRail trucker dispatch or your ocean carrier. Import RapidRail boxes will be moved to rail within 24-hours of becoming available (meaning released by Customs, EIR in order, and physically on the marine terminal). With proper coordination, RapidRail boxes can be moved to rail the same day as being offloaded from the vessel.

Norfolk Southern Train Schedule: Inland Port Greer

IMPORTS			EXPORTS		
	Charleston Cut-Off	Available @ SCIP		SCIP Cut-Off	Available In Charleston
Monday	Mo 1:00PM	Tu 8:00AM	**Monday**	Mo 3:00PM	Tu 4:00PM
Tuesday	Tu 1:00PM	We 8:00AM	**Tuesday**	Tu 3:00PM	We 4:00PM
Wednesday	We 1:00PM	Th 8:00AM	**Wednesday**	We 3:00PM	Th 4:00PM
Thursday	Th 1:00PM	Fr 8:00AM	**Thursday**	Th 3:00PM	Fr 4:00PM
Friday	Fr 1:00PM	Sa 8:00AM	**Friday**	Fr 3:00PM	Mo 12:00PM
Saturday	Sa 12:00PM	Mo 12:00PM	**Saturday**	Sa 3:00PM	Mo 12:00PM
Sunday	--	--	**Sunday**	--	--

Source: http://scspa.com/wp-content/uploads/inland-port-greer-qr.pdf.

Figure A.11 Inland Port Greer "Quick Reference Sheet" Page 2



INLAND PORT GREER

SIGN-UP FOR OUR E-NEWSLETTER AT WWW.SCSPA.COM

Inland Port Greer Benefits

Competitive or lower cost: Reduced empty miles, higher truck productivity, lower chassis/per diem/detention charges. Ability to terminate and source empties closer to the origin/destination. Competitive with round-trip all-motor on a one-way basis. Represents a modal shift to reduce trucking risks from higher fuel costs, driver availability, hours-of-service rules and other factors.

Reliability & Flexibility: Overnight, express daily shuttle six days per week. Operated by the Ports Authority. Closer access to inventory. 24/7 operating hours for quick access to cargo. Ocean carriers are provided 7-days free-time on import loads.

Future Growth: Ideally situated on I-85 between Charlotte and Atlanta, the fastest growing corridor in the country. Easy access to North Carolina, Tennessee, Georgia, western Virginia and eastern Kentucky. 94 Million consumers live within 500 miles. Adjacent air cargo services for e-commerce/fulfillment. Part of broader $2 billion CAPEX program in South Carolina.

Carbon Footprint: An air model based on EPA data typically shows companies can expect a 70-85% reduction in emissions from fewer truck/empty miles. Particularly attractive to leading global brands with corporate sustainability ambitions.

Frequently Asked Questions

How do I get started using Inland Port Greer?
Your first step is to notify your ocean carrier that you are interested in using Greer. Don't wait for your sales representative to present the option to you. If you believe it may work, ask for a Greer ramp rate.

So, I get the Greer ramp rate from whomever is arranging the transportation of my containers?
Yes, that is correct. As a cargo owner you will have no payable to SC Ports or NS. NS has supplied contract rates to all Port of Charleston ocean carriers and all SC Port charges, including RapidRail trucking services in Charleston, if utilized, will be incorporated into the rate supplied by the firm arranging your transportation.

How will the import process work? Give me an example.
- Import containers will be off-loaded from the vessel at one of the Port of Charleston container terminals.
- Boxes are delivered to the NS Charleston ramp within 24-hours of notification to move the box by the ocean carrier or other authorized party. With proper planning and notification, expedited boxes can be delivered to rail the same day as discharge, providing overnight service from vessel to SCIP.
- Cut-off time is 1:00PM Monday-Friday and noon on Saturday.
- NS will move the box to Inland Port Greer, Monday-Saturday.
- Containers will be available for pick-up the following day. Saturday boxes will be available on Monday.

How will the export process work?
- Export containers can be received in Greer 24/7.
- Cut-off time is 3:00PM daily.
- NS will move the boxes on trains operating Monday-Saturday.
- Containers from the Monday-Thursday trains will be available for pick-up at 7 Mile Yard in Charleston the next day for delivery to the marine terminal.
- Containers arriving Friday/Saturday will be available on Monday.

Will ocean carriers be able to dispatch an empty container for my export load from Greer instead of Charleston?
Yes. You should work with your ocean carrier to save time and money in the sourcing of your empty equipment.

Source: http://scspa.com/wp-content/uploads/inland-port-greer-qr.pdf.

Inland Port Greer was an early response to emerging growth and transportation pressures and featured a strong 'partnership' model from the start. The Greer facility actually existed in the 1990s, but had limited activity. In the run-up to formally opening the facility as an Inland Port in 2013, the key driver was BMW, which wanted to reduce its fuel costs and environmental footprint and improve its supply chain reliability. BMW engaged with SCPA and Norfolk Southern about the potential to move more freight through Inland Port Greer. SCPA took on the necessary 'inside the gate' facility development; Norfolk Southern provided the necessary 'outside the gate' rail improvements; South Carolina DOT was responsible for 'outside the gate' truck access; and BMW delivered the traffic to initially support the facility.

Inland Port Greer's commodity profile has grown and evolved. The initial business was finished BMW automobiles and tires, along with traffic for the established OEM community. As BMW production expanded and the OEM community grew, this traffic increased. But it also diversified, with other industries and distribution center/ "big box" traffic from the fast-growing Greenville-Spartanburg market, and (increasingly) from industries in nearby states. Importantly, this diversification has supported two-way traffic—with loaded railcars moving in both directions—making the operation more economically viable for the railroad. Today, it is estimated that BMW and related industries may represent around half of the Inland Port traffic, with other regional industries representing the other half.

The "Upstate Express" Project

The "Upstate Express" project secured federal discretionary grant funds to expand Inland Port Greer. Prior to the grant, Inland Port Greer operated on 40 acres and had been experiencing record growth—117,812 containers in the fiscal year ending June 2018, representing a 28.5-percent increase over fiscal year 2016—along with 10 percent growth in the first quarter of fiscal year 2019.[37] The award provided funding to expand the terminal by up to 40 acres with additional paved area for increased container handling and storage, along with lead track and siding track improvements allowing longer trains.[38] Together these improvements will allow Norfolk Southern to move more freight on its scheduled train services.

[37] See https://greerdevelopment.com/inland-port-greers-25m-expansion-plan/.

[38] See https://greertoday.com/greer-sc/25-million-grant-awarded-inland-port-expansion-norfolk-southern/2018/12/11/.

The United States Department of Transportation (USDOT) announced a $25 million Better Utilizing Investments to Leverage Development (BUILD) grant to support the expansion at South Carolina Ports Authority's (SCPA) Inland Port Greer, and the extension of Norfolk Southern's Carlisle Passing Siding.

"We are very appreciative for the support of our Congressional delegation, S.C. Governor Henry McMaster, Secretary Chao, and the USDOT," said Bill Stern, SCPA Board Chairman. "This is a strong, collaborative partnership by public and private entities, something the Trump Administration has put an emphasis on. We are proud to partner with these entities to better improve our infrastructure in South Carolina. While this project may be in the Upstate, it will serve the entire Southeast region for years to come."

The expansion of the Inland Port will increase terminal capacity, allow for additional storage and processing tracks inside the terminal which will improve rail capacity, efficiency and flexibility, and expand on-terminal support facilities.

"As SC Ports continues to see record growth, this funding is critical for the expansion efforts at Inland Port Greer," said Jim Newsome, SCPA president and CEO. "This project will support local manufacturing, increase capacity for logistics growth, and improve transportation networks supporting traffic flows for imports and exports throughout the state and region."

This grant award underscores the importance in partnering to build for the future of economic growth in South Carolina," stated Rob Martinez, Vice President of Business Development and Real Estate at Norfolk Southern. "Completion of the Upstate Express Corridor is an essential component for each partner's shared growth and we are grateful for this opportunity to build for South Carolina's future."

The SCDOT, Norfolk Southern, BMW, and the South Carolina Ports Authority partnered together for the grant application. "Like many companies in the region, BMW Manufacturing has benefited from the inland port since its opening in 2013," said Sky Foster, Department Manager, BMW Corporate Communications. "The inland port has been essential for our day-to-day logistics operations and in our ability to expand production and add new models. We appreciate the support of the state and federal Departments of Transportation, the South Carolina Ports Authority and other partners that worked diligently to secure this funding."

For the BUILD 2018 application, the lead agency was the South Carolina Department of Transportation, but project partners included SCPA, Norfolk Southern, and BMW (see Table A.1). Although USDOT considers it a rail modal project and cites the Federal Railroad Administration (FRA) as the operating administration, the Maritime Administration is actually the lead.

Table A.1 BUILD 2018 Award Summary from USDOT

Project Name	Upstate Express Corridor Capacity Expansion Project
Urban/Rural	Rural
Mode of Transportation	Rail
DOT Operating Administration	FRA
Applicant Name	South Carolina Department of Transportation
Applicant State	SC: South Carolina
Project Description	The project will make freight rail infrastructure improvements in South Carolina. It will expand the Inland Port Greer (IPG), extend the IPG lead track, and lengthen the Carlisle Siding to approximately 15,100 feet. The IPG expansion includes acquiring additional equipment for the handling, loading, and unloading of containers and the paving of up to 40 acres.
BUILD Award Amount	$25,000,000
Total Project Cost	$51,120,000

Source: https://www.transportation.gov/policy-initiatives/build/build-grants-2018-awarded-projects.

A.2.5 Measuring and Monitoring the Impact of the Investment

Performance Measurement for the Upstate Express Project

Federal discretionary grants for transportation projects place heavy emphasis on satisfying certain evaluation criteria, and many of these criteria are quantifiable performance metrics. Although each program and funding year has its own requirements, and requirements can vary in terms of content or emphasis, the programs generally include a "core" set of performance measures addressing safety; state of good repair; economic competitiveness; environmental protection; quality of life; and other factor areas. These may be informative for developing performance measures to support freight investment performance monitoring. The specific BUILD 2018 "merit criteria" are summarized below:[39]

- **Safety.** The project's ability to foster a safe transportation system for the movement of goods and people. Among other measures, this includes the projected impacts on the number, rate, and consequences of crashes, fatalities, and injuries among transportation users.
- **State of Good Repair.** Projects that ensure the good condition of transportation infrastructure, including rural transportation infrastructure, that support commerce and economic growth.
- **Economic Competitiveness.** Projects that decrease transportation costs and improve access; improve efficiency, reliability, or costs in the movement of workers or goods; increase economic productivity; result in long-term job creation and other economic opportunities; or help the United States compete in a global economy by facilitating efficient and reliable freight movement.
- **Environmental Protection.** Projects that improve energy efficiency, reduces dependence on oil, reduces congestion-related emissions, improves water quality, and avoids and mitigates environmental impacts and otherwise benefits the environment, among others.

[39] Published in the Federal Register/Volume 83, No. 82 / Friday April 27, 2018 / Notices.

- **Quality of Life.** Projects that improve the quality of life by increasing transportation choices for individuals; expanding access to essential services; improving connectivity to jobs, health care, and other critical destinations; and transportation projects that will allow concurrent installation of fiber or other broadband deployment as an essential service, especially in rural areas and Tribal Lands.

- **Innovation.** Projects that use innovative technologies, project delivery, or financing.

The BUILD grant application for the Upstate Express project was supported by a detailed Benefit-Cost Analysis (BCA) model, which provided quantitative values and estimates for each of the applicable merit criteria specified in the Notice of Funding Opportunity (NOFO). The methods, and most of the factors, used to prepare the BCA were specified in Federal BCA Guidance available at that time.[40] Details of the Upstate Express BCA are marked as Confidential Business Information and cannot be reported, but characterizing the approach generally, the analysis:

- Developed forecast growth volumes for customer traffic through Inland Port Greer over a 30-year analysis period.

- Established that without improvements, Inland Port Greer rail operations are near capacity, and will not be able to accommodate forecasted growth.

- Formulated two alternative strategies to handle the anticipated future growth. In the “Without Project” scenario, rail improvements are not made; rail volumes reach a maximum and additional growth is forced to utilize trucks. In the “With Project” scenario, rail improvements are made, and additional growth is accommodated by rail.

- Calculated transportation effects for each scenario. The Without Project scenario has higher truck vehicle miles of transportation (VMT), lower rail ton-mileage, and higher per-unit rail transportation costs; the With Project scenario has less truck VMT, more rail ton-mileage, and lower per-unit rail transportation costs. The VMT and rail ton-mileage effects are proportional to the cargo volume handled through Inland Port Greer, while the per-unit rail transportation costs are related to both cargo volume and train handling requirements.

- Calculated the required merit criteria performance metrics for each scenario, including avoided truck rail crashes; avoided highway damage from truck vehicle-miles of travel; reduced rail transportation costs for rail freight (savings from avoided diversion of rail traffic to truck were not considered); and reduced emissions from truck and rail engines. Each of these metrics is driven off some combination of truck VMT, rail ton-mileage, and per-unit rail transportation costs.

- Calculated the difference in performance between the scenarios, monetized the value of the difference, discounted monetized value to Net Present Value, and calculated the project Benefit Cost Ratio.

[40] This guidance, which is periodically updated, can be found at https://www.transportation.gov/office-policy/transportation-policy/benefit-cost-analysis-guidance-discretionary-grant-programs-0.

The USDOT Fact Sheet describing the award[41] summarizes the expected benefits:

> *The project will advance state of good repair by shifting freight transport from truck to rail, thereby reducing vehicle miles traveled and subsequent pavement damage caused by heavy trucks. The project will add inland transportation capacity to accommodate the economic growth that is expected at the port from the nearby automotive manufacturing facility and other manufacturers in the area. Quality of life will be improved by reducing highway congestion on Interstates 26 and 85.*

Performance Monitoring Requirements

The BUILD 2018 NOFO establishes requirements and procedures for continuing performance monitoring of awarded projects. One reporting area is progress on the receipt and expenditure of federal funds during project construction/implementation; another is "observed performance with respect to relevant long-term outcomes … over several years." As stated in the Notice of Funding Opportunity (NOFO):

i. *Progress Reporting on Grant Activities. Each applicant selected for BUILD Transportation Discretionary Grants funding must submit quarterly progress reports and Federal Financial Reports (SF–425) to monitor project progress and ensure accountability and financial transparency in the BUILD Transportation program.*

ii. *System Performance Reporting. Each applicant selected for BUILD Transportation Discretionary Grant funding must collect information and report on the project's observed performance with respect to the relevant long-term outcomes that are expected to be achieved through construction of the project. Performance indicators will not include formal goals or targets, but will include observed measures under baseline (pre-project) as well as post-implementation outcomes for an agreed-upon timeline, and will be used to evaluate and compare projects and monitor the results that grant funds achieve to the intended long-term outcomes of the BUILD Transportation program are achieved. To the extent possible, performance indicators used in the reporting should align with the measures included in the application and should relate to at least one of the selection criteria defined in Section E. Performance reporting continues for several years after project construction is completed, and DOT does not provide BUILD Transportation Discretionary Grant funding specifically for performance reporting.*

For the Upstate Express project, South Carolina and the USDOT Maritime Administration entered into a Memorandum of Agreement establishing the performance measurement procedures applicable to the award. As shown in Table A.2, the two primary metrics are quarterly and yearly rail container lifts at Inland Port Greer; and quarterly and yearly rail tonnage at Inland Port Greer. As the project's merit criteria are proportional to growth in rail volumes, providing these simple and easily collected metrics serves to demonstrate the project is achieving its intended effect—which is, simply put, to allow rail traffic at the Inland Port to continue to grow—and which, in turn, generates the desired public benefits that USDOT is investing to achieve. To establish a baseline, a "Pre-Project" report with 12 consecutive months of data is required; then quarterly reports are to be provided for three years after substantial completion of the project; and then a "Project Outcomes" report is due in 2027.

[41] See https://www.transportation.gov/policy-initiatives/build-2018-fact-sheets.

Table A.2 Upstate Express Performance Measurement Table

Measure Type	Benefit Type and Measurement Frequency	Measurement for Pre-Project Report	Measurement Following Completion
Cargo Lifts	Economic Competitiveness • Quarterly and yearly rail (cargo) lifts at Inland Port Greer. A rail lift is a movement of a container on or off a rail car.	Baseline Measurement • Annual average, accurate as of the Pre-project Measurement Date July 1, 2020. Interim Performance Measures • Accurate as of the 1st full day of the first full quarter after Substantial Completion.	Baseline Measurement • Pre-project Report Due Date July 1, 2020. Interim Performance Measures • For a period of 3 years, the first full quarter after Substantial Completion, for a period of 12 consecutive quarters.
Gross Tons	Economic Competitiveness • Quarterly and yearly tonnage moved by rail at Inland Port Greer.	Baseline Measurement • Annual average, accurate as of the Pre-project Measurement Date July 1, 2020. Interim Performance Measures • Accurate as of the 1st full day of the first full quarter after Substantial Completion.	Baseline Measurement • Pre-project Report Due Date July 1, 2020. Interim Performance Measures • For a period of 3 years, the first full quarter after Substantial Completion, for a period of 12 consecutive quarters.

Source: Reproduced from materials provided by the South Carolina Ports Authority.

Key Insights for Performance Measurement from BUILD

Partnership has been, and remains, a key to the success of the facility. There is a clear and collaborative operating structure: SCPA operates and staffs all functions within the terminal, Norfolk Southern (NS) runs the trains, and SCDOT manages local/regional/statewide transportation improvement planning. Private industries like BMW communicate their logistics needs and provide a strong base of traffic when those needs are met. The parties work regularly and closely together, and each was involved in formulating the Upstate Express project and preparing the BUILD grant. NS is currently preparing the bid documents package.

Each of the project partners tracks certain performance measures related to their organizational missions. SCPA focuses on terminal performance: time to load/unload vessels and trains, time to process trucks in and out of the terminal, container dwell time in the terminal, crane moves per hour, total throughput, etc. SCDOT focuses on the performance metrics mandated by Federal law, while supporting statewide goals for planning and economic development. Norfolk Southern emphasizes rail volume and customer satisfaction/utilization. The performance metrics required for the BUILD grant application were not measures that any party normally tracks, and required additional work by the application team; however, the performance metrics required for ongoing monitoring are regularly tracked in the course of normal operations, and should be relatively straightforward to provide.

One challenge was meeting the National Environmental Protection Act (NEPA) compliance requirements for the Upstate Express improvements was challenging in the sense that the applicable process for an Inland Port project was not obvious. Ultimately it was determined that Federal Highway Administration's NEPA compliance process and FRA guidance for rail project review were applicable, and an agreement between the FHWA Division Office and SCDOT allowed SCDOT to sign-off on a categorical exclusion for the project.

Another challenge was the timeline. The award was announced in February of 2018, but an agreement with USDOT was not executed until July 2020. It took more time than expected for USDOT to select an administering agency, and then took more time for Maritime Administration (MARAD) staff to become familiar with the project. While the outcome was good, knowing at the outset that MARAD would be the administering agency would have made the process faster and more efficient.

Overall, project participants are pleased with the progress of Inland Port Greer, the Upstate Express planning and funding application process, and the current state of work. The main complaints are "I wish we'd built it bigger" and "I wish we'd expanded it sooner." Since opening in 2013, Inland Port Greer reached capacity in only seven years, far faster than expected; the Upstate Express project will double its capacity and allow for continued growth into the future.

A.2.6 Lessons Learned and Notable Practices

As part of research for this Case Study, interviews were conducted with representatives of the South Carolina Department of Transportation, South Carolina Ports Authority, and Norfolk Southern Railroad. Lessons learned and other notable information from interviews are summarized below.

- **Success Factors for Inland Ports**—The successful development of Inland Port facilities requires a confluence of conditions: an identified and committed base of demand (in the form of one or more anchor users, and with as much diversity as possible) for start-up and growth; and strong partnership commitments from the facility operator, transportation service providers (rail and trucking), and state and regional/local governments. To the extent that partnerships are in place, but demand is not—for example, where Inland Ports are developed in greenfield areas and are intended to attract/support/serve future development—the Inland Port model can also work, but it will take more time to succeed. In such cases, expectations should be framed accordingly, and frameworks for sustaining partnerships and support through extended ramp-up periods should be established.

- **Measuring and Monitoring Inland Port Performance**—Once established, the performance of Inland Ports is measured differently by each stakeholder. Customers consider factors relevant to their supply chain requirements: volume, reliability, time, cost, security, and related factors. Transportation carriers consider factors relevant to their business operation and (ultimately) profitability: volumes, equipment utilization, operational safety, on-time performance, etc. Public sector partners consider a mix of factors that speak to public benefits, including direct factors such as volume, and indirect factors such as support for regional development, industrial growth, and job creation.

- **Pursuing Discretionary Grant Funds for Inland Ports**—For purposes of Inland Port expansion projects involving federal discretionary grants:

  - A different and more specific set of performance metrics is required. These metrics are proscribed by federal guidance and Notices of Funding Opportunity announcements and are generally similar across different federal funding programs with some variations. Few of the measures required for grant applications are tracked under normal operating conditions by stakeholders—the applications require comparisons of potential operating scenarios (with and without project) over long time periods (20 to 30 years), the estimation of primary effects (changes in volume, rail ton-mileage, truck VMT), and a variety of monetizable benefits derived from these primary effects (good repair, safety, economic protection, environmental competitiveness, quality of life, etc.). These performance measures must be custom developed for grant applications.

- Because Inland Ports are a hybrid of multiple modes—involving port-related traffic being moved inland by rail and then transferred between truck and rail—the 'modal ownership' may not be clear. For purposes of federal applications, it is important to establish the lead agency and applicable standards for review (particularly for environmental compliance) as soon as possible.

- Once an award is won, the performance monitoring process need not be complex or burdensome. For Inland Port Greer, the public benefits are all essentially derived as a function of growth in facility volume and reporting of facility volume was agreed as sufficient demonstration of achieved benefit.

A.3 Port of Baltimore Modernization

A.3.1 Introduction

This case study offers insights into the Port of Baltimore Modernization project, which delivered a 50-foot berth and super-size cranes through public-private partnership (P3) delivery. The public and private partners (Maryland Port Administration and Ports America Chesapeake, respectively) executed a 50-year leasing concession in 2009 to modernize the Seagirt Marine Terminal at the Port of Baltimore. The improvements, completed in 2012, established the Port of Baltimore as a key player on the U.S. east coast to serve larger post-Panamax containerized cargo ships in time for the planned opening of the expanded Panama Canal in 2016. P3 delivery of the project provided funding and other resources that the State of Maryland lacked to complete the project in time but came at the cost of long-term public control over Seagirt Marine Terminal. Nevertheless, the P3 project is considered a success due to the strength of the partnership between the public and private sectors and their shared, collaborative efforts to identify, measure, and meet freight performance goals.

Figure A.12 Seagirt Marine Terminals

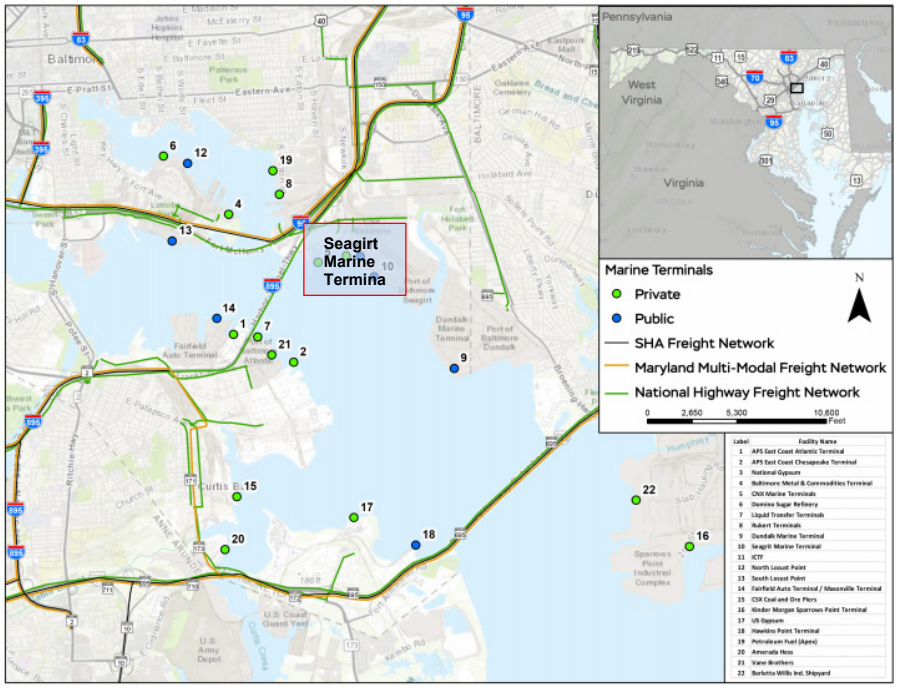
Source: Jeff Sauers.

A.3.2 Overview of the Region

The Helen Delich Bentley Port of Baltimore is located on the upper northwest shore of the Chesapeake Bay along the tidal basins of the three branches of the Patapsco River in Baltimore, Maryland. It is at the core of what makes the greater Baltimore region Maryland's leading goods movement center. Across the state, Maryland's goods movement transportation network encompasses 32,372 miles of roads, 758 miles of rail, 530 miles of inland waterways, and over 50,000 feet of air cargo runways, moving nearly 631 million tons of freight worth $835 billion annually.[42] In the Baltimore region alone, each year, more than 307 million tons of freight move over Baltimore's highway, rail, port, and airport facilities, serving domestic and international demand for a wide range of goods.[43] By 2040, more than 1 billion tons of freight worth close to $1.6 trillion, is expected to move within and through Maryland with a significant portion of this growth due to increasing freight moving through the Port of Baltimore. In fact, freight on the Baltimore region's transportation system will nearly double by 2030 compared to a 2015 baseline year, with significant increases across modes and the largest volume increase in truck tonnage.[44]

The Port of Baltimore is one of the nation's top ports for total cargo tonnage and overall dollar value of cargo, and is one of the most diverse ports in the U.S. with its seven State-owned public marine terminals handling such key commodities as autos, roll on/roll off (RoRo), containers, forest products, and project cargo. The Port of Baltimore's public marine terminals are managed by the Maryland Port Administration (MPA), a business unit of the Maryland Department of Transportation (MDOT), and located near many privately owned terminals, as well an extensive highway and freight network (see Figure A.13), including I-95, I-895, I-695, and Class I (CSX, Norfolk Southern) and short line freight rail infrastructure.

Figure A.13 Port of Baltimore Marine Terminals



Source: MDOT, 2017 Maryland Strategic Goods Movement Plan, page 19.

[42] Maryland Department of Transportation, Maryland Strategic Goods Movement Plan, 2017, page 9.

[43] Baltimore Metropolitan Council, Moving People and Goods Safely and Efficiently, page 8.

[44] Ibid.

Figure A.14 shows that, despite the network of freight rail infrastructure, most freight shipments in Maryland move by truck by weight and value of commodities. In fact, of the $385.5 billion that goods movement contributed to Maryland's economy in 2018, $298.2 billion, or over 77 percent, was generated from the trucking industry via Maryland's highways and roadways.[45] MPA officials interviewed for this case study confirmed this modal imbalance, providing that the vast majority of cargo transported to and from the Port of Baltimore is carried by truck (95 percent versus 5 percent by rail).[46]

Figure A.14 Percent of Shipments by Domestic Mode *2012*

Mode	Total	Within Maryland	From Maryland	To Maryland	Through Maryland
Truck Tonnage	83.9%	96.4%	92.0%	56.7%	84.6%
Truck Value	97.7%	97.9%	93.7%	94.4$	99.3%
Rail Tonnage	12.8%	0.5%	5.1%	42.2%	11.1%
Rail Value	0.9%	<0.5%	0.7%	3.2%	0.5%
Domestic Water Tonnage*	<0.5%	<0.5%	<0.5%	<0.5%	0.0%
*Domestic Water Value**	<0.5%	<0.5%	<0.5%	<0.5%	0.0%
Domestic Air Tonnage**	<0.5%	<0.5%	<0.5%	<0.5%	0.0%
*Domestic Air Value***	0.5%	<0.5%	2.0%	1.5%	0.0%

*Domestic water includes shallow draft, deep draft, Great Lakes, and intra-port shipments, but does not include international waterborne trade through the Port of Baltimore. The domestic (landside) moves of Port of Baltimore trade are accounted for in other modes.
**Domestic air includes air cargo between U.S. and domestic origin-destination pairs. The domestic portions of international air cargo movements are accounted for in the appropriate domestic modes.

Source: MDOT, 2017 Maryland Strategic Goods Movement Plan, page 9.

Due to investments at the 284-acre Seagirt Marine Terminal within the Port of Baltimore, including the Port of Baltimore Modernization project described in this case study, the Port is one of a few east coast ports that can handle larger post-Panamax vessels traveling through the expanded Panama Canal. Because of this infrastructure, the Port was able to welcome the Evergreen Triton in May 2019 (see Figure A.15), the largest container ship ever to arrive in Maryland carrying over 14,000 (twenty foot equivalent units [TEUs]) and spanning the length of four football fields.[47] A second 50-foot-deep berth at Seagirt Marine Terminal will begin construction shortly with plans to be operational in 2021, which is expected to further grow business at the Port.

[45] Maryland Department of Transportation, 2020 Attainment Report, page 19.

[46] MPA is undertaking the $466 million Howard Street Tunnel project with CSX and other partners to reconstruct the 125-year old CSX-owned freight tunnel under downtown Baltimore City and improve vertical clearances at 22 bridges between Baltimore and Philadelphia to create a double-stack rail corridor to and from the Port of Baltimore and the entire East Coast. The project is intended to modernize freight rail infrastructure benefitting the movement of containers by rail to and from the Port of Baltimore.

[47] Ibid., page 10.

Figure A.15 Evergreen Triton at the Port of Baltimore

Source: Ports America Chesapeake.

Although cargo levels are currently down due to the COVID-19 pandemic, the Port of Baltimore is faring better than the national average for cargo moved through ports. It remains a vital link for raw materials and manufactured goods moving into and out of Maryland, ranking at or near the top of all U.S. ports in a number of categories, including handling farm and construction machinery, automobiles, imported forest products, imported sugar, imported gypsum, and exported coal.[48] The Port imports foreign automobiles and equipment for consumption in the U.S. and exports American-made automobiles and equipment to consumers throughout the world.

In FY 2019,[49] the Port of Baltimore handled 11 million tons of general cargo, with over 2,000 ships calling on the Port.[50] The Port ranked number one among all U.S. ports in automobile imports for the ninth year in a row with 26 percent of the east coast auto market share in the third quarter of 2019.[51] It was also number one in

[48] Maryland Department of Transportation, Maryland Strategic Goods Movement Plan, 2017, page 18.

[49] Maryland's fiscal year starts on July 1 and ends on June 30.

[50] Maryland Department of Transportation, FY 2021 – 2026 Draft Consolidated Transportation Program, 2020, page 10.

[51] Ibid.; Maryland Department of Transportation, Excellerator Biannual Report, June 26, 2020, page 50.

RoRo imports, sugar imports, and gypsum, which helped the Port rank 9th among all U.S. ports for dollar value of foreign cargo with $59.7 billion in 2018 and 11th for total foreign cargo tonnage with 43.0 million tons.[52]

The Port of Baltimore supports the regional economy with over 15,000 direct Port-related jobs and a total of more than 139,000 jobs linked to port activities.[53] The Port provides close to $3.3 billion in personal wages and salaries, $2.6 billion in business revenues, and $395 million in State and local tax revenues, allowing over 82,000 freight industry businesses to employ about 1.5 million people and contribute $123.4 billion annually to the State's economy.[54]

A.3.3 Overview of the Freight Investment

The MDOT MPA's Port of Baltimore Modernization was a marine port expansion project delivered through an innovative P3 between MDOT MPA and Ports America Chesapeake, LLC (PAC), a subsidiary of Ports America, which is owned by Oaktree Capital Management, a global alternative investment management firm based out of Los Angeles. The project sought to modernize Seagirt Marine Terminal to serve larger post-Panamax containerized cargo ships in time for the planned opening of the expanded Panama Canal in 2016.

MPA officials interviewed for this case study provided that discussions about the project started around 2007. At that time, James J. White returned to lead the MPA, which was facing the looming threat of irrelevance due to the planned expansion of the Panama Canal. The "Third Set of Locks Project" was initiated in 2006, and though it was originally anticipated to be open to commercial traffic in 2014, the expanded canal did not begin commercial operations until June 2016. The project doubled the capacity of the Panama Canal by adding a new lane of traffic, which accommodated a larger number of ships, and increasing the width and depth of the lanes and locks, which facilitated the passage of larger ships. The "new Panamax", "post-Panamax", and "super-post-Panamax" ships were one and a half times the size of previous Panamax ships or larger, carrying over twice as much containerized cargo. They required container berths with 50-foot drafts and super-size cranes large enough to handle containers stacked on the ships. The Port of Baltimore contained three container berths, limited to 42-foot drafts, all at Seagirt Marine Terminal that lacked cranes and other infrastructure sufficient to meet the needs of larger ships.

Even before the Panama Canal expansion, ocean carriers had been moving towards a business model of lowering their slot costs (i.e., the cost charged to shippers for a container space on a vessel) through economies of scale, which involved a commitment to larger vessels. The Panama Canal project intensified this market shift. MPA understood that if the Port of Baltimore was not prepared to accommodate the increasing volume of larger vessels by 2014, it would lose relevance relative to its competitors, namely the Port of New York and New Jersey, which was the only other east coast port that could handle the new, larger ships.

In order to stay relevant in the market, the Port of Baltimore had to expand and invest in its container handling capacity at Seagirt Marine Terminal. Without these improvements, the Port would continue to only accommodate cargo destined for local consumption, and not discretionary cargo that could travel further west. Constructing a 50-foot-deep container berth and four state-of-the-art supersized container cranes at

[52] Maryland Department of Transportation, FY 2021 – 2026 Draft Consolidated Transportation Program, 2020, page 10; Maryland Department of Transportation, 2020 Attainment Report, page 3.

[53] Maryland Department of Transportation, 2020 Attainment Report, page 10.

[54] Ibid; Maryland Department of Transportation, FY 2021 – 2026 Draft Consolidated Transportation Program, 2020, page FRT-1.

Seagirt Marine Terminal was the only viable way to grow business at the Port and complete its portfolio of offerings to ocean carriers.

In the 2007-2008 timeframe, however, at the onset of the Great Recession, MDOT and all of its business units, including MPA, were experiencing a shortage of state funding and cuts to their capital programs. Therefore, MPA pursued a P3 as a means of inviting private capital to finance the Port of Baltimore Modernization project and deliver it in time for the Panama Canal expansion's anticipated opening in 2014. The project would be the first delivered through a P3 agreement in the State of Maryland, well before the 2013 passage of state legislation (House Bill 560) and promulgation of state regulations (Code of Maryland Regulations § 11.07.06 and 11.01.17) that describe the process for the development, solicitation, evaluation, award, and delivery of P3s projects in Maryland.

The P3 procurement for Seagirt Marine Terminal took place in 2008 – 2009, which ended in two short-listed parties: Ceres Terminals with Linda Capital; and PAC with Highstar Capital (acquired by Oaktree in 2014). Ceres Terminals withdrew their bid prior to final selection, so PAC was selected to negotiate the P3 lease and concession agreement with MPA. MPA and PAC entered into the P3 agreement in November 2009, which transferred responsibility for the operation of Seagirt Marine Terminal on January 12, 2010.[55]

Under the 50-year design-build-finance-operate-maintain (DBFOM) agreement, PAC controls gate, terminal, and vessel activity, while MDOT MPA retains security obligations. PAC receives a base payment for the 50-year term and all net revenues from Seagirt business. While MPA no longer has access to the operating revenues from the terminal for 50 years, it has benefited from PAC's agreement to make capital and state-of-good-repair investments over the life of the lease, including construction of a 50-foot deep-water berth (Berth 4) and four state-of-the-art super-post-Panamax cranes (see Figure A.16). The State of Maryland benefited from PAC making an upfront payment of $140 million to the State for rent and debt service on highway, bridge, and tunnel projects already completed near the Port of Baltimore by the Maryland Transportation Authority. The $140 million payment was conditioned on Highstar Capital's ability to acquire $250 million in 25-year tax-exempt municipal bonds backed by Seagirt revenues (MPA would have received $120 million if such bonds were not available to Highstar). In this way, MPA transferred to PAC the risks of construction and maintenance for the expansion project, as well as the risk that the expanded Panama Canal would not deliver the anticipated increase in container volumes.

Figure A.16 Seagirt Marine Terminal Receiving a Super-Post-Panamax Ship

Source: Ports America Chesapeake.

[55] Maryland Transportation Authority, Public-Private Partnerships in Maryland; Maryland Transportation Authority, Annual Report to the Maryland General Assembly regarding Public-Private Partnerships, January 2019, page 3.

The main value to the MPA of the P3 was the $105.5 million it has not paid for building, equipping, and operationalizing the new 50-foot Berth 4.[56] Additional value to the MPA from PAC over the 50-year lifespan of the project is estimated at $1.3 billion to $1.8 billion due to the non-refundable $140 million capital reinvestment payment, nominal annual rent of $3.2 million that increases with inflation, and revenue sharing ($15 per container in excess of 500 picks per year).[57] PAC is also responsible for covering the costs of maintenance, expenses, and major capital expenditures for Berth 4, which are valued at $462.7 million over 50 years, and will return 65 acres of leased land at the MPA's Dundalk Marine Terminal valued at $56 million.[58] The total investment in the project was projected to generate nearly $16 million per year in new taxes for Maryland and create 5,700 new jobs, over half of which (3,000) were one-time construction jobs and another 2,700 of which are permanent direct, indirect, and induced jobs.[59]

Within two years of taking over operations at Seagirt Marine Terminal, PAC delivered the cranes and deep berth construction to accommodate the larger vessels, two years ahead of schedule.[60] With the deep-water Berth 4 in place in 2012, far ahead of both PAC's contractual commitment (PAC was obligated to open Berth 4 six months prior to the Panama Canal opening) and the June 2016 opening of the expanded Panama Canal, the Port of Baltimore was able to welcome larger vessels earlier and see growth in container volumes which continues to this day. In fact, the interviewees for this case study noted that when Berth 4 opened, Seagirt Marine Terminal handled between 500,000 to 550,000 TEUs a year, but is now handling over 1 million TEUs a year, exceeding MPA and PAC's projections and expectations. Figure A.17 illustrates Seagirt Marine Terminal's expanded container handling capabilities as a result of the project.

[56] Bipartisan Policy Center, Infrastructure Case Study: Seagirt Marine Terminal, page 2.

[57] Maryland Port Administration, Seagirt Marine Terminal Maryland Port Administration-Ports America Chesapeake Public-Private Partnership, page 1.

[58] Bipartisan Policy Center, Infrastructure Case Study: Seagirt Marine Terminal, page 2.

[59] Ibid.

[60] Ibid.; Maryland Port Administration, Seagirt Marine Terminal Maryland Port Administration-Ports America Chesapeake Public-Private Partnership, page 1.

Figure A.17 Seagirt Marine Terminal Yard View
2020

Source: Ports America Chesapeake.

The MPA-PAC partnership is considered a success by both parties and, accordingly, has expanded over the past decade. Construction is currently underway on the Seagirt Marine Terminal Berth 3 modernization project, which will provide a second 50-foot berth (Berth 3) that will allow the Port of Baltimore to accommodate two super-post-Panamax ships at the same time. That berth and four additional cranes, as well dredging to widen and deepen the turning basin, are expected to be delivered by summer 2021. This $116.4 million investment includes $103 million from PAC, $7.8 million from MDOT, and $6.6 million from a federal FY 2019 BUILD grant.[61] Though the Berth 3 project is not covered under the P3 agreement between MPA and PAC, it was noted by both parties as needed for the continued growth of the Port of Baltimore's container business.

The success of the MPA-PAC partnership and growth of the Port's container business is also evident in MPA's recent purchase of the adjacent Intermodal Container Transfer Facility (ICTF) and 70 acres of property at the Point Breeze Business Center for the long-term expansion of Seagirt Marine Terminal, which

[61] Maryland Department of Transportation, FY 2021 – 2026 Draft Consolidated Transportation Program, 2020, pages 11 and FRT-2.

were both added to the leasing concession to PAC.[62] The revised agreement requires PAC to operate the ICTF and, within 12 years from May 2017, take down the buildings at Point Breeze to expand the marine terminal in order to accommodate another 200,000 TEUs, increasing the terminal's container-handling capacity to nearly one million TEUs. These facilities will provide 70 net acres of land for PAC to repurpose for direct maritime use, which is needed to accommodate the anticipated growth in container business at the Port of Baltimore. Without these additional properties and any further improvements beyond the Berth 4 project, Seagirt Marine Terminal will reach full capacity by 2030 to 2031. In the meantime, MPA is currently allowing PAC to utilize 12 acres of nearby property across Broening Highway for heavy damage repairs. The property had been used as a parking lot and will serve the MPA's RoRo expansion needs, but, because of the recent slowdown in RoRo business due to the COVID-19 pandemic, is available to serve PAC's container handling operations.

A.3.4 Measuring and Monitoring the Impact of the Investment

In 2000, the Maryland General Assembly enacted legislation, which required MDOT to develop an annual Attainment Report (AR) on transportation system performance that would:

- Report on progress toward achieving the goals and objectives in the long-range Maryland Transportation Plan (MTP) and the six-year MDOT Consolidated Transportation Program (CTP).
- Establish performance indicators that quantify achievement of these objectives.
- Set performance targets.[63]

The performance measures are intended to evolve and be updated periodically in a collaborative effort between the Secretary's Office, transportation business units (e.g., MPA), and an AR Advisory Committee. The AR performance measures were last updated in spring 2018 based on the goals and objectives provided in the updated 2040 MTP.

Since 1996, MDOT has also participated in the State's Managing for Results (MFR) program as part of the state budgeting process. MFR is described as "a strategic planning, performance measurement, and budgeting process that emphasizes use of resources to achieve measurable results, accountability, efficiency, and continuous improvement in state government programs."[64] Its performance measures align with the 2040 MTP's goals and objectives and 2020 AR.

Three of the 2040 MTP and 2020 AR's goals are relevant to MPA and Port of Baltimore operations. Each goal is associated with objectives and performance measures, as shown in Table A.3.

[62] Maryland Department of Transportation, Maryland Transportation Plan, 2019, page 19.

[63] Maryland Department of Transportation, FY 2021 – 2026 Draft Consolidated Transportation Program, 2020, page 21.

[64] Ibid.

Table A.3 MDOT Performance Management Goals, Objectives, and Performance Measures Related to the Port of Baltimore

MDOT Goals	Objectives	Performance Measures
Facilitate Economic Opportunity and Reduce Congestion in Maryland through Strategic System Expansion	Improve the movement of goods within and through Maryland by investing in intermodal connections and improvements to reduce freight bottlenecks.	• Freight Originating and Terminating in Maryland • Port of Baltimore Foreign Cargo and MDOT MPA General Cargo Tonnage
Maintain a High Standard and Modernize Maryland's Multimodal Transportation System	Strategically modernize infrastructure through new and innovative technology, enhanced partnerships, design standards, and practices to facilitate the movement of people and goods.	• Average Truck Turn Time at Seagirt Marine Terminal[1]
Promote Fiscal Responsibility	Ensure a consistent revenue stream and ample financing opportunities.	• Qualitative Discussion of P3 Initiatives and Other Innovative Solutions Underway

Source: MDOT.

[1] "Truck Turn Time" is the total time spent by a truck in the terminal area (i.e., the time it takes for a truck to enter the gate, pick up or drop off a container, and exit the gate). It includes the time from the arrival, loading, and unloading of containers, inspecting a truck, completing documentation, and going out from the terminal.

The 2040 MPT identifies a strategy under MDOT's goal to "Facilitate Economic Opportunity and Reduce Congestion in Maryland through Strategic System Expansion" and objective to "improve the movement of goods within and through Maryland by investing in intermodal connections and improvements to reduce freight bottlenecks." The strategy is to "acquire property adjacent to existing Port facilities to preserve opportunities for expanding terminal space,"[65] which has been achieved through MPA's acquisitions of the ICTF and Port Breeze Business Center, as described above.

Regarding the same goal, objective, and associated performance measures (freight originating and terminating in Maryland; Port of Baltimore foreign cargo and MDOT MPA general cargo tonnage), the 2020 AR noted that:

- PAC continues to invest in Seagirt with new capital investments in equipment, and deepening Berth 3 to 50 feet by 2021.
- MPA total general cargo tonnage moving through the Port of Baltimore has increased since 2010 and Port of Baltimore foreign cargo tonnage has been increasing since 2016 (see Figure A.18).
- The Port of Baltimore's public and private marine terminals handled a record 43 million tons of international cargo, breaking the previous mark of 41 million tons set in 1974.
- The Port handled more containers and cars/light trucks in 2018 than any previous year in its history.
- There were 2,058 ship calls at the Port in 2019 (86 more than 2018).

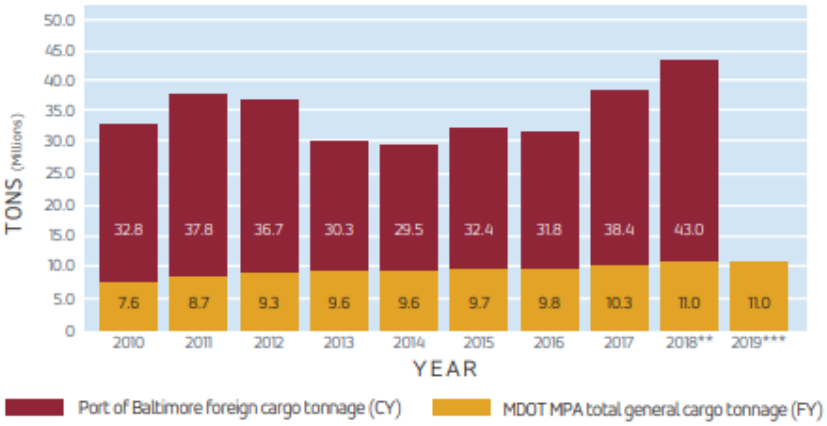
[65] Maryland Department of Transportation, Maryland Transportation Plan, 2019, page 29.

- For the first half of CY 2019, Baltimore's international cargo tonnage increased by 12.3 percent compared to the same period of the prior year; if this trend holds, it will be another new Port record.[66]

The AR identifies the following strategies to ensure future performance under the same goal and objective:

- Remain an active leader in the Baltimore Port Alliance and assist private port partners to increase waterborne commerce on behalf of the Port.
- Work with the U.S. Army Corps of Engineers to ensure the Port's channels are adequately dredged.

Figure A.18 Amount of Foreign and General Cargo Moving through the Port of Baltimore



* MDOT MPA cargo data is provided by fiscal year, but The Port information is reported using the latest full calendar year because The Port statistics combine data for public and private marine terminals that use different fiscal year reporting timeframes. Therefore, 2019 data cannot be reported until early 2020.

** 2018 data for The Port is revised from previous report.

*** MDOT MPA general cargo includes both foreign and domestic waterborne cargo, whereas, Port-wide data includes only foreign waterborne cargo. Port-wide data for calendar year 2019 is an estimate.

Source: MDOT 2020 Attainment Report.

- Work with the City of Baltimore and Maryland counties to efficiently manage highway permits for over-sized loads coming to/from the Port.
- Work with Baltimore City to encourage land use practices and zoning efforts that preserve industrial land and freight routes leading to/from the private and State-owned terminals in the Port.
- Construct terminal facilities to attract new cargo and maintain existing customers.
- Negotiate with manufacturers and international logistics providers to obtain long term contracts.[67]

MDOT also internally assesses its performance (and of its transportation business units, including MPA) through the quarterly MDOT Excellerator program. Ten teams representing all transportation business units use data to target structural and process improvements and develop and implement new or improved initiatives across the organization. The latest Excellerator Biannual Report (from June 2020) notes that the Port of Baltimore's market share of container business in the mid-Atlantic region has remained steady at slightly above 8.2 percent through 2019 and into 2020 (see Figure A.19).[68] According to the FY 2021 MFR for MDOT, container volumes were estimated to increase slightly by 3 percent from 746,000 TEUs in 2019 to 768,000 TEUs in 2020 (see Figure A.20). Though this growth may not seem significant, it is substantial

[66] Maryland Department of Transportation, 2020 Attainment Report, page 20.

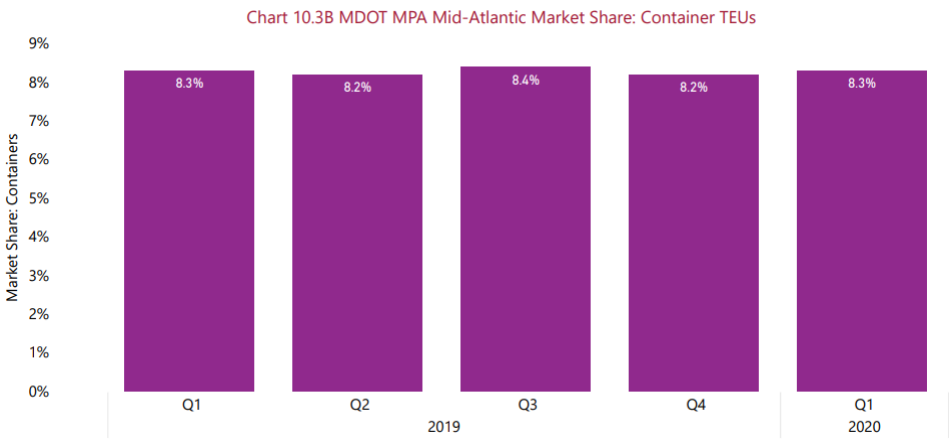
[67] Ibid.

[68] Maryland Department of Transportation, Excellerator Biannual Report, June 2020, page 49.

when the 2020 estimated container volume is compared to 2015 volumes, showing 26 percent growth from FY 2015 to 2020 (609,000 TEUs in FY 2015 to 768,000 TEUs in FY 2020).

The Port of Baltimore Modernization project to expand Berth 4 through P3 delivery is considered a success based on these measures identified in the MTP, AR, MFR, and Excellerator program, as well as other measures that are more specific to Seagirt Marine Terminal and gauge the impact of the investment. The P3 leasing concession agreement requires PAC to report its performance to MPA, but it does not require PAC to meet any performance thresholds, which the interviewees for this case study noted was a key to the success of the partnership. Instead, PAC provides monthly reports to MPA, and MPA and PAC meet on a regular basis (weekly or biweekly conference calls) to discuss a range of topics, including accounts and market developments. Quarterly meetings occur between the executives of MPA and PAC to go over performance, goals, and tracking beneficial cargo owners (BCOs), or parties that ultimately own the products being shipped). If any challenges are identified, MPA and PAC use the meetings to discuss how they will be addressed by either or both parties.

Figure A.19 MDOT MPA Mid-Atlantic Market Share
Container TEUs



Source: MDOT Excellerator Biannual Report.

Figure A.20 Port of Baltimore Performance as Reported in the State's FY 2021 MFR

Obj. 5.2 Improve the movement of goods within and through Maryland by investing in intermodal connections and improvements to reduce freight bottlenecks.

Performance Measures	2015 Act.	2016 Act.	2017 Act.	2018 Act.	2019 Act.	2020 Est.	2021 Est.
MDOT MPA Roll- On/Roll-Off tonnage (thousands)	828	740	684	772	886	913	940
MDOT MPA Auto tonnage (thousands)	1,130	1,099	1,054	1,110	1,196	1,135	1,135
MDOT MPA imported forest products tonnage (thousands)	672	709	736	676	586	590	595
Containers (Loaded TEUs) (thousands)	609	648	683	736	746	768	791

Source: State of Maryland FY 2021 Managing for Results—Department of Transportation, 2020.

An early iteration of the P3 solicitation included performance standards that the private concessionaire would be required to meet as a condition of the leasing agreement. These standards required the private partner to ensure a certain level of gate production (30-minute truck turn times for single moves, 60-minute truck turn times for double moves), vessel production (30 crane moves per hour), and total lifts (TEUs). However, MPA learned that the more performance restrictions they placed into the P3 solicitation and agreement, the less attractive the deal would be to potential private bidders, which would limit competition and the value MPA would receive from the deal. If performance standards were included in the P3 agreement, the private concessionaire would only perform to that standard, and no more. However, if the concessionaire had unlimited reach in its performance, they could determine how best to grow their investment.

Therefore, by not placing performance metrics on the private concessionaire, MPA was able to, in the words of MPA interviewees, "get out of their way and let them do their work" and "give them free reign to maximize the efficiency of [Seagirt Marine] terminal." So, today, PAC chooses what methods and performance metrics they must meet to best grow their investment, coordinating with MPA on how the Port of Baltimore is marketed to grow its container business.

The monthly reports provided by PAC provide data related to gate production (truck turn times), vessel production (crane moves per hour), and total lifts (TEUs), which were not included in the P3 solicitation. The interviews for this case study revealed that, with regard to gate production, truck turn times have exceeded 60 minutes for double moves, which prompted actions by MPA and PAC, including purchasing new equipment (e.g., rubber tired gantry cranes, as shown in Figure A.21, that move containers between truck and rail, and radiation detection portals that hasten U.S. Customs and Border Patrol clearance). These investments have helped to keep truck turn times closer to 60 minutes, despite the need to handle double the container volume within the same footprint as in 2009. With regard to vessel production, PAC is able to make more than 30 crane moves per hour consistently due to investments in better, faster cranes and technology.

Figure A.21 Rubber Tired Gantry at Seagirt Marine Terminal

Source: Ports America Chesapeake.

The increased gate and vessel productivity at Seagirt Marine Terminal have allowed container business to double in the decade since the start of the P3 agreement. In 2009, the terminal was handling approximately 517,000 TEUs. By 2018, it was handling about 1,020,000 TEUs (loaded and empty) due to the P3 and PAC's investments in Seagirt Marine Terminal. The interviewees for this case study noted that, without the P3, Seagirt Marine Terminal would be handling less than 517,000 TEUs today since it would not be able to handle larger post-Panamax ships, which would call to competing ports across the mid-Atlantic region.

A.3.5 Lessons Learned and Notable Practices

The research team for this case study conducted four interviews with current and former MPA officials and PAC staff. The interviews revealed that, while P3 delivery of the Port of Baltimore Modernization Project had its opportunities and challenges, there were lessons learned and notable practices that could be applied to performance measurement and monitoring, as well as P3 project delivery, by ITTS member states.

- **Set Clear Goals**—The interviewees noted the importance of setting specific agency goals for the investment. MPA identified, through internal discussions within the organization, why it was entering into a P3. It needed to compete for container business and remain relevant following the opening of the Panama Canal expansion project. This required immediate investments in a new berth and new cranes, as well as longer-term system preservation of the new infrastructure, which MPA and MDOT did not have the means to fund. Therefore, P3 delivery was chosen because it was the only viable alternative to meet this goal.

The decision to pursue a P3 was not easily made, however, because P3s were untested in Maryland and, by entering into a P3, MPA had to change the way that it did business at Seagirt Marine Terminal. Until January 12, 2010, MPA had direct control over the operations of Seagirt Marine Terminal. MPA charged ocean carriers that called to Seagirt Marine Terminal a fee that included dockage, wharfage, crane, land, and operator and handling costs. Under the P3, however, MPA handed day-to-day control of Seagirt Marine Terminal to PAC. Because of MPA's clear goals in entering the P3, they were able to determine that the costs of the P3 were outweighed by its benefits.

- **Select a Partner with the Same Goals**—The interviewees stressed the significance of PAC's alignment with MPA with regard to goals and transparency as a reason for the P3's success. They noted that having a layered strategy where multiple entities are headed in same direction is valuable, especially in Baltimore. Prior to the P3, PAC was the terminal operator for Seagirt, receiving and delivering containers, but otherwise not dealing with the carriers. MPA executed revenue agreements with carriers to perform all services at the terminal and passed through fees paid by the carriers to PAC. Thus, before and after execution of the P3 agreement, both MPA and PAC shared the goal of seeing growth in the Port of Baltimore's container business. It helped that PAC understood the dynamics of the Port of Baltimore before entering into the deal and was known to MPA and the Baltimore port community and stakeholders, ensuring a smooth transition.

  The parties' common goal defined the way that the P3 deal was structured. MPA gave up strict control of Seagirt Marine Terminal due to the P3, which was intentional on its part. While MPA can support PAC's operations, they do not have the authority to direct them. MPA's giving up of their control over the terminal increased the value of the P3 to PAC and thus, the return that the State received from the deal. While performance goals are not specified in the P3 agreement, both MPA and PAC have an interest in increasing container volumes at Seagirt Marine Terminal, as evidenced in the agreement's revenue sharing provision. This provision provides that if PAC exceeds 500 picks in a year, MPA receives $15 per container. The growth in container ship calls and volumes over the years (PAC currently handles about 700 picks a year) has resulted in MPA consistently receiving approximately $1 million annually from PAC under the revenue-sharing structure. In this way, if PAC hits its growth targets, MPA shares in the benefits.

  Accordingly, while it is not written into the concession agreement, MPA and PAC partner in marketing efforts to meet their shared goal of increasing the Port's container volumes. MPA and PAC regularly go on BCO visits together to demonstrate that they are a "one-stop shop" with PAC talking about business and MPA talking about the Port of Baltimore and region. Both "stand shoulder to shoulder in the overall image projection of Baltimore," which is unique in the maritime industry. In other regions, the public and private entities make their visits and pitches separately.

- **Foster a Partnership with Clearly Defined Roles**—MPA and PAC consider each other good partners with each going beyond the P3 agreement to market the Port of Baltimore together, transparently report performance against specific metrics, and hold regular meetings to discuss opportunities and challenges related to the performance of Seagirt Marine Terminal. MPA benefits from a local team in PAC, as well as the resources of Ports America, the largest port operator and stevedore with a presence in more than 42 ports and 80 locations in the nation. Ports America monitors and reports trends and patterns they have observed at their various operations and ports across the country, giving MPA conversations to plug into that help them understand and articulate the value proposition of the Port of Baltimore to customers.

  MPA also benefits from the best practices learned by Ports America at its other facilities. Among these best practices is having clearly defined roles for the private and public partners in a P3 and their day-to-

day cadence of communication. By virtue of the P3 arrangement, PAC is "fighting fires every day," while MPA is a level removed and resolves issues as they arise. MPA sees its role akin to a "shock absorber" or "customer service appendage" to PAC that performs "damage control," which gives PAC the room to focus on moving containers through Seagirt Marine Terminal. Through daily email exchanges, weekly calls, and meetings with shippers, truckers, and others in the supply chain, PAC can bring to MPA's attention the performance of Seagirt Marine Terminal and issues MPA can address as PAC's commercial point of contact. MPA can also address issues related to the community, elected officials, local, federal, and other state agencies, and labor. MPA regularly acts as a liaison for PAC, dealing on PAC's behalf with federal agencies, truckers, and warehouse owners, as well as leading lobbying and education efforts for elected officials, the City of Baltimore, Baltimore County, and the Maryland State Highway Administration on the value of Seagirt Marine Terminal and what it takes to make it successful.

MPA is also considered a friend of labor and truckers. Labor calls MPA first so that they can be involved to improve relations. If PAC or labor does something to impacts truckers, the Maryland Motor Truck Association will elevate the issue to the Governor's office, but MPA can intervene on PAC and labor's behalf to help mitigate the problem. This was demonstrated recently when PAC announced temporary intermittent closures of Seagirt Marine Terminal due to the COVID-19 pandemic and Hurricane Isaias, and MPA worked to smooth relations between PAC, labor, truckers, and elected officials.

- **Set Up Dedicated Conduits of Collaboration—**The interviewees for this case study recommended that other port agencies set up P3 projects for success by making sure they have a dedicated team of resources that can serve as the concessionaire's liaisons to the government's "nerve central." In this way, the agencies can allow their concessionaires to focus on what they need to do to be successful in financing and delivering capital improvements, operating facilities, and adequately addressing changes in demand and other trends. In MPA's case, the agency's Operations, Intermodal/Trade Development, and Finance teams deal with counterparts at PAC that act as conduits that were intentionally set up to formalize collaboration between the public and private partners. This is especially important given the long-term nature of the P3 agreement, representing a "new normal" for conducting container operations at the Port of Baltimore. Operationalizing formal channels of communication is key to the relationship-building necessary for tracking performance and mitigating any issues identified through performance management efforts.

A.4 California Trade Corridor Enhancement Program

A.4.1 Introduction

This case study considers the impacts of the California Trade Corridor Enhancement Program (TCEP). Unlike the other Case Studies, TCEP is not a single project; rather, it is a structured funding program for multimodal freight-supporting improvements, driven by performance measurement of competing project applications, authorized by state Senate Bill 1 (SB1) in 2017. This Case Study provides an overview of the TCEP program along with lessons learned at the program and project application levels.

A.4.2 Overview of the Region

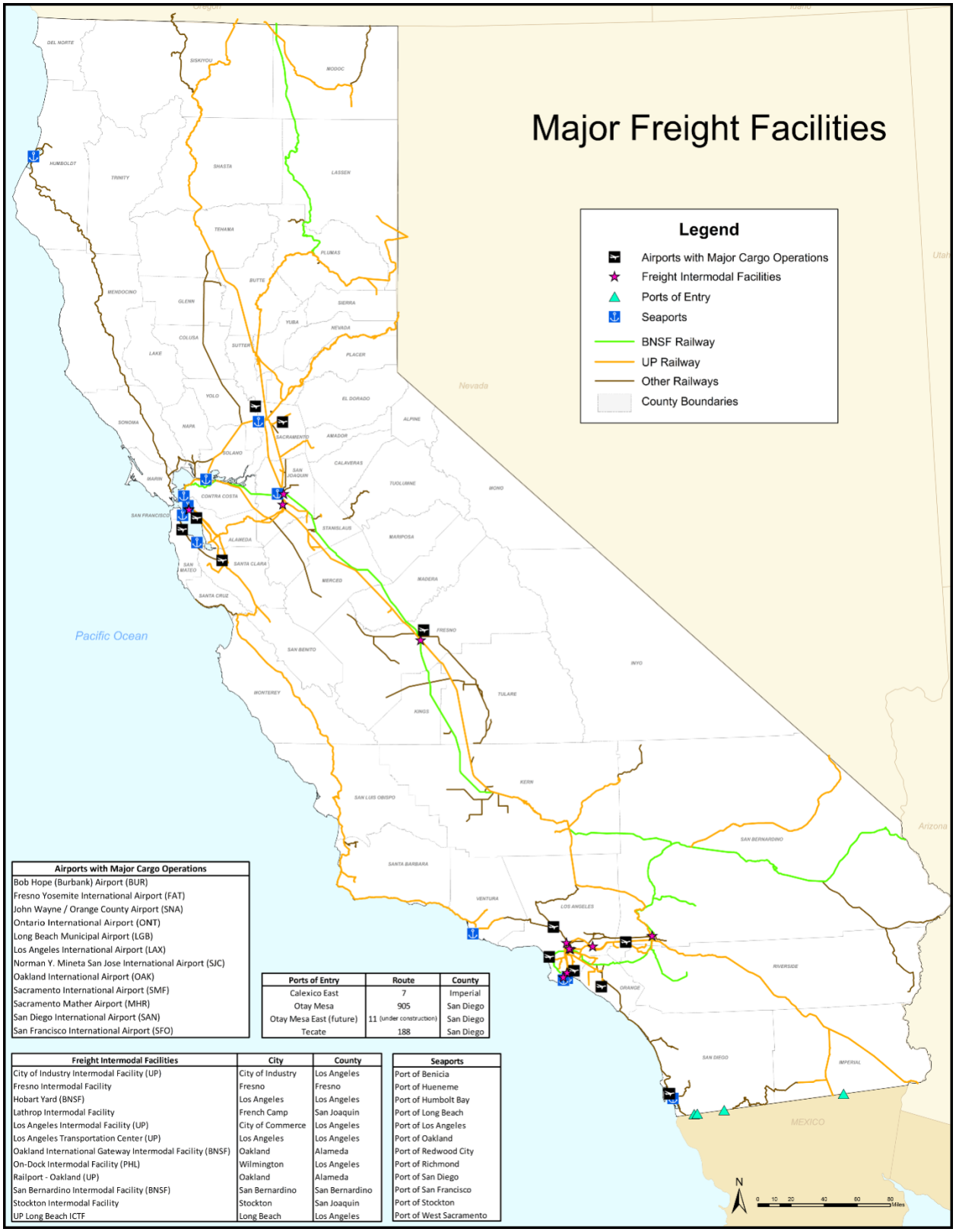
In this case study, the region is the entire state of California, and specific investigations were made into two TCEP applications for projects located in the City of Los Angeles. The California Freight Mobility Plan

(CFMP), published in March 2020, provides an overview of freight conditions in the state.[69] As documented in the CFMP, California's economy was comparable to the fifth largest economy in the world, with the State's GDP at $3.12 trillion in the year 2018. The State's freight sector was defined in the CFMP to encompasses businesses in the transportation, warehousing, utilities, trade, manufacturing, construction, agriculture, and mining industries. Generally, these freight-industries heavily rely on the transportation of their raw materials, intermediate goods, and/or finished products.

The CFMP also took inventory of California's freight assets that support the state's freight-intensive industries. These include 12 seaports, 12 airports with major cargo operations, two Class I railroads and 27 Class III railroads, three existing and one future commercial land border ports of entry (POE) with Mexico, approximately 19,390 miles of hazardous liquid and natural gas pipelines, and a large warehousing and distribution sector. Figure A.22 shows the state's major freight facilities.

[69] See https://dot.ca.gov/programs/transportation-planning/freight-planning/ca-freight-advisory-committee/cfmp-2020.

Figure A.22 California's Major Freight Facilities



Source: California Freight Mobility Plan, 2020.

A.4.3 Overview of the Freight Investment

As noted in the CFMP, TCEP is one of California's leading freight accomplishments, and is a key tool and mechanism to implement the state's freight planning vision and goals. TCEP is essentially a funding program which pools state funds with federal funds from the Fast Act's National Highway Freight Program (NHFP) program. The pooled funds are then distributed through a competitive application process. The first round of TCEP program applications was in 2018, and the second round was in 2020.

Purpose and Background of the TCEP

The TCEP is one of several dedicated programs established under California Senate Bill 1, the Road Repair and Accountability Act of 2017. The TCEP was originally established with an annual funding limit of $300 million annually from state funds, but subsequent legislation (Senate Bill 103) directed that anticipated NHFP funds be combined with the state contributions and allocated under the same process. This is important as the TCEP was originally envisioned to provide a one-time infusion of state funds for freight-related infrastructure improvements along corridors with a high volume of freight movement. By tying the program to NHFP funds, it allowed for an ongoing investment in the state's freight system assuming that the NHFP is re-authorized as part of future federal transportation legislation.[70]

The TCEP is administered by the California Transportation Commission (CTC), which was established in 1978 and is responsible for programming and allocating funds for multimodal transportation improvements throughout the state.[71] The purpose of the TCEP is to provide funding for infrastructure improvements on federally designated Trade Corridors of National and Regional Significance, on California's portion of the National Highway Freight Network (as identified in California Freight Mobility Plan), and along other corridors that have a high volume of freight movement. The TCEP provides approximately $300 million per year in state funding and approximately $515 million in NHFP funds.

Importantly, the TCEP is a competitive grant program similar to those administered by USDOT. Eligible applicants must apply for TCEP funds through the nomination of projects. All projects nominated must be identified in a currently adopted regional transportation plan. Projects are then evaluated based on the following criteria:

- Freight System Factors—Throughput, Velocity, and Reliability.
- Transportation System Factors—Safety, Congestion Reduction/Mitigation, Key Transportation Bottleneck Relief, Multi-Modal Strategy, Interregional Benefits, and Advanced Technology.
- Community Impact Factors—Air Quality Impact, Community Impact Mitigation, and Economic/Jobs Growth.
- The overall need, benefits, and cost of the project.
- Project Readiness—ability to complete the project in a timely manner.

[70] See TCEP Program Guidance at https://catc.ca.gov/-/media/ctc-media/documents/programs/senate-bill-1/tcep/2020-trade-corridor-enhancement-program-guidelines-a11y.pdf.

[71] See https://catc.ca.gov/programs/sb1/trade-corridor-enhancement-program#:~:text=The%20purpose%20of%20the%20Trade,Mobility%20Plan%2C%20and%20along%20other.

- Demonstration of the required 30 percent matching funds.
- The leveraging and coordination of funds from multiple sources.
- Jointly nominated and/or jointly funded.

Program Features and Requirements

TCEP guidelines approved by the CTC on March 25, 2020 provided for three years of programming (FY 2020-21, 2021-22, and 2022-23) for a total estimated funding level of $1.001 billion, including NHFP funds. The TCEP targets funding allocations at 40 percent for projects nominated by the California Department of Transportation (Caltrans) and 60 percent for projects nominated by other public agencies. The project sponsor must be a public agency, although the infrastructure to be improved may be privately owned (such as railroads). TCEP awards require a minimum 30 percent match of private, local, federal, or state funds for projects not nominated by Caltrans; no minimum match is required for Caltrans-nominated projects. Program guidelines prioritize the use of TCEP funds to provide non-federal matching amounts to projects that have received federal discretionary grants through INFRA, BUILD, and similar programs.

Projects receiving NHFP funds must be on the Primary Highway Freight System or a designated Critical Urban Freight Corridor or Critical Rural Freight Corridor. Projects not receiving NHFP funds may be located on any corridor. Under TCEP guidelines, not more than 10 percent of NHFP funds may be used for projects within the boundaries of public or private freight rail or water facilities (including ports), or projects that provide the surface transportation infrastructure necessary to facilitate direct intermodal interchange, transfer, and access into or out of a multimodal terminal.

Under TCEP guidelines,[72] an eligible project is one that: *"significantly contributes to the freight system's economic activity or vitality; relieves congestion on the freight system; improves the safety, security, or resilience of the freight system; improves or preserves the freight system infrastructure; implements technology or innovation to improve the freight system or reduce or avoid its negative impacts; or reduces or avoids adverse community and/or environmental impacts of the freight system; or improves system connectivity. To be eligible for funding under this program, a project must meet the aforementioned freight project definition, support the objectives of the program, and meet the screening and evaluation criteria."* TCEP funds *"may be used for any project component (project approval and environmental document; plans, specifications, and estimates; right-of-way; and construction), however, right of way and construction capital costs will only be programmed if the project has completed a project level environmental process in accordance with the California Environmental Quality Act (CEQA), within six months of program adoption."* Projects must commence right-of-way acquisition or actual construction within 10 years of receiving TCEP funds, or the funds must be repaid. Cost incurred prior to TCEP allocation or (after approval but before allocation) agreement with Caltrans are not eligible for reimbursement. Project types eligible for TCEP funding include but are not limited to:

- Highway improvements to accommodate the movement of freight more efficiently, particularly for ingress and egress to and from the state's land ports of entry, rail terminals, and seaports, to relieve traffic congestion, along major trade or goods movement corridors.

[72] See TCEP Program Guidance, op cit.

- Freight rail system improvements to enhance the ability to move goods from seaports, land ports of entry, and airports to warehousing and distribution centers, including grade separations.
- Port capacity and efficiency enhancements, excluding the purchase of fully automated cargo handling equipment.
- Truck corridor improvements, including dedicated truck facilities or truck toll facilities, including the mitigation of the emissions from trucks or these facilities.
- Border access improvements to enhance goods movement.
- Surface transportation, local road, and connector road improvements to effectively facilitate the movement of goods, particularly for ingress and egress to and from the state's land port of entry, airports, and seaports, to relieve traffic congestion along major trade or goods movement corridors.
- Port and/or rail projects to facilitate intermodal interchange, transfer, and access into or out of the facility (limited to 10 percent of federal yearly apportionments).
- Advanced Technology projects that employ advanced and innovative technology to improve the flow of freight, such as Intelligent Transportation Systems (ITS), public infrastructure (excluding vehicles) that enables zero-emission or near-zero emission goods movement, real time information systems, weigh-in-motion devices, electronic screening/credentialing systems, traffic signal optimization, work zone management and information systems, and ramp metering.
- Environmental/community mitigation, or efforts to reduce environmental impacts of freight movement, such as projects that reduce noise, overnight truck idling, or truck queues and advanced traveler Information Systems such as Freight Advanced Traveler Information Systems (FRATIS).

A.4.4 Measuring and Monitoring the Impact of the Investment

TCEP funding applications are evaluated and scored based on a range of qualitative and quantitative factors, including a defined set of Performance Metrics that are used to measure the impact of the proposed investment. Many of the metrics are similar to those required under federal benefit-cost analysis guidance for discretionary grant applications; while others go beyond federal guidance (e.g., throughput capacity, supply chain transportation time, and job creation) to specifically address California's program objectives. The full list of performance metric as specified in TCEP guidelines[73] include:

- **Freight System Factors.**
  - Throughput—Project provides for increased volume of freight traffic through capacity expansion or operational efficiency to improve the interregional transportation network and move goods to, through, and from ports.

[73] See TCEP Program Guidance, op cit.

  - Velocity—Project increases the speed of freight traffic moving through the distribution system, including critical freight corridors and ports.
  - Reliability—Project reduces the variability and unpredictability of travel time.

- **Transportation System Factors.**
  - Safety—Project increases the safety of the public, industry workers, and traffic.
  - Congestion Reduction/Mitigation—Project reduces daily hours of delay on the system and improves access to freight facilities.
  - Key Transportation Bottleneck Relief—Project relieves key freight system bottlenecks where forecasts of freight traffic growth rates indicate infrastructure or system needs are inadequate to meet demand, this includes bottlenecks on critical freight corridors and near our state's borders.
  - Multi-Modal Strategy—Project employs or supports multi-modal strategies to increase port and transportation system throughput while reducing truck vehicle miles/hour traveled (VMT/VHT) or truck idling times.
  - Interregional Benefits—Project links regions/corridors to serve statewide or national trade corridor needs and to improve the interregional transportation network.
  - Advanced Technology—Project employs advanced and innovative technology and integrates transformative ideas to increase the amplitude of benefits for the state's people, economy, and environment. Examples include Intelligent Transportation Systems (ITS) or supporting infrastructure for deployment of current and future technologies, such as zero and near-zero emission equipment or ITS elements.

- **Community Impact Factors.**
  - Air Quality Impact—Project reduces local and regional emissions of diesel particulate (PM_{10} and $PM_{2.5}$), carbon monoxide, nitrogen oxides, greenhouse gases, and other pollutants.
  - Community Impact Mitigation—Project reduces negative impacts on communities (noise, localized congestions, safety, public health, etc.).
  - Economic/Jobs Growth—Project stimulates local economic activity, enhances trade value, and preserves/creates jobs. Project enhances California's competitiveness while protecting its community and environmental assets.

TCEP applicants must document the estimated project benefits in a Performance Metrics form that is included with their applications (see Figure A.23 for an excerpt of the form). Detailed guidance for completing the Performance Metrics form is provided by CTC[74] and requires use of the Caltrans Cal B/C benefit-cost

[74] See https://catc.ca.gov/-/media/ctc-media/documents/programs/Senate-Bill-1/TCEP/3-2-20-FINAL-TCEP-Performance-Metrics-Guidance-a11y.pdf.

analysis tool[75] for the estimation of emissions benefits. The CTC also encourages the use of the Cal B/C tool for other factors where it is applicable but does not require its use. Cal B/C has several versions, including one tailored for truck and freight rail projects. It can be downloaded as a spreadsheet with built-in factors and calculations that are pre-populated based on several potential project types. One-page fact sheets for three recent project applications by Caltrans, one in association with the Port of Los Angeles and two in association with LA Metro, illustrate the diverse range of project applications under the TCEP (see Figure A.24 through Figure A.26). They also demonstrate the manner in which different projects are supported by the relevant Performance Metrics.[76]

[75] The suite of Cal B/C applications is available at https://dot.ca.gov/programs/transportation-planning/economics-data-management/transportation-economics.

[76] See https://catc.ca.gov/SearchResults?q=tcep%2B2020%2Bfact%2Bsheets.

Figure A.23 Excerpt of TCEP Performance Metrics Form

Measure	Metric	Project Type (All Freight)	Build	Future No Build	Change	Metho dology	Data/ Assumptions
Congestion Reduction	Daily vehicle hours of travel time reduction	Road, sea port, land port					
	Daily truck trips	Rail, sea port					
	Daily truck miles traveled	Rail, sea port					
	(Optional) other possible information for narrative discussion	All					
Throughput	Change in annual truck volume that can be accommodated due to improvement	Road, land port, airport					
	Change in annual rail volume that can be accommodated due to improvement	Rail, sea port					
	Change in annual cargo volume that can be accommodated due to improvement	Sea port, airport					
	(Optional) other possible information for narrative discussion	All					
System Reliability	Truck travel time reliability index	National and State Highway System only (subcategory that falls under "Road" project type)					
	Daily vehicle hours of travel time reduction	Road, sea port, land port					
	(Optional) other possible information for narrative discussion	All					
Velocity	Travel time or total cargo transport time (including dwell time in logistics facility - port, railyard etc.) if applicable for project	All					
	(Optional) Change in average peak period weekday speed for road facility	Road					
	(Optional) Average peak period weekday speed for rail facility	Rail					
	(Optional) other possible information for narrative discussion	All					

Source: California Transportation Commission.

Figure A.24 TCEP Fact Sheet

Port of Los Angeles Application for Fenix Yard

FACT SHEET — 2020 Trade Corridor Enhancement Program

Port of Los Angeles Fenix Container Terminal Intermodal Railyard Expansion and Modernization Project

Sponsors: Caltrans (in partnership with the Port of Los Angeles)

Contact: Kerry Cartwright, Director of Goods Movement, Port of Los Angeles | kcartwright@portla.org | (310) 357-4996

Project Location: City of Los Angeles-Port of Los Angeles

Project Scope:
The project entails adding five new working tracks just north of/parallel to the existing Fenix on-dock railyard, including tail track, including pavement & turnouts

Project Cost

Total Project Cost:	$ 51,470,000	Total TCEP Request:	$ 19,194,000

Project Schedule

PA&ED:	PS&E:	RTL:	R/W:	Beg CON:	End CON:
12/12/2020	09/22/2021	03/21/2022	NA	09/18/2022	03/10/2024

Project Benefits

- Net present value benefit of $389,705,226; benefit-cost ratio = 10.2
- Reduced cargo dwell and transit times by as much as two days for the shifted 520,000 TEU/year, which in turn improves reliability, and reduces transportation and inventory carrying costs
- Reduced truck trips (-2,000/day & 27,400 miles-traveled) on Congressionally approved (via the FAST Act of 2015) NHFN/Primary Highway Freight System (PHFS) routes, including I-710, I-110, SR 47, and several other National Highway System Intermodal Connector Routes, which in turn reduces travel times for port and domestic cargo movement, as well as all other motorists (-4,600 vehicle-hours/day)
- Reduced truck trips reduces accident potential inside the terminal and on external roadways
- Reduced emissions of 6,550 tons/year (including greenhouse gas reductions): in the UPRR ICTF and BNSF Hobart off-dock railyards; in numerous State designated "Disadvantaged/Low Income Communities" and the State's highest ranked communities in the California Communities Environmental Health Screening Tool (CalEnviroScreen 3.0, 2018); and on numerous State/PHFS routes

Port of Los Angeles National Multimodal Freight Network Improvement Program
Fenix Container Terminal Intermodal Railyard Expansion and Modernization Project
August 3, 2020

Source: California Transportation Commission.

Figure A.25 TCEP 2020 Fact Sheet

LA Metro Application for Malabar Yard

2020 Trade Corridor Enhancement Program

Fact Sheet: The LA County Freight Rail Efficiency Project at Malabar Yard Caltrans, the Los Angeles County Metropolitan Transportation Authority

Contact: William Ridder, Exective Officer | ridderw@metro.net | (213) 922.2887

Project Location:
The City of Vernon, Los Angeles County

Project Scope:
The LA County Freight Rail Efficiency Project at Malabar Yard (the "Project") will provide replacement for intermodal railcar storage capacity that will otherwise be lost due to implementation of the Link Union Station (Link US) project. Construction to support passenger-rail improvements for the Link US project will require the removal of existing intermodal freight railcar storage tracks at BNSF's West Bank Yard. The West Bank Yard stores and stages empty intermodal railcars, which are regularly moved to and from nearby Hobart Yard, the busiest intermodal rail terminal in the country and a critical link for the Ports of Los Angeles and Long Beach. Unless replacement intermodal railcar storage capacity is provided, the loss of intermodal railcar storage capacity at West Bank Yard will necessitate that displaced intermodal railcars be stored on mainline tracks as rolling stocks to Barstow and points east, which will substantially degrade on-time service levels on the freight-rail mainlines. Therefore, the Project will convert Malabar Yard's operational and infrastructure aspects to offset the loss of intermodal rail car storage at West Bank Yard due to the Link US project. The Project will provide safety, public health, economic competitiveness, and other benefits as compared to the "No-Build" scenario. The Project components include the following:

1. *49th Street Closure:* Permanently closing the 49th Street at-grade rail crossing through the existing seven tracks at Malabar Yard, will add approximately 2,500 to 3,000 feet of uninterrupted track storage capacity, which will allow intermodal railcar sets to be stored at this facility.
2. *The Los Angeles Junction (46th Street) Connector:* Constructing approximately 750 feet of new track to connect Malabar Yard with the Los Angeles Junction Railway (LAJ) through East 46th Street in the city of Vernon will provide a short direct route between LAJ and Malabar Yard, which will maintain existing BNSF customer service in the city of Vernon.
3. *Fruitland Avenue Restriping:* Creating one new travel lane in each direction through restriping of the existing right-of-way, will minimize impacts to vehicular traffic from the 49th Street closure.

Project Cost:

Total Project Cost:	$84,738,000	Total TCEP Request:	$65,200,000

Project Schedule:

End PA&ED:	Beg PS&E:	RTL:	R/W:	Beg CON:	End CON:
12/31/2020	01/01/2021	02/28/2023	10/01/2021	03/01/2023	05/31/2024

Project Benefits:
The proposed improvements will offset the loss of empty freight railcar storage capacity to the BNSF West Bank Yard due to Link US and produce net present value of over $139 million with a BCR of 2.8 over 30 years at 4 percent discounting rate. The Project benefits derive from a variety of effects, including: (1) reduced intermodal railcar miles of travel, (2) reduced Operation & Maintenance costs for maintenance of grade crossings and locomotives; (3) reduced transportation handling costs for empty intermodal railcars; (4) reduced delay times for manifest railcar customers in the Project area; (5) improved mainline rail network capacity to support regional freight rail growth; and (6) avoided truck VMT, VHT, and fuel consumption due to loss of mainline rail net-work capacity and diversion of rail-served demand to long-haul trucking. The Project implementation will also result in 556 jobs created during construction.

The LA County Freight Rail Efficiency Project at Malabar Yard
08/03/2020

Source: California Transportation Commission.

Figure A.26 TCEP Fact Sheet

LA Metro Application for I-710 Integrated Corridor Management

2020 Trade Corridor Enhancement Program

Fact Sheet:
Interstate 710 Integrated Corridor Management (ICM) Project
Caltrans, the Los Angeles County Metropolitan Transportation Authority

Contact: Michael Cano, Deputy Exective Officer | canom@metro.net | (213) 418.3010

Project Location:
LAC | I-710 between SR-91 and SR-60

Project Scope:
The Project will integrate and upgrade, as necessary, real-time traveler information and intelligent transportation system (ITS) technologies, currently managed by 15 local agencies and Caltrans along the I-710 corridor between SR-91 and SR-60, into an integrated corridor management (ICM) system. The ICM system will actively manage traffic during non-recurring congestion to benefit both trucks and passenger vehicles on the nation's most vital goods movement corridor. The Project will support the freeway capacity to maintain truck travel speed during incidents, actively manage diverted passenger vehicles off the I-710 onto adjacent arterials to minimize impacts from such traffic on local arterial network. The Project implementation elements include but are not limited to local traffic signal equipment upgrades and signal synchronization, improvements to interagency field communication devices, and improvements to the LA County's Information Exchange Network and Regional Integration of Intelligent Transportation Systems networks. The Project is part of the Transportation System Management (TSM)/Travel Demand Management (TDM) and ITS improvements under the Locally Preferred Alternative 5C of the I-710 Corridor Project EIR/EIS.

Project Cost:

Total Project Cost:	$40,000,000	Total TCEP Request:	$27,800,000

Project Schedule:

End PA&ED:	Beg PS&E:	RTL:	R/W:	Beg CON:	End CON:
04/01/2021	12/01/2021	12/31/2022	N/A	04/30/2023	10/30/2025

Project Benefits:
During congestion caused by incidents, trucks on I-710 often must remain on the freeway with no available alternative routes. This Project will improve reliability of freight movement for trucks through operational efficiency gains. As a result, trucks will experience shorter idling time and reduced travel times on the I-710 corridor. The Project will ensure traveler safety by minimizing secondary collisions through technology-focused solutions. The Project will result in enhanced travel time reliability for all users, improved air quality corridor-wide, and actively managed local road traffic. Enhancing truck travel time reliability will benefit the productivity of the logistics industry and contribute to Southern California's economic vitality and competitiveness. The Project is estimated to result in $125.2 million of monetized benefits at a benefit-cost ratio of 4.6.

Interstate 710 Integrated Corridor Management (ICM) Project

Source: California Transportation Commission.

In addition to the Performance Metrics, which establish how the performance impacts of potential freight system investments will be measured, the TCEP guidelines[77] also establish monitoring and reporting requirements. These include:

- **Front-End Accountability.** All TCEP projects must execute a Baseline Agreement with Caltrans documenting project scope, schedule, benefits, and costs.
- **In-Progress Accountability.** Reports demonstrating satisfactory progress toward project completion must be delivered to the CTC, addressing schedule, work performance, budget performance, and achievement of expected benefits. CTC reviews requests for program or project amendments and allocates funds.
- **Program Reporting.** Quarterly reports must be submitted to CTC for all SB1 program funded projects, addressing current cost, schedule, scope, and expected benefits compared to the Baseline Agreement.
- **Follow-up Accountability.** Within six months of completed construction or project operability, CTC must receive a Completion Report with the scope of the completed project, estimated final cost, schedule, and project benefits compared to the Baseline Agreement. Within six months following the conclusion of all activities following completed construction, CTC must receive a Final Delivery Report addressing any differences from the Completion Report.

With respect to Performance Metrics, project applicants are required to report their achievement of project benefits (if any) during the construction phase (as part of Program Reporting) and their achievement of project benefits during the period within six months of completed construction/project operability. However, there is no provision for continued monitoring of performance metrics beyond the Final Delivery Report; reporting only covers the first months of project operation, even though the promised project benefits may assume a gradual phase-in and/or long-term (20 years or more) accrual.

Additional Insights on TCEP Performance Measurement and Monitoring

The program targets for TCEP allocations may evolve. Case study interviewees indicated that some stakeholders have expressed a desire that the limitation on use of FAST Act-sourced (not more than 10 percent for non-highway projects) may be lifted. This would allow the TCEP to be amended to fund non-highway improvements more easily. Also, some TCEP stakeholders have questioned whether the allocation of 40 percent of funding to Caltrans-sponsored projects and 60 percent to all other sponsors is the best distribution of program funds. Others have noted that the regional spending share targets were originally established for the 2006 Trade Corridor Improvement Fund (TCIF) established under Proposition 1B and could be re-evaluated.

The performance metrics in TCEP have substantially evolved over time. They were first established in the 2006 TCIF and evolved through the 2007 Goods Movement Plan, the 2016 Sustainable Freight Action Plan, the 2017 SB1 legislation, the first (2018) cycle of TCEP, and related planning and legislation. The current (2020) TCEP metrics were jointly framed based on legislative guidance, past metrics, and discussions between CTC, Caltrans, the California Air Resources Board, and regional agencies. Furthermore, discussions on what are the 'best' metrics are ongoing and are expected to continue to evolve over future

[77] See TCEP Program Guidance, op cit.

TCEP cycles. For example, the utility of the federal travel time index for highways being applied at the project level has been questioned.

A challenge of the TCEP is the variation in freight performance measures tracked by stakeholders and potential applicants to the program. For example, public agencies (e.g., MPOs, county or city transportation departments, etc.) generally focus on federally required measures (such as the mandated Highway Performance Monitoring System metrics) and on advanced use of NPMRDS and other real-time data sources for highway network analysis; ports focus on emissions, terminal performance (throughput, truck gate transactions and turn time, railcar moves, container dwell time, vessel calls and in-port time, etc.), and supply chain data;[78] railroads focus on train volumes and delay per train. Many, if not most, of the TCEP metrics are not tracked or calculated in the course of normal business by these entities and must be custom developed for each project. There is a general recognition that better tools for calculating the required metrics would be valuable—particularly for freight projects, which can involve complex supply chain and logistics effects across multiple modes and large geographies. The Cal B/C tool is effective for evaluating highway improvements and highway-related effects of multimodal improvements but is less effective for non-highway effects. As a result, different applications may be supported by different customized models and data, creating inconsistencies across applications, and placing considerable demand on CTC reviewers. Upgraded performance estimation and BCA tools, tailored specifically for freight and covering a wide range of project types, could simplify and improve the TCEP process for both applicants and reviewers.

In future iterations, the TCEP emphasis on performance metrics for individual projects might be expanded to cover groups of projects within a larger program. Stakeholders cited the CREATE program of rail improvements in Chicago as an example. In CREATE, a long list of project improvements was developed based on the goal of larger network performance, with each project addressing certain bottlenecks or chokepoints; each project has independent utility, but the greatest value is derived from the projects in combination. As funding becomes available, each separate project advances. Stakeholders expressed that some mechanism to evaluate the performance and BCA value of improvement programs—not just individual projects—could be useful in determining which individual projects to advance under TCEP. This would add a focus to the TCEP on larger improvement programs with bigger impacts to freight mobility.

Lastly, stakeholders that participated in the case study expressed that the ongoing performance monitoring requirements for TCEP could be clarified. The required Completion Report and Final Delivery Report address benefits achieved with the project. However, because the reports are due within six months of completing project activity, benefits might not yet be achieved or (if achieved) be measurable. For example, if a potential project benefit is the diversion of a certain amount of port traffic volume from truck to rail, it may not be fully realized within a 6-month timeframe. Furthermore, if the project has been impacted by external factors (e.g., changes to federal trade policy, a pandemic that alters global trade patterns, etc.), the achievement of benefits may be further delayed or altogether altered as the project faces a completely different real-world environment from which it was conceived. More broadly, the analysis of many of the performance metrics included in TCEP occurs under laboratory conditions, where hypothetical future no-build and future build conditions are estimated and compared. In the actual world, there are many different drivers and effects in play at any given time, so the specific effects of a project may be difficult to identify, measure, or isolate from unrelated effects. Federal BCA programs, which require performance reporting over longer periods of project operation, also wrestle with this question. As a result, in many cases reporting requirements only ask for simple and easily obtainable performance metrics, such as facility volumes. Future

[78] A good example is the Port of Los Angeles “Port Optimizer.” See https://www.portoflosangeles.org/business/supply-chain/port-optimizer%e2%84%a2.

iterations of TCEP may further revise performance measurement and reporting requirements to better handle this challenge.

A.4.5 Lessons Learned and Notable Practices

As part of this case study, interviews were conducted with representatives of the California Transportation Commission, Caltrans, Port of Los Angeles, LA Metro, and BNSF Railway (a participant in the Malabar Yard application described in Figure A.24). Lessons learned and other notable information from interviews are summarized below.

- **Formulate Dedicated Processes for Allocating Freight Funds**—Dedicated freight funding from the FAST Act's National Highway Freight Program is an important resource for states. NHFP funded projects must be specified in adopted state freight plans, but how they get into those plans and rank-ordered is up to the states. Based on previous experience in allocating state freight funding, California had a process in place for freight project evaluation and selection. Over time, this process has been expanded to include the NHFP funds and improved to incorporate state-of-the-practice methods for benefit-cost evaluation, consistency, transparency, and conformity with state goals. Such an approach could serve as a useful model for ITTS member states, for their NHFP funding alone, or for pooled state and federal freight funds.

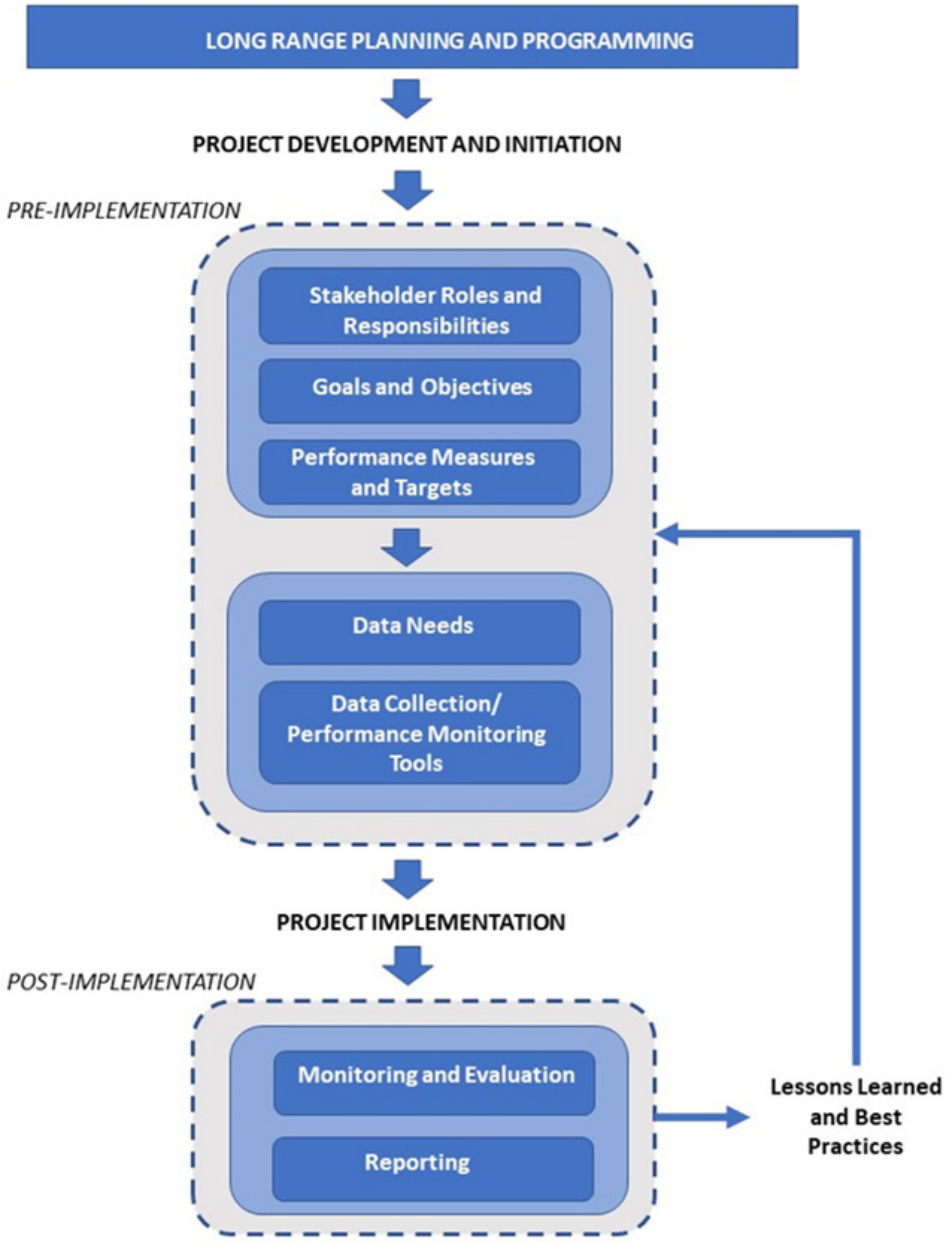
- **Be Mindful of Resource Requirements**—The process requires effort to develop and administer. Several rounds of state legislative action were needed to bring California's program to its current formulation. The California Transportation Commission puts significant work into producing guidance, answering questions, making project recommendations, and identifying program enhancement opportunities. TCEP and similar programs are not simple "checklist" operations—they are living programs that both demand and reward attention. States considering such programs need to be mindful of the associated resource requirements.

- **Limit the Burden on Applicants**—The process also places demands on project applicants. In many ways, the demands are similar to federal discretionary grant programs; but in other ways, California's program is more demanding as it seeks to address environmental and equity issues at a more detailed level than federal programs. The applications therefore require substantial effort. Efforts to simplify and streamline the process are being considered, and aim generally to achieve consistency with state goals and legislatively established program objectives; performance metrics that are widely applicable across a broad range of modes and project types; and improved tools to make the required analyses simpler and more standardized for project applicants. Should ITTS states wish to explore programs similar to TCEP, these would be primary considerations in how the application and review process is framed, developed, and supported.

Appendix B. Example Application of the Framework for a State DOT

This section provides a high-level example of a state DOT applying the freight investment performance monitoring framework to an investment intended to relieve congestion at a highway freight bottleneck. This example follows the step-by-step approach to the framework outlined in Sections 3 and 5 and shown in Figure B.1. Though the example takes the perspective of a state DOT, it could be applied by any transportation agency.

Figure B.1 Freight Investment Performance Monitoring Framework



Source: Cambridge Systematics, Inc.

B.1 Overview

State Highway 100 is an important freight corridor as it routinely carries tens of thousands of trucks on a daily basis. However, motor carriers and commuters frequently complain that it suffers from congestion and unreliable travel times. As part of its long-range freight planning activities, the State DOT previously identified a 7-mile stretch of State Highway 100 as a freight bottleneck and eventually worked to scope and program an investment to address that corridor's needs.

B.2 Identify Stakeholders and Define Roles and Responsibilities

B.2.1 Identify Stakeholders

The first step to implement the framework is for the State DOT to identify the stakeholders that will be impacted by the investment so that they may be involved in setting the foundational elements (i.e., vision, goals, objectives, and performance measures) and making decisions for the key steps that follow in the process. At this step in the process, the roles and responsibilities of each stakeholder are also defined. To do this, the State DOT focused on questions, such as:

- Who will own the investment? Who will be responsible for maintaining it?
- Who will benefit from the investment? Who might be adversely impacted?
- Who will pay for the investment?
- Who must approve the investment?

Because the investment is within a metropolitan area, the State DOT first recognized that the MPO is a key stakeholder that should be involved in gauging the impact of the investment. The MPO was involved in the long-range planning process responsible for identifying and developing the investment into a project.

Besides the MPO, the State DOT reached out to the local governments, including the city and county, that are home to the bottleneck. Those communities stand to benefit from the investment as they are currently disproportionately impacted by its negative externalities (e.g., exposure to higher emissions due to the bottleneck as well as limited mobility). In addition, these communities have contributed local dollars to help fund the investment.

The State DOT then reached out to FHWA to help implement the framework and participate in monitoring the performance of the investment. State Highway 100 is also US 101 and is part of the National Highway System, so the investment must adhere to federal guidelines. In addition, this project is partially funded with a BUILD grant, and the state DOT is responsible for reporting on agreed upon performance measures to FHWA.

Lastly, the State DOT reached out to motor carriers, third-party logistics providers, and other representatives from freight-intensive industries located along the corridor to ensure system users participated in implementing the framework. The State DOT reached out to these stakeholders because they recognized that private sector individuals and businesses are primary users of the freight system and understand the mobility and safety challenges of this corridor. Furthermore, the State DOT is hoping these private

businesses will be able and willing to share system user data that would otherwise be unavailable. All of these individual stakeholder groups were brought together under a single umbrella as a working group.

B.2.2 Define Roles and Responsibilities

With the working group consisting of public and private sector stakeholders in place, the State DOT turned its attention to defining their roles and responsibilities for implementing the framework. This is an important step because it provides all stakeholders with a clear understanding of what they need to do to successfully implement the framework. The assignment of roles and responsibilities was done collaboratively among stakeholders and completed through candid discussions on the capabilities of each stakeholder in initial working group meetings (see Table B.1 for the results). As the lead agency, State DOT has a role in all key tasks. For example:

- **Data Collection and Performance Monitoring.** A stakeholder should be responsible for collecting the data needed to measure performance and to monitor the results and performance trends. Since the State DOT has ready access to road tube counters, CCTVs, and other monitoring equipment, the working group decided the State DOT should lead this role.

- **Performance Measurement.** Another stakeholder must be responsible for measuring performance over the evaluation period including all the technical steps involved in the calculation of the selected performance measures. Because of their experience with performance measurement, the working group decided that the MPO should lead this role with support from the State DOT.

- **Investment Evaluation.** A stakeholder is needed to evaluate the investment, which involves analyzing the gathered information to understand to what extent the investment has been effective. The working group decided it was best for the State DOT to perform the evaluation analysis under guidelines developed by FHWA given their experience in these types of analyses as part of administering discretionary grant programs.

- **Stakeholder Coordination and Engagement**. A stakeholder should be responsible to ensure coordination among stakeholders and to be responsible for reporting results to the broader public and external stakeholders. Local government and private sector stakeholders were selected for this role as they have greater connections to the local communities and outside groups impacted by the investment. However, the State DOT still offers critical support in the form of technical resources for sharing data electronically, creating websites, and developing online dashboards, among others.

Table B.1 Example of Defining Roles and Responsibilities for Stakeholders

Stakeholder	Data Collection and Performance Monitoring	Performance Monitoring	Investment Evaluation	Stakeholder Coordination and Engagement
State DOT	✓	✓	✓	✓
MPO	✓	✓		
Local Government	✓			✓
FHWA			✓	
Trucking Industry Association				✓

B.3 Set Goals and Objectives

For this example application, the State DOT and its working group developed two goals with supporting objectives that were consistent with regional and statewide freight planning goals and objectives. They achieved this by referring back to the long-range planning goals and objectives under which the investment was originally conceived and refining them to focus specifically on the investment. This is shown in Table B.2. Though a simple and straightforward endeavor, it is an important exercise as it positions the State DOT to define meaningful performance measures and set targets that align with broader regional and statewide priorities as part of the next step in framework.

Table B.2 Example Refinement of Long-Range Goals and Objectives

Long-Range Planning Goals and Objectives	Investment Goals and Objectives
• **Goal 1**—Reduce congestion and improve system efficiency and performance. – Objective 1—Reduce the number of miles of the highway freight network performing at unacceptable congestion levels. – Objective 2—Improve travel time reliability on the highway freight network.	• **Goal 1**—Reduce congestion and improve the efficiency and performance of the portion of State Highway 100 determined to be a freight bottleneck. – Objective 1—Reduce the number of miles of State Highway 100 performing at unacceptable congestion levels. – Objective 2—Improve travel time reliability on State Highway 100.
• **Goal 2—**Improve multimodal transportation safety. – Objective 1—Reduce rates of truck-involved crashes, injuries, and fatalities on the highway freight network.	• **Goal 2—**Improve multimodal transportation safety on the portion of State Highway 100 determined to be a freight bottleneck. – Objective 1—Reduce rates of truck-involved crashes, injuries, and fatalities on State Highway 100.

Source: Cambridge Systematics, Inc.

B.4 Select Performance Measures, Identify Data Sources, and Set Targets

The next step was for the State DOT's working group to develop performance measures. The working group identified, reviewed, and ultimately selected performance measures. They also identified the data needed to support these measures and set performance targets.

To arrive at the final performance measures, the working group reviewed measures used by local jurisdictions, the MPO, the State DOT, FHWA, and those listed as best practices. To assist with the selection of the performance measures, the working group used the Performance Measure Resource and Data Assessment table presented in this guidebook that was adapted from the FHWA TAP Performance Management Guidebook to support the freight investment performance monitoring framework. The questions in the table helped to confirm if the selected performance measures would be relevant to the investment and achievable given the data collection, analysis, and reporting requirements. The measures selected for each goal and objective are shown in Table B.3.

Table B.3 Example Performance Measures and Targets

Investment Goals and Objectives	Performance Measures	Targets
• **Goal 1—**Reduce congestion and improve the efficiency and performance of the portion of State Highway 100 determined to be a freight bottleneck. – Objective 1—Reduce the number of miles of State Highway 100 performing at unacceptable congestion levels. – Objective 2—Improve travel time reliability on State Highway 100.	• Performance Measure 1—Truck Travel Time Delay per Mile • Performance Measure 2—Truck Travel Time Reliability (TTTR)	• Target 1—Reduce truck travel time delay 20 percent. • Target 2—Achieve a value of 1.2 for the TTTR measure.
• **Goal 2—**Improve multimodal transportation safety on the portion of State Highway 100 determined to be a freight bottleneck. – Objective 1—Reduce rates of truck-involved crashes, injuries, and fatalities on State Highway 100.	• Performance Measure 3—Truck-Involved Crashes per 100 Million Truck Miles Traveled • Performance Measure 4—Serious Injury Truck-Involved Crashes per 100 Million Truck Miles Traveled • Performance Measure 5—Fatal Truck-Involved Crashes per 100 Million Truck Miles Traveled	• Target 3—Reduce the truck-involved crash rate by 35 percent. • Target 4 – Reduce the truck-involved serious injury crash rate by 15 percent. • Target 5 – Reduce the truck-involved fatal crash rate by 5 percent.

Source: Cambridge Systematics, Inc.

At the same time performance measures were selected, the working group identified the data needed to support them. As the State DOT was tasked with taking on the responsibility of data collection in the first step, the working group concentrated on identifying the data the State DOT already has access to. They made the following determinations:

- **Traffic Monitoring Data.** The State DOT already has road tube counters, cameras, and other devices that can be used to accurately measure traffic volumes on State Highway 100. This data will be needed to calculate truck travel time delay performance measure. They will also support the TTTR measure and the truck-involved crash rate measure.

- **Truck Probe Data.** The State DOT has an agreement in place with a data vendor for providing truck probe data on its statewide system, including State Highway 100. The data vendor's online website will be used to collect travel time data on State Highway 100 in support of the delay and TTTR performance measures. Furthermore, the State DOT's cameras may be used to QA/QC the travel time data to ensure its accuracy.

- **Crash Reporting System.** The State DOT regularly collects crash data for the entire state. This data will be used to support the truck-involved crash rate measure for the State Highway 100 corridor.

B.5 Identify Performance Measurement and Monitoring Tools

Once the State DOT's working group selected performance measures and identified the data needed to support them, they next identified the tools needed to collect and compute performance data. Again, the focus was on the State DOT and the MPO as they were tasked with taking on the responsibility of measuring performance.

- **Traffic Monitoring Tools.** The State DOT uploads the data collected using the devices previously discussed to its online traffic analysis and data application. This tool is used to store and display speed, volume, and other traffic data that is accessible via an online user interface that uses maps, graphs, tables, and other visual aids. The online traffic analysis and data application tool reports this information for State Highway 100 and other State DOT-owned roadways. It will be needed to calculate truck travel time delay performance measure and to support the TTTR measure and the truck-involved crash rate measure.

- **GIS.** Both the State DOT and the MPO routinely use GIS to analyze system performance. For the State Highway 100 investment, the MPO will use GIS to locate crashes along the corridor for calculating the safety performance measure and depicting safety and travel time performance on maps. Figurative depictions of performance will be important for communicating the impact of the investment to the broader public.

- **General Data Analysis Tools.** The working group also determined that general data analysis tools—such as programming languages (e.g., R, Python), data visualization software (e.g., Tableau, PowerBI), and spreadsheets—would be needed. These tools will be used for storing data, calculating performance measures, evaluating performance, and communicating results to the broader public.

B.6 Evaluate Performance and Report Results

With all the pre-investment components of the framework, including the actual implementation of the investment, the working group moves into the post-investment phase of the framework. The first step in the post-investment phase is to conduct the performance evaluation. As the task lead, the State DOT took the following actions:

- The State DOT gathered historical data on traffic volumes, travel times, crashes, and other data to analyze baseline conditions. Establishing a baseline was necessary to gauge the true impact of the investment. Without knowing the level of performance for State Highway 100 beforehand, it would be impossible to determine if the investment has had a positive impact on performance. In consultation with the other working group members, the State DOT settled on a 3-year period for establishing baseline conditions.

- The State DOT and MPO monitored performance on State Highway 100 over a 3-year evaluation period. To accomplish this, the State DOT and MPO used the tools they identified in the previous step of the framework—GIS, traffic monitoring tools, and general data analysis tools.

- Once the evaluation period expired, the State DOT took the newly collected performance data and performed the evaluation of the investment. This consisted of a before-and-after evaluation of traffic impacts as well as an evaluation of economic impacts. For the evaluation of transportation impacts, the State DOT compared post-investment average truck travel times, TTTR values, and truck-involved crash rates to pre-investment values to determine if they achieved their targets. For the evaluation of economic impacts, the State DOT monetized the reduction in travel times and crash rates to calculate a monetary value of the transportation improvements that resulted from the investment. This was compared to its cost to calculate a benefit-cost ratio.

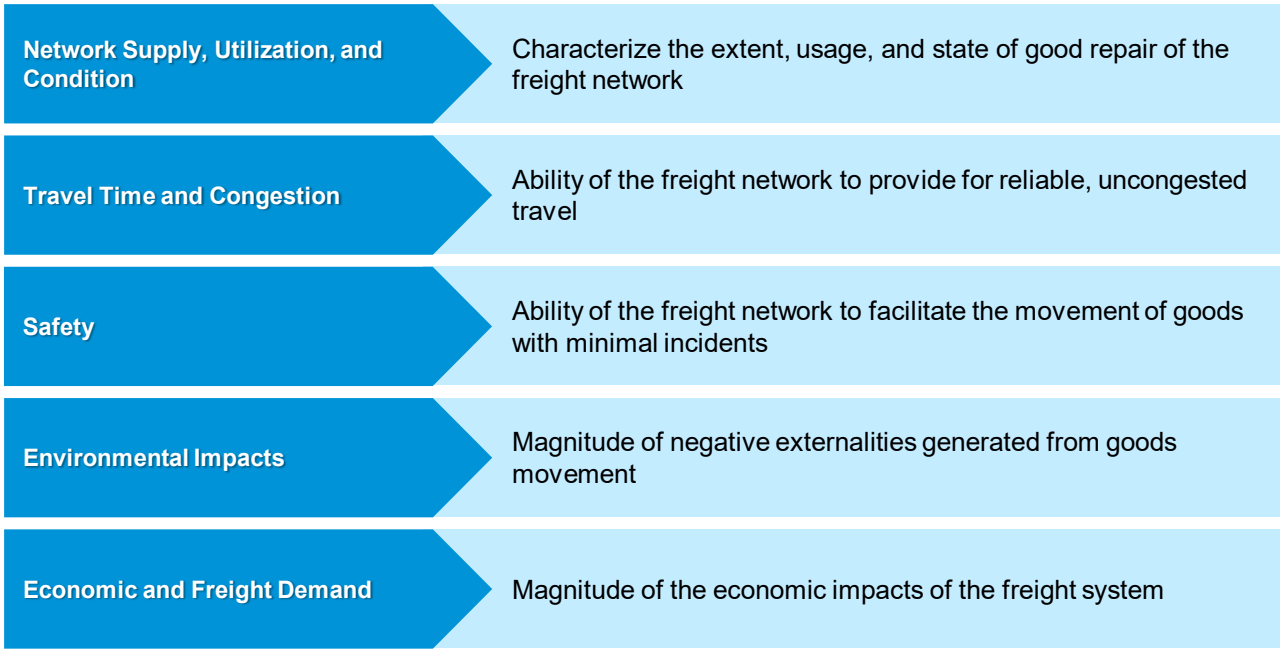
Once the performance evaluation was completed, the State DOT shared the results with the other working group members. The local government and private sector stakeholders then took the lead in reporting the results to the broader public. They accomplished this through a dedicated page on the State DOT's website

about the State Highway 100 project. On this site, they used graphics, maps, and other visuals to convey the reduction in travel times and crash rates on the State Highway 100 corridor.

Appendix C. What are Some Useful Freight Performance Measures?

For purposes of this guidebook, freight performance is broadly defined in terms of the characteristics and quality of freight system condition, utilization, operations, and economic outcomes. While freight performance may be more narrowly defined as the outcome of utilization under particular physical conditions, a broader definition is applied to reflect the scope of state freight programs that tend to collect data and report on a larger dimension of metrics.[79] Figure C.1 shows the categories of freight performance measures as defined and used in this study. They include measures of network supply, utilization, and condition that characterize the physical infrastructure and the freight volumes on it; measures of travel time and congestion that characterize the quality of freight mobility; measures of safety; environmental measures that gauge the environmental impacts of freight; and economic and freight demand measures that gauge the freight system's economic impacts.

Figure C.1 Categories of Freight Performance Measures



Source: Cambridge Systematics, Inc.

C.1 Network Supply, Utilization, and Infrastructure Condition

Network supply and infrastructure condition measures gauge the performance of the multimodal freight system by characterizing the extent, utilization, and condition of the system. In characterizing the extent and condition of the system, network supply and infrastructure condition-based measures provide insight into the accessibility of the multimodal freight system for its users. Performance measures that focus on utilization inform agencies on which portions of the multimodal network have the highest usage and may require

[79] BouMjahed, L., and J. Schofer, "Freight Performance Measurement in FAST Act-Mandated State Freight Plans," Transportation Research Record, Volume 2673, Issue 4, 2019.

greater prioritization from an investment perspective. Performance measures that focus on infrastructure condition provide insight into the accessibility of an area for freight as they indicate which origins and destinations have freight mobility and fluidity. Table C.1 contains an inventory of common network supply, utilization, and infrastructure performance measures.

Table C.1 Inventory of Common Network Supply, Utilization, and Infrastructure Condition Freight Performance Measures

Mode	Measure
Network Supply	
Highway	• Miles or lane-miles of highway by functional classification • Miles or lane-miles of designated truck routes
Railroad	• Miles of rail by carrier class • Miles of double-tracked rail • Number and type of rail yards
Water	• Number of ports • Miles of navigable inland waterways
Air	• Number of cargo carrying airports
Pipeline	• Miles of pipeline by type (i.e., distribution, gathering, transmission)
Network Utilization	
Highway	• Annual or average annual daily truck traffic • Annual or average annual daily truck miles traveled • Annual or average annual daily truck ton-miles
Railroad	• Annual or average annual daily number of trains per segment • Annual or average annual daily number of lifts by intermodal terminal • Annual or average annual daily train miles traveled • Annual or average annual daily train ton-miles
Water	• Annual tonnage by port • Annual number of containers by port • Annual number of vessel calls by port • Average vessel capacity per call by port
Air	• Annual landed weight of all-cargo operations by airport • Annual cargo revenue ton-miles • Annual cargo revenue tons enplaned
Pipeline	• Annual tonnage by state or region
Infrastructure Condition	
Highway	• Percent of pavement in good condition on freight significant highways • Number of weight restricted bridges divided by total number of bridges • Percent of bridges that meet good and poor structural condition thresholds • Service life remaining on highway pavement • Benefit of truck weight enforcement on pavement service life
Railroad	• Miles of track in FRA Class I divided by total miles of Class I track • Number of double-stack tunnel restrictions divided by number of tunnels • Percent of rail track-miles with 286,000-pound railcar capacity rating
Water	• Percent of tons on river moving though locks with constraints • Unscheduled lock closure time (hours)

Mode	Measure
	• Channel depths at the port divided by depths at competitive ports
Air	• Percent of pavement in fair or poor condition at freight-significant airports
Pipeline	• Percent of pipeline by decade of installation • Leaks per mile of pipeline • Leaks eliminated per mile of pipeline

Sources: FHWA, Freight Performance Measure Primer, October 2017; Georgia Transportation Institute University Transportation Center, Trucking in Georgia: Freight Performance Measures, 2011; Cambridge Systematics, Inc.

The network supply, utilization, and infrastructure condition performance measures shown in Table C.1 are summarized in the paragraphs below:

- **Network Supply—**Network supply measures provide information on the number and extent of freight assets such as miles of highway suitable for truck traffic, miles of freight rail, and the number of rail intermodal terminals. These measures provide insight into the accessibility and coverage of the multimodal freight system.

- **Network Utilization—**Utilization measures reflect the throughput on freight assets, such as annual or average annual daily truck traffic or annual or average annual number of trains. They indicate where freight activity is most prevalent on the multimodal freight system, which may have implications for where system investments are targeted.

- **Infrastructure Condition:**

  - Highways—Infrastructure condition freight performance measures include those that characterize the conditions of pavements and bridges. States are required to have an assessment of bridge data that considers structural deficiencies including condition ratings for the deck, superstructure, and substructure, and functional deficiencies including width, vertical clearance, approach curvature, and other design standards. Certain structural and functional deficiencies could result in load limits that hinder freight movement. States also collect pavement data that includes pavement thickness, surface type, cracking, and international roughness index. These conditions highlight structural gaps in the network that limit freight movement and impact performance.

  - Rail—Rail condition performance measures primarily center on weight restrictions on railroad tracks and vertical clearances for tunnels. Excepted and weight-restricted track may result in rail shipments taking longer, more circuitous routes to avoid the impacted area. This increases costs in terms of time, labor, and fuel.

  - Water, Air, and Pipeline—Infrastructure condition performance measures for other freight modes may include pavement conditions on airport runways, channel depth at ports, and lock conditions on navigable inland waterways. Measures such as the age of pipelines and the number of leaks per mile provide an indication of the system's condition.

C.2 Travel Time and Congestion

Travel time and congestion-based freight performance measures are an important category of performance measures as these (along with safety) have the most direct impact on the cost of freight operations. Delays

can be costly to shippers as they wait for delivery of time-sensitive goods such as an input to a manufacturing process or a consumer good that must make it to retailers in time for a busy shopping period. Delays are also costly to carriers as contracts for carriage typically include provisions for on-time deliveries that contain financial penalties for failing to do so. In addition, travel time and congestion-based freight performance measures also reflect the costs associated with factoring buffer time into schedules (and the associated labor, fuel, and other vehicle costs) to account for unanticipated delays. Data on travel times are typically derived from loop counters and Global Positioning System (GPS) data. Table C.2 contains common travel time and congestion freight performance measures.

Table C.2 Inventory of Common Travel Time and Congestion Freight Performance Measures

Mode	Measure
Highway	• Percent of interstate providing reliable travel times. • Percent of interstate where peak hour travel times meet expectations. • Percent of non-interstate National Highway System (NHS) providing reliable travel time. • Percent of non-interstate NHS where peak hour travel times meet expectations. • Annual hours of excessive delay per capita. • Average hours of delay per day for freight vehicles on freight-significant links. • Travel Time Index (TTI) on freight-significant links (ratio of the peak travel time to free-flow travel time). • Percent of interstate mileage providing for reliable truck travel times. • Percent of interstate mileage that is uncongested. • Clearance time for incidents, crashes, or hazardous materials. • Number of intersections and ramps with inadequate turning radii for large trailers on freight significant corridors. • Buffer Time Index on freight-significant links (95th percentile travel time - average travel time/average travel time). • Planning Time Index on freight-significant links (ratio of the 95th percentile travel time to average travel time or free flow travel time). • Mean travel time. • Truck Travel Time Reliability Index. • Volume-to-capacity ratio.
Railroad	• Average terminal dwell time train-hours of delay. • Railroad corridor level of service. • Average train speeds.
Water	• Gate reliability or truck turn time. • Ship unload rate (time per container). • Ship load rate (time per container). • Average delay per barge tow on river.
Air	• Flight frequency by airlines with cargo capacity (number per day). • Average time between flights by airlines with cargo capacity (minutes). • Percent of on-time departures at freight significant airports. • Percent of on-time arrivals at freight significant airports.

Sources: FHWA, Freight Performance Measure Primer, October 2017; Georgia Transportation Institute University Transportation Center, Trucking in Georgia: Freight Performance Measures, 2011; Freight Performance Measure Approaches for Bottlenecks, Arterials, and Linking Volumes to Congestion Report, 2015; Cambridge Systematics, Inc.

The travel time and congestion freight performance measures shown in Table C.2 are summarized in the paragraphs below.

- **Travel Time and Congestion:**
  - Highways—Travel time and other congestion freight performance measures characterize the ability of the highway system to provide for unimpeded freight travel. They include measures such as delay (in person-hours and vehicle-hours), average truck travel times, the mean travel time index (e.g., mean travel time over the highway segment divided by the travel time that would occur at the posted, free flow, or normal speed), and travel time reliability (e.g., planning time index, buffer time index, and truck travel time reliability index).
  - Rail—Speed can also be used as a way to measure time. Although it might not always be possible to measure travel times from origin to destination, speed measurements can provide insight related to transportation corridors with heavy levels of congestion that can result in freight delivery delays. For example, the nation's six major railroads (BNSF, Canadian Pacific, CSX Transportation, Kansas City Southern, Norfolk South, Union Pacific) report train speed on a weekly basis to evaluate network performance and reliability issues that can be used to highlight bottlenecks in the network, or provide justification for seeking public funds to expand or provide network extensions. Identifying corridors where speeds are slow and congestion costs are high may influence the location of distribution warehouses and logistics clusters.
  - Water and Air—For air cargo and waterborne freight, travel time and congestion measures may take the form of gate turn times for trucks serving those facilities, cargo loading/unloading times, and travel times between origins and destinations.

C.3 Safety

Traffic incidents are a major cause of nonrecurring congestion and associated delay for freight operations. Furthermore, those incidents involving trucks or trains tend to be costlier in terms of the severity of crash outcomes and incident clearance times. Freight safety performance measures are essential to ensure the safety and security of people and goods movement on the multimodal transportation network. Typical freight safety performance measures cover various aspects of goods movement including the rate and severity of incidents, incidents involving multiple modes (e.g., truck crashes involving pedestrians or bicyclists, highway-rail incidents), and the supply and adequacy of truck parking. Table C.3 contains an inventory of common safety freight performance measures.

Table C.3 Inventory of Common Safety Freight Performance Measures

Mode	Measure
Highway	• Truck crash rate (per mile or per miles-traveled). • Motor carrier truck at-fault rate. • Number of heavy truck-related fatalities. • Capacity of weigh stations—number of trucks processed per hour. • Number of truck parking spaces. • Number of truck parking spaces per mile of NHS. • Number of truck parking spaces per truck VMT. • Total cost of freight loss and damage from accidents/Vehicle Miles Traveled (VMT).

Mode	Measure
Railroad	• Total loss and damage from accidents per route-mile. • Total loss and damage from accidents per ton moved. • Number of highway-rail crashes. • Number of at-grade railroad crossings along freight significant corridors such as freeways and interregional corridors. • Number of rail fatalities. • Train derailments per ton moved.
Water	• Value of cargo lost or damaged per ton or value of cargo moved. • Containers damaged or lost per containers handled/total containers.
Air	• Total loss and damage from accidents divided by value of freight. • Percent of study airports meeting Traffic Safety Administration (TSA) guidelines for general aviation security. • Incidents per 1,000 operations at freight-significant airports.
Pipeline	• Annual or average annual number of incidents. • Annual or average annual number of incidents per mile. • Annual or average annual number of excavation incidents. • Excavation damages per number of excavation tickets (i.e., receipt of information from a one-call center about a proposed excavation).

Sources: FHWA, Freight Performance Measure Primer, October 2017; Georgia Transportation Institute University Transportation Center, Trucking in Georgia: Freight Performance Measures, 2011; Cambridge Systematics, Inc.

The safety freight performance measures included in Table C.3 are summarized below.

- **Safety:**
  - Highway—Truck traffic safety data helps to better understand the impacts of truck-related injuries and fatalities. This data is often collected by state's and used to produce a Strategic Highway Safety Plan (SHSP). The FHWA requires each state to produce a SHSP as a component of the Highway Safety Improvement Program, in an effort to reduce highway fatalities and serious injuries on all public roads. States can use NHTSA data and their SHSP as a tool to identify safety issues related to freight movement. Truck parking metrics often include the number of public and private spaces available per state, the number of spaces in relation to the NHS mileage in the state, number of spaces in relation to truck VMT, and number of spaces in relation to Gross Domestic Product (GDP) by state.[80]
  - Rail—Highway-rail crashes at at-grade crossings is a key rail freight safety performance measure.[81] Highway rail at grade crossing crashes occur when a rail user and a highway user impact at a crossing site. This includes motor vehicles and other highway, roadway, and sidewalk users at both public and private crossings. Railroads operating in the United States are required to submit monthly accident reports to FRA (and the state in which the accident or incident occurred) and crash data updates are published monthly.
  - Water, Air, and Pipeline—For pipelines, waterways, and air cargo, freight safety performance measures may take the form of annual or average annual number of incidents. The PHMSA

[80] Federal Highway Administration, Freight Performance Measure Primer, October 2017.

[81] Ibid.

recommended national performance measures for pipelines that may be adapted at the statewide level.[82] These include the number of incidents, the rate of incidents per mile, the rate of excavation damage per ticket (e.g., the operator's receipt of information from a one-call center about a proposed excavation), and the rates at which leaks are eliminated.

C.4 Environmental Impacts

Single-unit and combination trucks are estimated to have accounted for just under 10 percent of annual vehicle miles traveled.[83] However, trucking is estimated to have accounted for nearly 23 percent of all greenhouse gas emissions across all transportation modes.[84] This observation implies that environmental freight performance measures are critical to mitigating the negative externalities caused by the movement of freight. While states are required by the U.S. Environmental Protection Agency (EPA) to measure air quality in order to demonstrate compliance with National Ambient Air Quality Standards, information on emissions is not typically included in SFPs. Table C.4 contains an inventory of common environmental freight performance measures.

Table C.4 Inventory of Common Environmental Freight Performance Measures

Mode	Measure
All Freight Modes	• Total tons of emissions reduced from Congestion Mitigation and Air Quality Improvement Program (CMAQ) projects for applicable criteria pollutants and precursors • Pounds of greenhouse gas emissions • Increase in energy consumed or costs related to energy consumption • Increase in air pollution impacts/costs

Sources: FHWA, Freight Performance Measure Primer, October 2017; Georgia Transportation Institute University Transportation Center, Trucking in Georgia: Freight Performance Measures, 2011; Cambridge Systematics, Inc.

Some states—Washington and New Mexico for example—included in their SFPs estimates of the magnitude of emissions from highway freight movements. Measures such as the change in emissions and/or energy consumed over a predetermined timeframe due to freight activity would be an indicator of freight environmental performance.

C.5 Economic and Freight Demand Measures

Economic and freight demand performance measures are important because they provide insight into the factors that drive shippers to consume freight services and ultimately result in the physical manifestation of that demand—freight vehicles operating on the multimodal transportation network. In addition, these

[82] PHMSA, National Pipeline Performance Measures, https://www.phmsa.dot.gov/data-and-statistics/pipeline/national-pipeline-performance-measures#:~:text=National%20Pipeline%20Performance%20Measures,on%20pipelines%20and%20pipeline%20infrastructure.&text=PHMSA%20tracks%20data%20on%20the%20frequency%20of%20failures%2C%20incidents%20and%20accidents.

[83] https://www.bts.gov/share-highway-vehicle-miles-traveled-vehicle-type.

[84] Bureau of Transportation Statistics, Freight Facts and Figures, Table 6-15, 2019, https://www.bts.gov/us-greenhouse-gas-emissions-domestic-freight-transportation. Note: Trucking accounted for approximately 429 million metric tonnes of CO2 equivalent in 2018, while the total for all domestic transportation was 1,887 million metric tonnes.

measures help state DOTs and other transportation agencies gauge the effectiveness of policies intended to shift freight demand to modes that provide for improved environmental sustainability and/or have excess capacity and thus relieving freight modes that are operating under capacity-constrained conditions. Furthermore, a state's ability to provide a reliable freight network directly impacts available jobs, delivery times for consumer goods, standard of living, and other measures of economic competitiveness. Table C.5 presents some common economic and freight demand performance measures.

Table C.5 Inventory of Common Economic and Freight Demand Performance Measures

Mode	Measure
All Freight Modes	• Tonnage of freight by mode. • Value of freight by mode. • Average or total vehicle operating costs. • Indirect economic impact of an investment (e.g., changes in personal income, employment, property value, etc.) resulting from a transportation investment. • Benefit-cost ratio—direct economic impact of an investment (e.g., travel time savings, reduced vehicle operating costs, emissions reduction, etc.) resulting from a transportation investment.

Sources: FHWA, Freight Performance Measure Primer, October 2017; Georgia Transportation Institute University Transportation Center, Trucking in Georgia: Freight Performance Measures, 2011; Cambridge Systematics, Inc.

As shown in Table C.5, economic and freight demand measures may examine the share of goods moved (by weight or value) among all freight modes. They may also examine the economic impacts of freight such as share of gross domestic product or changes to personal income. Types of analytical tools that can be used to derive economic freight performance measures include:[85]

- **Transportation Impact Assessment:**
  - Benefit-Cost Analysis—Future benefits and hazards associated with a project are determined and compared to estimated costs.
  - Economic Impact Assessments—Examines the effects of a new project or development on surrounding communities.
  - Analyses focused on estimating the impact of transportation on industry productivity and competitiveness.

C.6 Inventory of Freight Performance Data Sources

Table C.6 presents an inventory of freight performance data sources and the measures they support. It may be used a resource for identifying the information needed to implement the freight investment performance monitoring framework.

[85] FHWA, Measuring the Impacts of Freight Transportation Improvements on the Economy and Competitiveness.

Table C.6 Inventory of Freight Performance Data Sources

Data Source	Data Description	Freight Performance Measures Supported
Highway		
Highway Performance Monitoring System (HPMS)	Provides the analysis of highway system condition, performance, and investment needs that make up the biennial Condition and Performance Reports to Congress.	• Network Supply, Utilization, and Infrastructure Conditions: – Miles or lane-miles of highway by functional classification. – Miles or lane-miles of designated truck routes. – Pavement conditions (i.e., international roughness index). – Annual or average annual daily truck traffic. – Annual or average annual daily truck miles traveled. • Safety: – Truck crash rate (per mile or miles-traveled). – Total cost of freight loss and damage from accidents/Vehicle Miles Traveled (VMT).
Road Network Linear Reference Data	State DOTs maintain linear referenced roadway data such as number of lanes, pavement conditions, AADT, and other data that support freight performance management.	• Network Supply, Utilization, and Infrastructure Conditions: – Miles or lane-miles of highway by functional classification. – Miles or lane-miles of designated truck routes. – Pavement conditions (i.e., international roughness index). – Annual or average annual daily truck traffic. – Annual or average annual daily truck miles traveled. • Safety: – Truck crash rate (per mile or miles-traveled). – Total cost of freight loss and damage from accidents/Vehicle Miles Traveled (VMT).
National Performance Management Research Data Set (NPMRDS)	Provides average travel times measured in 5-minute increments.	• Travel Time and Congestion: – Percent of interstate providing reliable travel times. – Percent of interstate where peak hour travel times meet expectations. – Percent of non-interstate NHS providing reliable travel time. – Percent of non-interstate NHS where peak hour travel times meet expectations. – Annual hours of excessive delay per capita. – Average hours of delay per day for freight vehicles on freight-significant links. – Travel Time Index (TTI) on freight-significant links (ratio of the peak travel time to free-flow travel time). – Percent of interstate mileage providing for reliable truck travel times.

Data Source	Data Description	Freight Performance Measures Supported
		– Percent of interstate mileage that is uncongested. – Buffer Time Index on freight-significant links (95th percentile travel time - average travel time/average travel time). – Planning Time Index on freight-significant links (ratio of the 95th percentile travel time to average travel time or free flow travel time). – Mean travel time. – Truck Travel Time Reliability Index.
Truck GPS and Travel Time Data	Truck GPS and travel time data are provided by a number of private vendors and include point-by-point information on the location, speed, travel time, and direction of trucks.	• Travel Time and Congestion: – Percent of interstate providing reliable travel times. – Percent of interstate where peak hour travel times meet expectations. – Percent of non-interstate NHS providing reliable travel time. – Percent of non-interstate NHS where peak hour travel times meet expectations. – Annual hours of excessive delay per capita. – Average hours of delay per day for freight vehicles on freight-significant links. – Travel Time Index (TTI) on freight-significant links (ratio of the peak travel time to free-flow travel time). – Percent of interstate mileage providing for reliable truck travel times. – Percent of interstate mileage that is uncongested. – Buffer Time Index on freight-significant links (95th percentile travel time - average travel time/average travel time). – Planning Time Index on freight-significant links (ratio of the 95th percentile travel time to average travel time or free flow travel time). – Mean travel time. – Truck Travel Time Reliability Index.
Crash Data	State DOTs maintain databases of crash data including information such as crash severity, type of vehicles involved, and crash location, among others.	• Safety: – Truck crash rate (per mile or miles-traveled). – Number of heavy truck-related fatalities. – Total cost of freight loss and damage from accidents/Vehicle Miles Traveled (VMT).
Railroad		
Surface Transportation Board Waybill Sample	Provides carload waybills for all U.S. rail traffic submitted by those rail carriers terminating 4,500 or more revenue carloads annually.	• Network Supply, Utilization, and Infrastructure Conditions: – Annual or average annual daily number of trains per segment. – Annual or average annual daily train miles traveled. – Annual or average annual daily train ton-miles.

Data Source	Data Description	Freight Performance Measures Supported
		• Travel Time and Congestion: – Railroad corridor level of service.
American Association of Railroads	Provides information on North American freight railroads including finances, operations, performance, input cost indexes, traffic, U.S. carloads, intermodal traffic, and Class 1 rail tons.	• Network Supply, Utilization, and Infrastructure Conditions: – Miles of rail by carrier class. – Miles of double-tracked rail.
National Transportation Atlas Database (NTAD)	The NTAD, published by BTS, is a set of nationwide geographic databases of transportation facilities, transportation networks, and associated infrastructure. These datasets include spatial information for transportation modal networks and intermodal terminals, as well as the related attribute information for these features.	• Network Supply, Utilization, and Infrastructure Conditions: – Miles of rail by carrier class. – Miles of double-tracked rail.
Federal Railroad Administration (FRA) Highway-Rail Crossing Database	This database contains information on the locations of rail crossings, number of trains, average train speeds, and incident history. It is maintained by the FRA Office of Safety.	• Safety: – Number of highway-rail crashes. – Number of at-grade railroad crossings along freight significant corridors such as freeways and interregional corridors.
Water		
U.S. Army Corps of Engineers Navigation Data Center	Provides data on commerce, facilities, locks, dredging, imports and exports, and accidents.	• Network Supply, Utilization, and Infrastructure Conditions: – Number of ports. – Miles of navigable inland waterways. – Annual tonnage by port. – Annual number of containers by port. – Annual number of vessel calls by port. – Average vessel capacity per call by port. – Percent of tons on river moving though locks with constraints. – Unscheduled lock closure time (hours). – Channel depths at the port divided by depths at competitive ports.
U.S. Maritime Administration Data and Reports	Provides data on fleets, agricultural trade, and safety statistics.	• Network Supply, Utilization, and Infrastructure Conditions: – Number of ports. – Annual tonnage by port. – Annual number of containers by port. – Annual number of vessel calls by port. – Average vessel capacity per call by port.
Air		
Air Cargo Summary Data	Provides a monthly freight summary, including both freight and mail carried by U.S. airlines in all service classes.	• Network Supply, Utilization, and Infrastructure Conditions: – Annual cargo revenue ton-miles. – Annual cargo revenue tons enplaned.

Data Source	Data Description	Freight Performance Measures Supported
Landing Weights	Provides information on landing weights for cargo bearing airports throughout the U.S.	• Network Supply, Utilization, and Infrastructure Conditions: – Annual landed weight of all-cargo operations by airport.
Pipeline		
Oil Pipeline Statistics	Provides statistics on crude oil, gasoline, diesel, propane, jet fuel, ethanol, and other liquid fuels, including petroleum prices, crude reserves, and production, refining and processing, imports/exports, stocks, and consumption/sales.	• Network Supply, Utilization, and Infrastructure Conditions: – Volumes of crude oil and refined petroleum products.
Pipeline and Hazardous Materials Safety Administration Data and Statistics	Provides data about federally regulated and state-regulated natural gas pipelines, hazardous liquid pipelines, and liquefied natural gas plants.	• Network Supply, Utilization, and Infrastructure Conditions: – Average age of pipelines. • Safety: – Annual pipeline incidents including severity.
Energy Information Administration GIS Data	Provides GIS data on the locations and types of pipelines as well as the locations of crude oil rail terminals.	• Network Supply, Utilization, and Infrastructure Conditions: – Locations and types of pipelines.
Air Freight Modes		
Commodity Flow Survey (CFS)	Provides national and state-level data on domestic freight shipments.	• Economic and Freight Demand: – Tonnage of freight by mode. – Value of freight by mode.
Freight Analysis Framework (FAF)	Integrates data from a variety of sources to create a comprehensive picture of freight movement among states and major metropolitan areas by all modes of transportation.	• Economic and Freight Demand: – Tonnage of freight by mode. – Ton-miles by mode. – Value of freight by mode.

Source: Cambridge Systematics, Inc.