Project Briefs for

SHRP 2 Capacity Research

Collaborative Decision Making

Economic Impact Analysis

Integrating Conservation, Highway Planning, and Environmental Review

Freight Demand, and Dynamic Integrated Models and Networks

TRB

Capacity Project Brief

Reaching Decisions that Deliver Capacity

Elected officials and the public are demanding that highway projects be delivered both faster and in a more environmentally friendly manner. If we are going to meet both expectations, our profession will need to change the way we develop projects. The SHRP 2 Capacity Program is developing a collaborative decision-making process that is based on sound research and will serve as the new way of doing business in highway project development in the twenty-first century.

Neil Pedersen
Administrator, Maryland State Highway Administration
Cochair, SHRP 2 Capacity Technical Coordinating Committee

Over the next four decades, the U.S. population is expected to grow by 40 percent to 420 million in 2050 (*1*). Between 1985 and 2005, vehicle miles traveled increased 80 percent but lane miles increased only 4 percent (*1*), thus consuming much of the highway capacity built during the Interstate construction period. It is estimated that an 80 percent expansion—an additional 173,000 Interstate lane-miles—will be needed to meet the demand for car and freight travel to the middle of the century (*2*). In addition, the population is not expected to grow evenly, but to cluster in megaregions, with 60 percent of the growth in six southern and western states (*1*). The demands on highway capacity in these states will be particularly great.

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Even though much of the projected expansion of highways involves only widenings and upgrades, the public demands that we get the most out of our existing highways through better operations management before they

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will consider supporting expansion. There is also an expectation to do more than just mitigate impacts. Transportation agencies are expected to be stewards of the environment with respect to natural habitats, wetlands, air quality, and greenhouse gas emissions. The agencies are also expected to serve as stewards of the community, delivering transportation capacity that people want. Because many interests are represented, finding the most appropriate solutions only gets harder. The price for failure to work together is endless redo loops in the planning and design process, lawsuits, delays, and cost escalation.

With all this in mind, Congress's charge to the SHRP 2 Capacity program is to:

> Develop approaches and tools for **systematically** integrating environmental, economic, and community requirements into the analysis, planning, and design of new highway capacity. (*emphasis added*)

Many of the strategies involved are familiar: consultation, ecological approaches to mitigation, practical or context-sensitive design, broad-based performance measurement, environmental justice, integrated corridor management, right-sizing, integrating planning and the requirements of National Environmental Policy Act, commitment tracking, and others. "Systematically" is emphasized because these strategies are not yet woven into the planning and programming processes.

How do we translate the most successful of these practices into business as usual? How can 50 states and more than 350 metropolitan planning organizations, at least six federal agencies and their many districts, and hundreds of state environmental organizations do this efficiently and repeatedly? And should they? What is the business case for this approach from all perspectives? SHRP 2 Capacity research is delivering the answers to these questions.

The Case for Change

Transportation agencies today are charged with quicker delivery of the right transportation solutions. To speed project delivery and have the flexibility to consider nontraditional solutions, the entire organization needs a systematic approach to collaboration, ensuring that the right people are engaged at the right time with the right information. The Collaborative Decision-Making Framework provides this systematic approach. It is delivered as a web-based resource that can be used as a troubleshooting guide or a road map to changing a business process.

Will a transportation agency be better off if these strategies are adopted? The case studies on which the Framework is based suggest yes. As a next step state departments of transportation, metropolitan planning organizations, and their partners will be asked to pilot test the first release of the Framework to answer that question. SHRP 2 will issue a request for proposals in March 2010 for interested agencies partnered with consultants or universities.

The Collaborative Decision-Making Framework

The Framework is an integrated web-based resource designed primarily for practitioners. It identifies key decision points in four phases of transportation decision making: long-range transportation planning, corridor planning, programming, and environmental review and permitting. Key decisions are those that require review and approval from higher levels of authority or a consensus among diverse decision makers before the project can advance. Occurring most often at the policy level, they effectively link the many steps of planning and project development. Many key decision points are common to most transportation agencies. Some are defined by law; others follow established practice.

The Framework offers detailed information for each key decision point, such as the following:

- The resulting outcomes;
- The decisions;
- Roles and responsibilities of the formal decision makers;
- Stakeholders or project-champion roles and relationships;
- Supporting data, tools, and technology;
- Planning processes other than transportation;
- Primary products; and
- Associated case studies of effective practices.

An Executive Guide to Collaborative Decision Making will be a companion resource, indicating when senior transportation and environmental officials need to be personally involved and providing successful examples.

The Basis for Decisions that Stick

The products and outcomes of other SHRP 2 research will be integrated into the Framework or will otherwise be made available to strengthen the basis for decisions about when, where, and how much capacity is needed; what the economic impacts will be; and how to build capacity in ways that enhance communities and the environment. Those products include the following:

- A customizable performance measurement framework with links to key decision points; case studies of expedited decision making;
- Guides for integrating into transportation planning and programming: freight demand, greenhouse gas emissions, land use issues, travel time reliability performance measures;
- Tools for estimating the economic impact of new capacity; for implementing an ecosystem approach to environmental review and permitting; for determining driver responses to congestion and pricing; for analyzing the effect of operations, technology, and design on highway capacity;

- Strategies for linking community vision to transportation decision making; for minimizing disruption by managing construction at corridor and network levels; and for improving freight demand models and data; and
- Major advances in travel demand modeling that will be sensitive to policies such as pricing, telecommuting, time and route choices, and mode selection.

These research outcomes collectively map a route to decisions that deliver highway capacity.

What's Ahead

A prototype version of the Framework will be demonstrated at conferences in the fall of 2009. At the 2010 TRB Annual Meeting, a workshop will provide opportunity for researchers to collect feedback from participants who test the prototype. A web seminar is planned for February 2010. It will provide information useful to transportation agencies that may propose in March to participate in the pilot tests. The funded ($1.25 M) pilot tests will likely begin in the fall of 2010 and end in 2012, at which point the participants will assess whether they are better off for having used the strategies and practices included in the Framework. Following the tests, the Framework will be revised to respond to the pilot test findings, and steps for implementing the revised version will be formulated.

References

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A SHRP 2 Capacity Project Brief

Transportation for Communities

Advancing Projects through Partnerships

OCTOBER 2013

Because many interests with diverse points of view and goals are represented in the process of planning and delivering highway capacity, finding the most appropriate solutions is inherently difficult. Transportation for Communities—Advancing Projects through Partnerships, or TCAPP, is a web-based resource for planning, programming, and developing highway capacity enhancement projects that may range from operational improvements to widening to new construction.[1] Available at www.transportationforcommunities.com, TCAPP provides a systematic approach for bringing multiple partners and stakeholders to the table to integrate environmental, economic, freight, financial, smart growth, operational, and community concerns. Systematic collaboration can facilitate the planning of capacity enhancement projects, pleasing stakeholders and accelerating the planning process. But failure to address the needs of key stakeholders can result in redo loops, delays, lawsuits, cost escalations, public opposition, and even project derailment.

TCAPP is meant to be used by transportation practitioners, environmental resource specialists, and stakeholders to improve how they lead, participate in, and inform transportation decision making. At its core, TCAPP offers a basic decision support system for planning, programming, and project development activities by providing information that practitioners need. TCAPP clarifies the decision-making process, which can be quite complex, by identifying data and tools to support all the key decisions. It can be used as a trouble-shooting guide or as a roadmap to a changing process.

TCAPP provides knowledge and tools to support collaboration among all partners, including resource agencies and transportation agencies. It was built by practitioners, for practitioners. TCAPP describes key decisions in the transportation decision-making process and the information needed to support collaboration.

TCAPP was initially built as part of SHRP 2 Project C01 in A Framework for Collaborative Decision Making on Additions to Highway Capacity. Over time the results of several other SHRP 2 projects were incorporated into TCAPP, and it was additionally refined based on the results of pilot tests.

Case Studies

TCAPP is built around data collected from 23 case studies of innovative and collaborative practice in several different types of projects, which range from a simple bridge reconstruction to a full corridor-wide planning program. Created in SHRP 2 Project C01, these case studies examine real-world practices, pitfalls, and lessons learned from notable success stories of delivering highway

[1] The name TCAPP will change once revisions to the beta version of the web tool have been made by FHWA and an updated version is rolled out in 2014.

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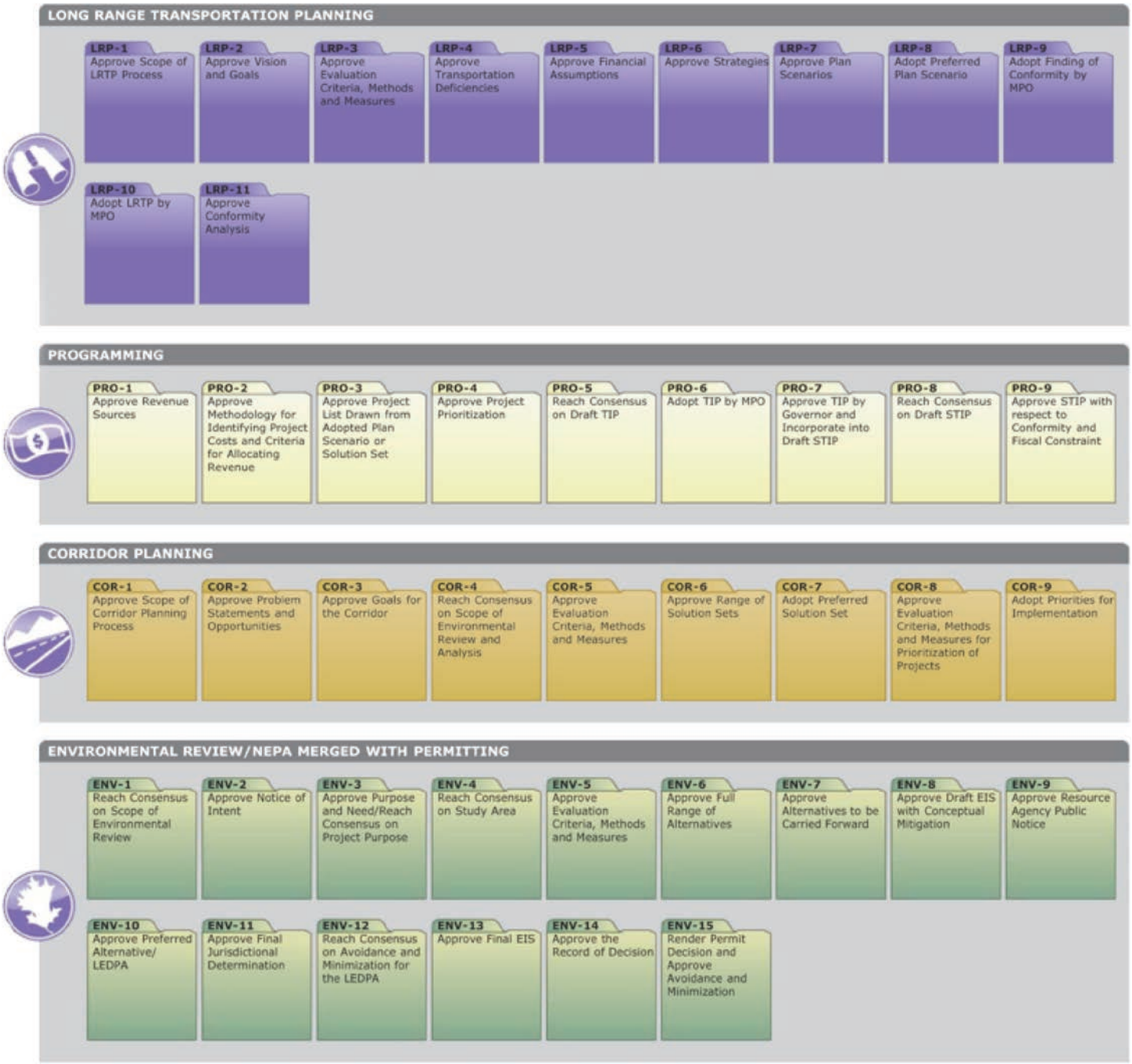
capacity projects. The case studies from C01 are available in the library section of TCAPP, along with case studies from other relevant SHRP 2 research projects. Data from the case studies were used along with a series of facilitated workshops with transportation professionals from the Federal Highway Administration (FHWA), state transportation agencies, metropolitan planning organizations (MPOs), resource agencies, and stakeholder representatives to create the Decision Guide—the underlying framework of TCAPP.

The Decision Guide

The Decision Guide is the foundation of TCAPP. It represents the key decisions in the transportation planning, programming, and project-development process and the data required to support collaboration. Key decisions are those that need consensus among decision makers, need approval from a higher level of authority, or are required by law or regulation. The Decision Guide can help transpor-

The Decision Guide 44 Key Decisions that Span the Four Phases of Transportation Decision Making



tation planners and resource specialists understand what information is needed at each key decision, how that information is used, and how the decisions can have an impact. TCAPP identifies and describes the roles of all participants and stakeholders at each key decision. The guide consists of 44 key decision points that span the four phases of transportation decision making: long-range planning, corridor planning, programming, and environmental review and permitting. The Decision Guide is a description of current practice, which was developed through five, week-long workshops and subsequently reviewed by SHRP 2's Capacity Technical Coordinating Committee.

The Decision Guide organizes key decision details in file folders. Clicking on one of these folders reveals the key decision details. These details provide the pertinent information at each key decision, and they are based on known successful practices. The Decision Guide can be used to compare the specifics of an agency's existing process to this information in order to see what could be changed to enhance collaboration.

Stakeholder Portal

Even though they are not formal decision makers, stakeholders have a large role in transportation decision making—they can propel a project forward or stop it dead in its tracks. The Stakeholder Portal provides access to all of the information available on TCAPP about collaborating with stakeholders. TCAPP defines a stakeholder as a person or group that may be affected by a transportation plan, program, or project. Stakeholders can include government agencies that are not decision-making partners, formal advocacy groups, and informal groups that come together during transportation decision making. The stakeholder portal includes a stakeholder collaboration assessment, which reflects how an agency addresses the viewpoints of those who do not have decision-making authority, but have an interest in the outcome; and a stakeholder collaboration application, which focuses on how transportation key decisions are informed by stakeholder collaboration and why it is important. The features of the stakeholder portal are useful for both transportation practitioners hoping to improve stakeholder collaboration and for stakeholders who want to increase their understanding of transportation decision making and improve their ability to communicate effectively.

Partner Portal

Partners are agencies that must agree to key decisions in order for a project to move forward. Each partner has a set of specific interests that guides their involvement in transportation decision making—some are shared by all partners, while others relate to the agency's specific mission and authority. In order to collaborate, it is essential that each agency understand what other partners care about. Because each partner has the power to block the transportation decision-making process, partner collaboration is essential to making decisions that stick. The Partner Portal provides information that can help partners understand when it is most important for them to engage in the transportation decision-making process and the types of information they should provide. The Decision Guide is based on the collaboration of the primary partners in transportation decision making—FHWA, state transportation agencies, MPOs, and resource agencies. It offers a unique perspective by demonstrating that each partner is engaged at almost every key decision, but that the exact role for each partner changes from key decision to key decision.

Assessments

In general, assessments are meant to help overcome existing problems in transportation decision making or to guide the design of an approach to transportation decision making that will avoid problems. Assessments can help users identify barriers to successful project and plan development, and find strategies for overcoming those barriers. TCAPP offers three assessments: Partner Collaboration, Stakeholder Collaboration, and Expediting Project Delivery. These assessments help prioritize weak areas and offer strategies to improve the process or overcome a barrier.

Transportation plans and projects are at risk when collaboration is missing or ineffective. The Partner Collaboration Assessment is intended to pinpoint where process or team dynamics are not supportive of collaboration among key decision makers.

The Stakeholder Collaboration Assessment reflects the viewpoints of those who do not have decision-making authority, but clearly have an interest in the outcome. It is useful for transportation practitioners who hope to improve stakeholder collaboration or as a self-assessment by stakeholders who want to increase their understanding and improve their ability to communicate effectively.

Projects can be delayed or expedited in every phase of project delivery. The Expediting Project Delivery Assessment helps to streamline project delivery by identifying constraints to expediting project delivery and providing mitigation strategies for those constraints. This assessment can help transportation agencies conduct an efficient planning and project delivery process without sacrificing broad-based support for the outcome, and it is applicable to all phases of transportation planning. This tool is based on the results of *Expedited Planning and Environmental Review of Highway Projects* (SHRP 2 Project C19). The objective of

this project was to identify, describe, and evaluate effective tools and techniques for expending the delivery of transportation projects.

Applications

Applications can be used to show how certain concerns and interests relate to specific key decisions. Applications indicate what steps need to be taken at key decisions to achieve a desired outcome. TCAPP organizes the applications into three categories:

- Phase applications, which can be used by all partners and stakeholders of transportation decision making for better understanding of the process and the key decisions.
- Special topics applications, which are most relevant to transportation practitioners who are leading or carrying out the decision-making process. Users turn to these applications for help incorporating a specific strategy or approach in the decision-making process.
- Integrated planning applications, which can be used by transportation practitioners who are leading or carrying out the decision-making process to identify what information is needed from technical processes to inform each key decision. These applications can also be used by resource specialists and stakeholders to understand when and how their process informs transportation decisions.

Phase Applications

TCAPP has four phase applications: Long-Range Transportation Planning, Integrated Programming and Fiscal Constraint, Corridor Planning Studies, and Environmental Review Merged with Permitting.

The Long-Range Transportation Planning Application can assist transportation planners by identifying how to increase collaboration at specific key decisions, as well as when and how to use long-range planning information as the starting point for corridor planning or environmental review.

Programming is the process through which a transportation improvement plan is funded and included in a transportation improvement program. The Integrated Programming and Fiscal Constraint application links fiscal constraint with project programming, which can result in the sharing and coordinating of information and decisions.

Corridor planning studies the concepts and solutions for individual corridors or small areas within a region, which helps lead to the selection of a preferred concept. The Corridor Planning Studies application can be used in urban or rural areas, and may precede the programming process.

The environmental review merged with permitting phase represents the regulatory process that encompasses the actions required under the National Environmental Policy Act (NEPA), the Clean Water Act, the Endangered Species Act, and other various federal regulations. The TCAPP phase application for this process provides information on the ways that collaboration can be incorporated at specific points or key decisions within the environmental review process, including links to relevant case studies and links between these decisions and those in the other three phases of transportation decision making.

Performance Measures Application

Performance measures are a valuable tool for building consistency, transparency, and accountability into the transportation decision-making process. Performance measures can be used within a decision-making process as evaluation criteria. After completion of a plan or process, performance measures provide a way to monitor the effectiveness of implementing solutions. This application in TCAPP can assist decision makers in determining how and when to use performance measures, and to provide guidance on the types of measures that could be used. Several key decisions are directly related to the selection of appropriate performance measures. Performance measures can also be used as an analysis tool that informs the decision-making process at several points.

The content for the performance measures application came from two SHRP 2 projects: A Systems-Based Performance Measurement Framework for Highway Capacity Decision Making (Project C02) and Incorporating Reliability Performance Measures into the Transportation Planning and Programming Processes (Project L05). Project C02 identified 17 performance factors under 5 broad areas of performance: transportation, environment, economics, community, and cost. This project also developed the Performance Measurement Framework for Highway Capacity Decision Making, which is accessible through TCAPP. Project L05 developed guidance for transportation agencies to incorporate travel time reliability into the transportation planning and programming processes. TCAPP shows how reliability performance measures relate to three of the four decision-making phases—long-range planning, corridor planning, and environmental review.

Visioning and Transportation

Visioning is a planning and policy exercise that engages community stakeholders to create a consensus about the future of their community. Visions describe the desired

futures of communities and outline clear strategies for reaching those futures, based on present conditions and anticipated future trends. *Linking Community Visioning and Highway Capacity Planning* (Project C08) developed T-VIZ, a visioning activity framework that provides guidance for how transportation practitioners can participate in broad-based community visioning. This product, which is accessible through TCAPP, can be used with TCAPP to help practitioners engage in visioning to support transportation planning. T-VIZ identifies the visioning elements that are applicable to transportation, and TCAPP links these elements to specific key decisions during the four phases of transportation decision making.

Public-Private Partnerships

Public-private partnerships (P3s) are contractual agreements between public agencies and private entities that allow for greater private-sector responsibility in the design, delivery, financing, operation, and maintenance of transportation improvements than traditional design-bid-build procurements. P3 options range from design-build procurements—where design and construction services are bundled in a single, fixed-price agreement—to concessions—where a private investor or operator is responsible for financing, designing, constructing, operating, and maintaining new highway projects in exchange for the right to collect toll proceeds or to receive period availability payments for the duration of the concession period.

The Effect of Public-Private Partnerships and Non-Traditional Procurement Processes on Highway Planning, Environmental Review, and Collaborative Decision Making (SHRP 2 Project C12) studied P3s to determine when and how P3 procurements can best be considered during the transportation decision-making process. The Public-Private Partnerships application in TCAPP used the results of Project C12 to provide three areas of information that can support the application of P3s: 1) Partnership Options, which describes options for involving P3s before, during, and after the NEPA process; 2) P3s and the Decision Guide, which identifies which key decisions can support the integration of P3s; and 3) Innovative Financing, which describes how financial resources made available by P3s may free up traditional funding to be applied to other projects.

Streamlining a Bottleneck Project

When decision-making partners support the need for an improvement project and have the right data analysis to advance this need, project streamlining can occur. Bottleneck improvements address a confined problem area where the existing design or operation of a road or bridge limits traffic flow, resulting in congestion. The Streamlining a Bottleneck Project application, which is based in part on the results of SHRP 2 Project C19, can help avoid the problems that may arise when trying to streamline a bottleneck. It can be used to highlight the key decisions in long-range planning, environmental review, and programming where communication between plan and project teams should be initiated and consistency checks should be made. This application can help move a bottleneck project from the very early steps of long-range planning directly into environmental review.

Linking MPO Planning and NEPA

Linking MPO planning with the NEPA process allows projects to advance quickly by building on existing decisions and taking advantage of prior work, which reduces redundancy in decision making. When NEPA practitioners and planners collaborate to successfully integrate the products from long-range planning into the consideration of project alternatives, project development is more efficient, programming is more realistic, and early protection of the environment is possible. This application identifies the data, analysis, and decisions that transfer between the process, as well as the individual key decisions that they support.

Stakeholder Collaboration

When stakeholders are not involved in collaborative transportation decision making, there is an increased risk that the best decisions will not be made and, ultimately, the improvements will be slowed or stopped. Conversely, transportation decisions often exhibit breakthroughs when decision makers engage collaboratively with those outside the process who are interested in and affected by the outcome. The Stakeholder Collaboration application identifies the points in the decision-making process where there should be a flow of information between decision makers and stakeholders. It also identifies questions that decision makers should ask to gather information from stakeholders and questions to incorporate their interests.

Capital Improvements

Capital improvement planning identifies and prioritizes investments for local infrastructure—including utilities, sidewalks and bike ways, schools, transit capital, and locally funded roads. The primary benefit of integrating capital improvement plans with transportation decision making is the sharing of information between the two processes. This information sharing occurs at multiple key decisions in long-range planning, corridor planning, and environmental review. The Capital Improvement application provides detailed information on the individual key decisions at which these processes are integrated.

Safety and Security

Safety and security are high priorities for all transportation agencies. TCAPP shows how these concerns can be integrated into all phases of transportation decision making. Explicitly integrating these considerations as early as long-range planning ensures that safety and security are built into the foundation of every project.

Human Environment

The human environment encompasses the issues of community characteristics, values, and vision. Integrating human environment data and information with transportation decision making helps ensure local support for plans and projects, and it can facilitate the sharing of information between these two processes. TCAPP shows how this information sharing can occur at specific key decision points.

Economic Impacts

Collaborating with economic development stakeholders can align transportation decision making and economic development efforts, which maximize investments in both. The Economic Development application can help transportation practitioners understand when and how to consider the economic development impacts of transportation choices.

TCAPP also provides a link to a web tool known as Transportation Project Impact Case Studies, or T-PICS, which uses pre-project and post-project data to show how economic and land-development conditions changed during the interval. Viewed in terms of the transportation planning process, T-PICS supports the initial screening of proposals and development of conceptual plans. T-PICs and the Economic Development application in TCAPP are both based on the results of *Interactions between Transportation Capacity, Economic Systems, and Land Use* (SHRP 2 Project C03).

Natural Environment and the Integrated Ecological Framework

Ecosystem and watershed restoration and species recovery needs are expanding as a more holistic view of the Endangered Species Act is taking hold. Stakeholders expect more from government agencies in terms of avoiding impacts to ecosystems and using transportation projects as a way to support ecosystem recovery. Furthermore, environmental mitigation comes at a real cost to transportation agencies: The Environmental Law Institute estimates that $2.9 billion is spent annually on compensatory wetlands mitigation alone.

To help transportation agencies with environmental mitigation, the SHRP 2 C06 projects—An *Ecological Approach to Integrating Conservation and Highway Planning, Volumes 1 and 2* developed the Integrated Ecological Framework, or IEF, a nine-step process designed to bring about efficient, integrated consultation on natural resources to inform transportation and mitigation decisions. The companion *Guide to the Integrated Ecological Framework* supports transportation planners and resource specialists in the use of a standardized, science-based approach to the identification of ecological priorities and their integration into transportation decision making.

The IEF responds to two critical needs:

1. Identifying potential impacts to regulated resources very early in the planning process so that they can be avoided or minimized
2. Assuring that any mitigation that must occur will provide effective, measureable, and high quality environmental outcomes

TCAPP links the technical process of the IEF with key decisions in the Decision Guide. The IEF is intended to be scalable to the time, resources, data, and expertise available. Ideally, the IEF process is conducted in conjunction with long-range planning; however, it can be used during any of the four phases of transportation decision making.

Greenhouse Gas Emissions

Transportation is one of the leading contributors to greenhouse gas (GHG) emissions, contributing 28% of the United States' GHG emissions. Concerns about climate change and its impacts have led many public agencies, including transportation agencies, to consider ways to reduce these emissions. System strategies, which can be implemented during the transportation decision-making process, have the potential to reduce all transportation GHG emissions by 5–20%. The GHG application in TCAPP provides three types of information to help practitioners reduce GHG emissions; it describes a series of steps involving data collection and analysis of the implications of transportation choices on GHG; it shows which key decisions can support the reduction of GHG emissions; and it describes examples from practice that address GHG emissions. This application was based on the results of *Incorporating Greenhouse Gas Emissions into the Collaborative Decision-Making Process* (SHRP 2 Project C09).

Air-Quality Conformity

Transportation improvement projects in air-quality nonattainment or maintenance areas must undergo a rigorous analytical process to demonstrate that they do not negatively impact air quality. Decisions made by agencies

responsible for air-quality planning have direct effects on the transportation planning process; it requires transportation agencies to be responsible for ensuring that air-quality plans reflect community priorities and transportation plans. This TCAPP application provides detailed information for integrating air-quality planning with transportation planning at the key decision points.

Land Use and Smart Growth

Land use and transportation directly impact one another. The location and density of development affects travel demand, and the number and location of access points influences land-development patterns and growth. The need for additional transportation capacity depends strongly on anticipated changes in land use patterns that result in increased demand. This application can be used to facilitate collaboration between land use stakeholders and transportation decision makers to integrate land use planning and transportation decision making. It was based on the results of The Effect of Smart Growth Policies on Travel Demand (SHRP 2 Project C16), which examined the underlying relationships between households, firms, and travel demand.

Freight

Efficient freight movement is essential to the economic competitiveness and vitality of communities and regions. Freight operations also have a significant impact on air quality, land use, sustainability, and environmental conditions. The Freight application can help practitioners understand how freight providers will use the transportation system to ensure that reasonable future scenarios, sound investment decisions, and public safety will be considered. Effective freight planning requires multijurisdictional and multiagency collaboration across local and state boundaries. This application provides resources to help transportation practitioners better engage the freight industry and incorporate freight considerations at specific key decisions. The application was based on the results of Integrating Freight Considerations into Collaborative Decision Making for Additions to Highway Capacity (SHRP 2 Project C15), which explored how freight transport movements are considered in highway capacity planning and project development.

Library

The TCAPP library includes many resources on collaborative decision making. It includes case studies, SHRP 2 reports, and reference links, to find detailed information about each of the topics that TCAPP covers. The TCAPP Quick Start Guide, which is available on the reports page, provides a brief overview of each of the features of TCAPP.

Pilot Tests

SHRP 2 ran two sets of pilot tests to test the premises of TCAPP and the IEF. The C18 series of pilots tested TCAPP in four scenarios in the Washington State Department of Transportation (DOT), Puget Sound Regional Council, Minnesota DOT, and the Pikes Peak Area Council of Governments (Colorado). The main objective of the C18 series was to test TCAPP while it was still under development and to use feedback obtained from the pilots to modify the product and enhance its usefulness to practitioners. The C18 pilots concluded that TCAPP was helpful in supporting collaborative decision making and at getting to decisions that stick. The C21 series of pilots (Pilot Test the C06 A&B Approaches to Environmental Protection) tested the IEF, which is in the TCAPP tool, in Colorado, Oregon, California, and West Virginia; each of these pilots tested specific steps of the nine-step IEF process. The C21 pilots found that the IEF is a useful process for guiding agencies through a multiagency ecology-oriented endeavor in a state or region, and the diverse scope of the four pilots indicate the IEF's range across a variety of applications. Pilot Tests to Improve TCAPP (SHRP 2 Project C39A) is under way with additional pilot tests by the South Carolina DOT, the Policy Consensus Initiative with Oregon DOT, The Thomas Jefferson Planning District Commission (Charlottesville, Virginia) and Metro Regional Government (Portland, Oregon).

TCAPP Pilot Tests

In the C18A pilot, TCAPP was pilot tested in Washington State DOT's (WSDOT) I-5/SR 509 Corridor Completion and Freight Improvement Project. WSDOT used TCAPP to work collaboratively with stakeholders to successfully define Phase 1 of the project. The resulting design reduced the initial project implementation costs by approximately $400 million while preserving most of the project benefits.

In the C18B pilot, the Puget Sound Regional Council (PSRC) evaluated the ability of TCAPP to update the project prioritization criteria in PSRC's Transportation 2040 Update, the update to their long-range transportation plan. This pilot resulted in several suggested revisions to TCAPP.

The City of Grand Rapids, Minnesota; Itasca County; Minnesota DOT; and FHWA used TCAPP to develop a Complete Streets plan for the City of Grand Rapids in the C18C pilot test. TCAPP was used to provide guidance on effective collaboration beyond traditional highway improvements, including multimodal options, additional enhance-

ment features, and other innovative solutions for the Complete Streets plan.

In the C18D pilot, the Pikes Peak Area Council of Governments (PPACG) tested the applicability of the TCAPP process during their 2013 long-range transportation planning update. This project resulted in both specific recommendations about the use of TCAPP and overall recommendations about the use of the guidance and methods that are embodied in TCAPP.

IEF Pilot Tests

In the C21A pilot, Colorado DOT, Colorado State University, and numerous partners tested steps two through six of the IEF in the South Park area of Colorado. The project team for this pilot was able to bring conservation stakeholders and data together to generate a comprehensive vision for development, conservation, restoration, and mitigation; and the IEF promoted a more accurate assessment of the cumulative impacts by including a spatially explicit analysis using data not included in the original assessment.

In the C21B pilot, the IEF process was used to identify priority natural resource areas, to avoid impacts, and to select mitigation improvements for a section of US 20 between Pioneer Mountain and Eddyville in Oregon. It also compared the IEF with the process used by the Rogue Valley Council of Governments. The IEF recommended mitigation in larger priority wetland areas in the watershed that would provide opportunities to enhance salmon habitats.

The IEF was applied to a corridor planning study of Highway 37 in the San Francisco Bay Area in the C21C pilot. The lessons learned from this project included specific issues related to TCAPP and the IEF, as well as larger issues associated with combining transportation planning and environmental stewardship.

In the C21D pilot, the West Virginia Department of Highways (WVDOH) and West Virginia University (WVU) applied the IEF to two highways under construction in southern West Virginia—the Coalfields Expressway and King Coal Highway. The research team combined the IEF with other tools to create a framework specific to West Virginia for evaluating highway impacts on streams, wetlands, and terrestrial landscape integrity.

Implementation

At the request of the American Association of State Highway and Transportation Officials (AASHTO), SHRP 2 partnered with FHWA and AASHTO for a series of TCAPP reviews in 2013. Workshops were conducted in each of the four AASHTO regions to train practitioners in the use of TCAPP and to receive comments. The workshops were completed in May of 2013, and the recommendations were presented to the SHRP 2 Oversight Committee in June 2013. It was recommended that FHWA assume hosting and maintenance responsibilities for TCAPP, establish an oversight structure that includes state and MPO stakeholders, and make recommended improvements. During this process it was determined that FHWA would take delivery of the beta version of TCAPP in October 2013 and release an updated version in the summer of 2014.

In parallel with this activity, a rebranding study was conducted. Many stakeholders were presented with alternative names, logos, and color schemes through surveys and meetings. That work was completed in August 2013. FHWA will make a decision and roll out the new look in 2014.

FHWA will convene an Implementation Planning Workshop in 2014 to develop an implementation plan. Planning assistance may also be provided to states and MPOs.

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PROJECT BRIEF C02 MAY 2009

Capacity Project C02: Performance Measurement Framework for Highway Capacity Decision Making

This document summarizes the findings of SHRP 2 Capacity project C02. The final report from this project will include targeted case studies and specify data investments that can yield valuable returns. The framework being developed in this project will be made available as a web tool, which will include case studies and will be updated as additional SHRP 2 Capacity research projects are completed. The Responsible Staff Officer for this project is Steve Andrle, who can be contacted at sandrle@nas.edu.

Transportation agencies have used performance measures since the 1950s, but most of the advancements in performance measures have occurred in the last two decades. These advancements were largely fueled by demand from the public and elected officials for increased accountability in the decision-making process. The decision-making environment has become more complex as a result, and it could benefit from more structure and organization.

Currently, only a few state departments of transportation (DOTs) and metropolitan planning organizations (MPOs) have begun transitioning to a full-fledged measurement approach to decision making. However, as the budgetary pressures on transportation agencies continue to grow, it seems likely that the use of performance-based decision-making systems will increase. The performance measurement framework being developed in project C02 provides an opportunity to improve the consistency of decision making by organizing a set of performance measures that are linked to each stage of the planning and development process.

Intended Users

The primary users of the performance measurement framework would likely be transportation agencies such as DOTs and MPOs, though the framework could also be used by counties and cities, as well as by natural resource agencies and land-use permitting agencies.

Objectives

The researchers for this project focused on meeting three key objectives. The objectives are to:

1. Develop a framework to implement performance measurement in all stages of project development—from long-range planning to environmental review;
2. Systematically integrate environmental, economic, and community con-

siderations into the analysis of highway expansion; and

3. Support the collaborative decision-making framework (CDMF) that is being developed by Capacity project C01's researchers.

Research Approach and Relevant Trends

To develop the performance measurement framework, the researchers reviewed literature on performance measurement, focusing on areas such as the environment, community, and economics; interviewed transportation agencies to determine the extent to which they are using performance measures; and targeted case studies to identify performance measures and applications at various agencies. They also examined other frameworks, such as the Florida DOT's Performance Measures Framework. During the research, several trends and themes in performance measurement became evident. Some of the trends that relate to performance measures in general are listed here.

Table 1: SHRP 2 C02 Performance Factors

Transportation
Mobility Reliability Accessibility Safety
Environment
Ecosystems, Habitat, and Biodiversity Water Quality Wetlands Air Quality Climate Change Environmental Health
Economics
Economic Impact Economic Development
Community
Land Use Archeological and Cultural Resources Social and Environmental Justice
Cost
Cost Cost Effectiveness

The researchers determined that performance measures are best identified in response to goals and objectives, not the other way around. They also determined that input (e.g., time, capital, resources), output (e.g., speed, throughput, congestion), and outcomes to the community and the environment should be included.

It is the researchers' opinion that excessive and redundant measures can overwhelm the end user and obscure key drivers of service quality. In the broadest sense, performance measures should determine if a transportation project will meet the goals of the transportation agency and if the project will significantly impact the environment or any communities. It is also important to establish early warning mechanisms that can identify anything that might derail a project before significant resources are invested. These broad questions can be informed by different types of data, but to be useful to decision makers, the answers must be basic.

All of the state DOTs and MPOs interviewed during the research cited limited federal and state funding as a key constraint on prioritization efforts for capacity enhancement projects. Each interview emphasized that more funding is allocated for projects that preserve aging infrastructure than for those that add highway capacity. Capacity-adding roadway projects are typically the focus of increased scrutiny due to the great cost and physical impact of these projects. For both state DOTs and MPOs, the critical driver of implementing a performance-based system is using data-driven decision processes to support improved decision making and accountability within the organizations and, ultimately, to improve transportation system performance through better project selection.

Performance Factors

The performance measures developed in this project are organized around five broad factors, which are displayed in table 1. Some of the trends found during the research in each of these factors are noted here. The full report explains each of the factors in detail, as well as gaps in the data and possible methods of filling the gaps.

Transportation Factors

In recent years, shifts have been found in transportation performance factors. The literature has shown that the performance measurement of transportation systems has become increasingly operations-oriented. A trend to measure how customers experience the transportation system has also emerged from both the literature and feedback from practitioners. Travel time reliability has also grown in importance as just-in-time production and delivery methods increase in popularity.

Environmental Factors

According to the background literature, prior to the 1970s the environmental effects of transportation projects were investigated but not heavily weighted in decision making. This changed with the 1969 National Environmental Policy Act that advanced the state of the practice by requiring environmental review of all federal actions, including transportation improvements, but some DOTs admit that they are not as advanced in the field as they would like to be. However, DOTs are working with partners to better address environmental issues through the transportation planning and project development process. One such effort is *Ecological: An Ecosystem Approach to Developing Infrastructure Projects*, which was developed by eight federal agencies in cooperation with

four state transportation agencies.

Economic Factors

Economic trends indicate that there is an increasing demand for transportation. And according to the literature, it is important to consider the economic costs and benefits that potential transportation projects can have in order to maximize the positive outcomes. It is also important to note that determining whether a project is worth the resources that would be invested in it and how the benefits and costs would be distributed throughout the economy are two distinct but complementary analyses, and when determining the economic impacts, the decision makers should be careful to discern net economic growth from redistribution of wealth. Ideally, analyses could be conducted after a project is complete to gauge the accuracy of the predicted costs and benefits.

Community Factors

Comprehensively assessing the effects of a proposed transportation project on a community is complex. There can be many different effects and a wide range of preferences and opinions. Literature has shown that community outreach is important, because something that may not appear critical to a transportation analyst may be crucial to a community. It is also important to keep the design flexible to achieve the goals of individual communities. The Federal Highway Administration recognized the importance of flexibility by publishing its *Flexibility in Highway Design* manual in 1997 and the American Association of State Highway and Transportation Officials followed suit by publishing *A Guide for Achieving Flexibility in Highway Design* in 2004.

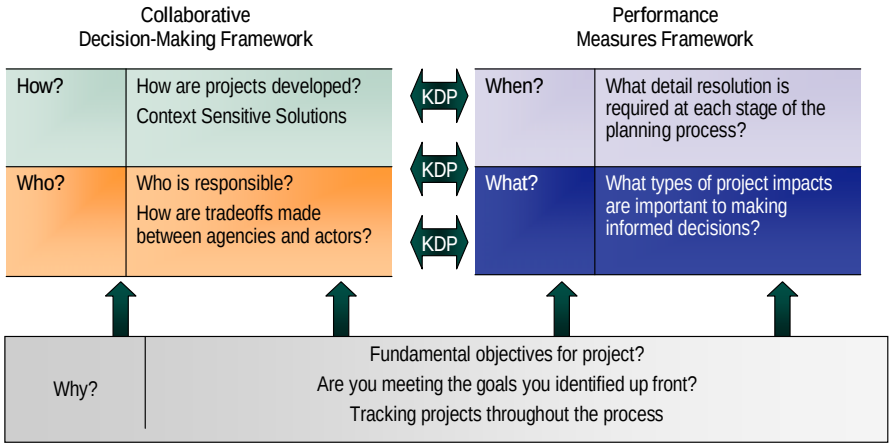
Cost Factors

It is important to consider project costs early and often. Project costs can escalate unexpectedly for a variety of reasons, some controllable and others unavoidable. It can be beneficial to monitor costs closely so that avoidable costs can be controlled and unavoidable costs can be identified early and accounted for in the budget. It is also important to consider possible opposition to a project before it occurs, because opposition to a project, regardless of its nature or merit, can significantly increase costs, including the cost of redesigning or abandoning a project after completing significant preliminary work.

The Framework

The performance measurement framework provides a variety of information that can be useful to many types of users within their organization. The primary purpose of the framework is to help practitioners find and define performance measures. It provides introductory material on a wide range of topics that can help educate all levels of transportation staff, e.g., practitioners with limited experience in ecosystem analysis can find key sources for information on the topic. It can also be used to develop a consistent evaluation process across several phases of transportation projects by providing information on how measures can be used at the various stages of planning and project development to support project identification and prioritization methodologies.

Figure 1: Relationship between Performance Measurement Framework and Collaborative Decision-Making Framework



From C02 Report: Performance Measurement Framework for Highway Capacity Decision Making

The framework being developed in project C02 will be made available as a web tool, which will include a database of the performance measures. This framework helps to support the CDMF by identifying relevant performance factors and measures to consider at the various stages of planning and project development. The CDMF being developed in project C01 identifies key decision points (KDPs), which are specific points in planning and project development that require consensus and formal approval. The relationship between the CDMF and the performance measurement framework is displayed in figure 1.

The performance measurement framework offers practitioners a way to organize how they use per-

Table 2: Example—Specific Objectives Used to Organize Performance Measures

SHRP 2 C02—Generic		Example—Specific	
Factor	Objective	Agency	Objective
Mobility	Reduce Recurring Congestion – Improve Travel Time	Arizona DOT—Long-Range Transportation Plan	Maintain and enhance the ability of goods to move through and around urban areas with minimal delay.
Air Quality Climate Change *(Environment broadly)*	Reduce greenhouse gas emissions from transportation sources	Florida DOT—Florida Transportation Plan	Make transportation decisions that conserve and optimize nonrenewable resources and promote the use of renewable resources (materials, facilities, and sources of energy) and include strategies to decrease greenhouse gases and air pollutants.
Land Use	Integration of land use and transportation planning efforts	Oregon DOT—Oregon Transportation Plan	Support the sustainable development of land with a mix of uses and a range of densities, land use intensities, and transportation options in order to increase the efficiency of the transportation system. Support travel options that allow individuals to reduce vehicle use.

formance measures so they serve as an effective decision-support tool for examining when, where, and how to add highway capacity. To offer flexibility, the performance measures can be grouped two ways: (1) according to when in the project delivery process it would be most helpful or (2) according to the factor of the project delivery process to which it would be most helpful. The phases of the decision-making process in which the framework can be used include: long-range planning, programming, corridor studies, environmental review, and design and permitting.

The specific measures of the framework are designed to be broad enough to be adapted by any agency and the measures are intended to address at least one of the following two objectives: identification and prioritization of statewide capacity needs; and support for evaluation of project-level options. An example of how agencies could adapt the specific measures to suit their needs is displayed in table 2. When measures are selected, the following characteristics should be considered: the relevance it has to the decision-making process; how it should be incorporated into the project; the agency responsible for addressing each issue at each phase; the level of detail that is appropriate to each stage and measure; and the number of measures and associated information that would support performance-based decision making the most.

The C02 research was conducted and a report was prepared by the research team led by Hugh Louch of Cambridge Systematics, Inc. The other authors of this report are Virginia Smith Reeder of Cambridge Systematics, Inc. and Joe Crossett of High Street Consulting Group. They received support from Steve Pickrell, Erik Cempel, Tracy Clymer, Randall Halvorson, and Joanne Potter of Cambridge Systematics; Anna Williams and Tim Larson of Ross & Associates; and Frances Harrison of Spy Pond Partners.

The Technical Coordinating Committee for Capacity Research in SHRP 2 oversaw the conduct of the research that is the basis for this report and reviewed its findings. The co-chairs of the committee are **Neil J. Pedersen**, Maryland State Highway Administration, and **Mary Lynn Tischer**, Virginia Department of Transportation.

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Capacity Project Brief

Operations Guide to Improving Highway Capacity

AUGUST 2012

When considering how to improve highway capacity, decision makers would benefit greatly from being able to compare the capacity gain of operational improvements to that of adding a lane. Applying enhanced models, diagnostic tools, and analytic methodology can provide a more realistic basis for such comparisons. Analysis methods can evaluate improvement strategies cutting across the full spectrum of operations, technology, and design; and they can also provide multiple performance measures that can be used to evaluate different strategies according to their impacts at the point, link, corridor, and network levels. This project developed a guide to using enhanced simulation methods that can test the impact of alternative traffic operations solutions and demonstrate whether or not they solve a problem.

Limited financial resources, high construction costs, environmental considerations, long timelines, and an increasingly complex regulatory process have rendered capacity-adding projects actions of last resort; nevertheless, the continuing growth in urban travel demand will inevitably lead to a need for more physical capacity within the transportation system. Before such projects are undertaken, decision makers, planners, and engineers typically must evaluate alternative operational improvement strategies that can—individually or in combination—eliminate, mitigate, or forestall the need for a more traditional highway construction project.

Dynamic traffic assignment (DTA) methods (simulations) are rapidly being improved and use is increasing. Ideally, such methods would be able to evaluate operations, technology, and design issues simultaneously and produce performance measures at point, link, corridor, and network levels.

SHRP 2 project C05 (Understanding the Contribution of Operations, Technology, and Design to Meeting Highway Capacity Needs) was created to advance the state of practice in this area. This project had three objectives:

1. Quantify the capacity benefits—individually and in combination—of operations, design, and technology improvements at the network level for both new and existing facilities;
2. Provide information and tools to analyze operational improvements as an alternative to traditional construction; and
3. Develop guidelines for sustained service rates to be used in planning networks for limited access highways and urban arterials.

Through these objectives, the project developed methodologies that effectively determine the capacity gain that can be expected from candidate operational improvements relative to the capacity gain that would be provided by constructing an additional lane. A better understanding of the contributions of operations, technology, and design to meet highway capacity needs will be useful in making public investment decisions; planning and evaluating alternative optional improvement strategies; evaluating highway designs; advancing research and professional training; and exploring the benefits of current and future ITS technologies.

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Enhanced Analysis Methodologies

This research project has four primary findings: (1) The capacity effect of traffic operational improvements is related to the network. A similar improvement may have different effects in different locations. (2) Capacity in both freeway and arterial situations is variable, or stochastic. Capacity should be treated as a variable related to other factors, not as a constant. For example, empirical evidence shows that freeway flow breakdowns occur across a range of volumes even at the same location. On arterials, saturation flow rates at signals are observed to vary from cycle to cycle. (3) In saturated real-world networks, spill-over blockage from left- and right-turn bays has an inordinate effect on arterial capacity. Simulation models must be sensitive to this. (4) The real-world consequence of a stochastic freeway or arterial bottleneck is that breakdown conditions vary from day to day. Combined with daily variation in travel demand, this means that real-world drivers make choices based on actual conditions they have encountered across multiple driving days. This research incorporated such a feature into the simulation model.

The primary products of this research are the recognition that the principles described above should be taken into account when estimating the effect of a traffic operational improvement and that enhanced analysis methodologies should be used to carry out such analysis.

Operational Strategies

Table 1 lists 25 operational strategies that were selected from an initial list of more than 100 as being particularly effective in enhancing the performance characteristics of links, corridors, and networks. Some of the strategies are applicable only to freeways, some are applicable only to arterials, and some are applicable in both environments.

Table 1. Non–Lane-Widening Strategies to Improve Capacity

FREEWAY	ARTERIAL	BOTH
HOV Lanes	Signal Retiming	Narrow Lanes
Ramp Metering	Signal Coordination	Reversible Lanes
Ramp Closures	Adaptive Signals	Variable Lanes
Congestion Pricing	Queue Management	Truck Only Lanes
Pricing by Distance	Raised medians	Truck Restrictions
HOT Lanes	Access Points	Pre-Trip Information
Weaving Section Improvements	Right/Left Turn Channelization	In-Vehicle Info
Frontage Road	Alt Left Turn Treatments	VMS/DMS
Interchange Modifications		

Notes: HOV = High Occupancy Vehicle; HOT = High Occupancy Toll; Alt LT = Alternate Left Turn; VMS = Variable Message Sign; DMS = Dynamic Message Sign

Because the practical use of such methods in a real-world environment depends on the ability to implement them, an important question was raised at the start of this project: "What assignment or simulation tools can be considered for this purpose?" DTA modeling tools were targeted because of their unique ability to evaluate network performance under time-varying demand and supply conditions created by various operations-based, design-based, and technology-based strategies. A wide range of network analysis tools is currently available. The research team selected Dynasmart-P and DTALite for enhancement and testing of strategies.

Network Operations Modeling Approach

The effectiveness of each operational strategy listed in Table 1 was found to vary according to the context in which it is applied. Physical factors such as network structure as well as the existence and relative proximity of freeway/arterial alternatives have an important influence on a particular strategy's effectiveness; travel desire lines and overall demand levels were also found to have a significant impact. Thus, the effectiveness of a particular operational strategy within a particular network and demand setting could not be reliably estimated from static, location-blind look-up tables. Instead, some form of a travel demand forecasting model was found to be necessary.

Because of their ability to provide a more realistic assignment of traffic in oversaturated networks, DTA models are especially useful for evaluating strategy effectiveness. They recognize that drivers have varying levels of knowledge about the travel time on each of the travel paths available to them, and they also recognize that the effects of congestion and queues can prevent drivers from reaching their destinations in a timely manner.

The capabilities of DTA models overcome some but not all of the limitations associated with more traditional models. A review was conducted of currently available DTA models and none was found to include all the modeling capabilities desired. The internal logic of one of these models (DYNASMART-P) was modified to incorporate several analytic enhancements. This new version of DYNASMART-P also served as the test engine for the validation and demonstration activities that were used during completion of the analytic enhancements.

For an example of how the new model functions, we can look at the way arterial bottlenecks are represented. The approaches to signalized intersections along arterial roadways often include left- and right-turn pockets as a way of separating turn movements and increasing capacity. But when the queue length of through and/or turning vehicles extends beyond the length of the turn pocket, the result is a blockage that prevents upstream vehicles from taking advantage of the capacity that is available at the intersection (Figure 1). This is an important phenomenon to model

in oversaturated networks because it directly affects the efficiency and productivity (or sustained service rates) of individual links and turn movements. By incorporating this phenomenon, the enhanced model developed in this project can recognize when queue lengths exceed available storage lengths at these locations and then adjust the downstream discharge rate accordingly.

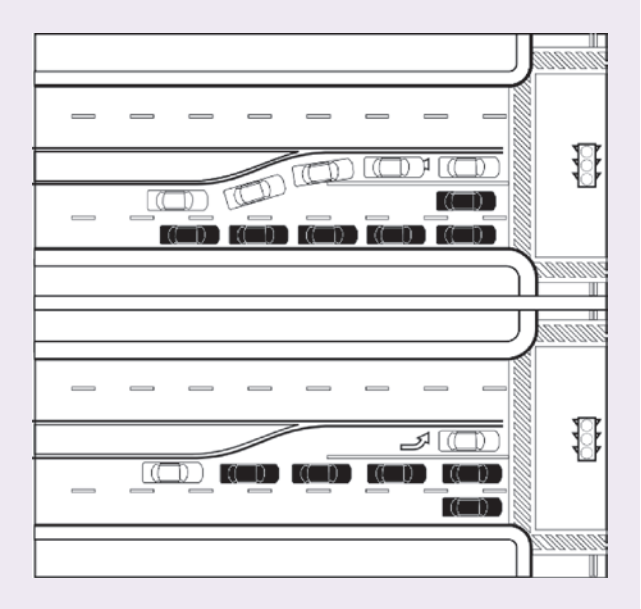
Strategic Testing

To test the enhanced models and demonstrate the usefulness and usability of the new methodology, two separate networks were used. The first network used was a small subarea of the Dallas/Fort Worth, Texas, metropolitan area; its small size produced great efficiencies in testing and debugging the enhanced DTA models, and also provided a good platform for implementing and evaluating each of the 25 operational strategies presented in Table 1. The second network was a subarea of the Portland, Oregon, metropolitan area—encompassing approximately 210 traffic analysis zones, 860 nodes, 2,000 links, and more than 200,000 vehicle trips initiated during a four-hour weekday time interval between 3 and 7 PM.

A straightforward method was developed to test the effectiveness of one or more operational strategies either as standalone projects or as alternatives to traditional new construction project(s). In the first step of this method, the location of the operational strategy and/or new construction project to be tested is identified, and a subarea or network that appropriately surrounds the location is established. Next, geometric, volume, and operational characteristics of each link within the subarea are identified and provided as inputs to the DTA model, including stochastic capacity distributions at the geometric or operational bottlenecks; and appropriate link, corridor, and/or network performance measures are established for subsequent evaluation purposes. In order to effectively use the day-to-day learning process and generate results that can be usefully compared, the DTA model has to run under three separate regimes. During the baseline stabilization period (Regime I), the DTA model is run for a period of simulated days to achieve equilibrium under the baseline scenario (that is, without any of the operational strategies or new construction projects that are to be evaluated). The number of simulated days necessary to achieve equilibrium varies according to the characteristics of the network and/or subarea being investigated. For the Dallas/Fort Worth network, the 200-day baseline stabilization period was longer than necessary. This was not a problem in the case of the Dallas/Fort Worth network because the subarea was small and the runtime for each simulated day was very short. For larger networks, a baseline stabilization period of 50 days may be more appropriate.

As an example, consider the capacity addition scenarios shown in Figure 2 that were tested for a southbound freeway corridor section within the Dallas/Fort Worth subarea network. This Figure illustrates the existing (baseline)

Figure 1. Traffic Model Enhancements to Account for Short Lane Effects

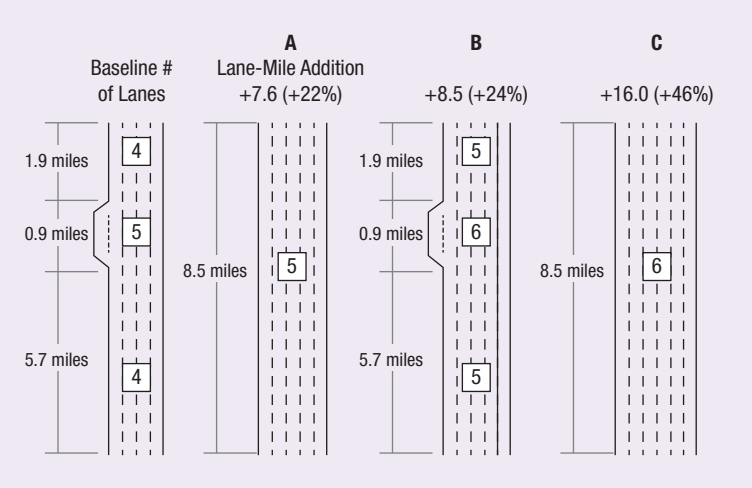


condition as well as three separate lane addition projects (denoted as A, B, and C) that were contemplated and tested.

In addition to the three lane addition projects identified in Figure 2, four other operational strategy alternatives to the lane addition projects were also evaluated at this intersection:

1. An advanced traveler information system (ATIS) strategy in which the fraction of drivers having access to pre-trip information (for example, via radio, television, and/or websites) was increased from 1 percent to 10 percent;
2. Another ATIS strategy in which the fraction of drivers having access to en-route information (through

Figure 2. Capacity Scenarios (Southbound Freeway Corridor)

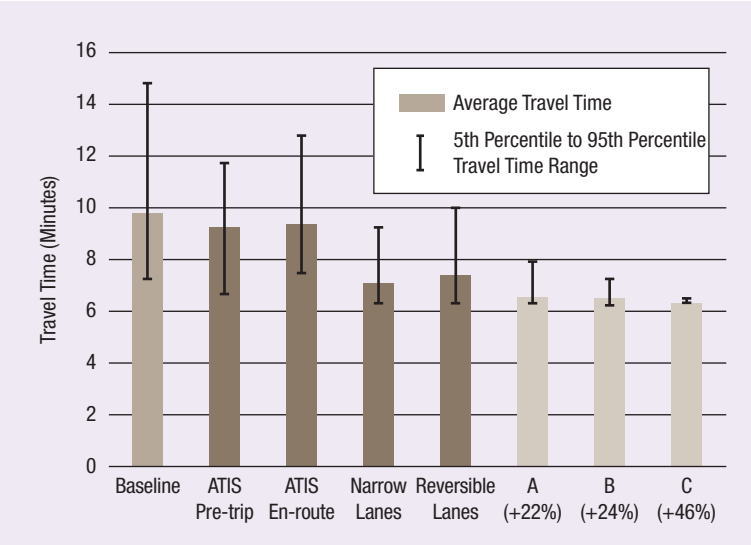


in-vehicle navigation systems, for example) was increased from 1 to 10 percent;

3. An operational modification to the existing baseline condition in which the width of the freeway lanes and shoulder within a critical 3.1-mile section of the southbound freeway corridor was narrowed so that a fifth lane could be introduced; and
4. An operational modification to the existing baseline condition in which one northbound lane was reversed in the same 3.1-mile section during the peak hour so that a fifth lane could be added in the southbound direction.

Figure 3 shows the results of a 20-day comparison based on average travel time in minutes and travel time reliability expressed as the range between the 95th and 5th percentile travel times. The gray bar represents performance for baseline conditions. The black bars represent the effects of individual non–lane-widening strategies. The white bars represent three lane-widening scenarios: (A) five lanes across all three segments; (B) one additional lane across all three segments; and (C) six lanes across all three segments. This graphic demonstrates how tradeoffs for improvement strategies can be examined in terms of their impact to average travel time (expressed as minutes of travel time) and travel time reliability (expressed as the range between the 5th and 95th percentile travel times).

Figure 3. 20-Day Model Results at Corridor Level



Note: ATIS = Advanced Traveler Information Systems

Notice that pre-trip and en-route travel information improved reliability but had little effect on throughput. The narrow lane strategy (which yields more lanes) improved throughput and reliability, but the effects on safety were not evaluated. In some cases (the provision of pre-trip information, for example), travel time reliability associated with the tested option is significantly improved in relation to the base condition, even though the average travel time is largely unaffected. In other cases, such as the narrow lanes strategy and each of the new construction projects, both travel time and travel time reliability are significantly improved by the tested option, although the narrow lane strategy may have negative safety impacts that were not considered in this analysis.

Without the examination and assessment of reliability as a performance measure, a primary benefit of the strategies would go unrecognized, particularly for the non–lane-widening strategies. The results shown in Figure 3 were taken from a test network and should not be considered to be representative of outcomes that can be expected in other applications because they are dependent upon the particular chara cteristics of the network and the travel-demand levels that are being modeled.

Report Availability

The Operations Guide to Improving Highway Capacity will be available online in fall 2012. The enhanced DTA model described in the Guide can be applied within virtually any local network environment with only a few adaptations. t

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A SHRP 2 Capacity Project Brief

Incorporating Greenhouse Gas Emissions into Transportation Planning and Decision Making

MAY 2013

Most climate scientists agree that humans are accelerating a change in the Earth's climate through the emission of greenhouse gases (GHG). In response, governments and organizations in the United States at the state, regional, and local levels have been enacting policies aimed at reducing energy consumption and GHG emissions. These policies typically include an overall emissions reduction target for a city, a state, or an agency. To meet reduction targets, some agencies and organizations are developing plans and strategies that are often disaggregated by emissions sources. Transportation, surface transportation in particular, is one of the most significant sources of GHG emissions: About 29% of all U.S. GHG emissions are from transportation, and emissions are expected to increase, as can be seen in Figure 1.

So far, the most common transportation-related response to reduce GHG emissions and promote energy security through reduced energy consumption has focused on four core strategies: reduce vehicle miles traveled (VMT), reduce carbon intensity of fuels, improve vehicle efficiency, and improve overall operational efficiency of the surface transportation system. Several of these strategies would require federal policy changes, namely advancements in vehicle technology and further regulation of fuel sources. However, transportation agencies at the state and local levels have more control over reducing VMT and improving the operational efficiency of the surface transportation system since they own, operate, and regulate much of the nation's transportation system. Systematically incorporating GHG emissions into transportation planning and decision making can lead to successful strategies and plans for mitigation.

To further this process, SHRP 2 undertook Project C09, Incorporating Greenhouse Gas Emissions into the Collaborative Decision-Making Process, which had three objectives:

1. Develop strategies for incorporating GHG emissions at key points in transportation planning and decision making, using an analysis framework as a point of departure;
2. Identify relevant information and materials for GHG emissions analysis, and areas where more information is needed; and
3. Prepare materials and methods that guide GHG emissions and energy analyses.

The products of this research project include *Incorporating Greenhouse Gas Emissions into the Collaborative Decision-Making Process* (SHRP 2 Report S2-C09-RR-1), *Practitioner's Guide to Incorporating Greenhouse Gas Emissions into the Collaborative Decision-Making Process* (SHRP 2 Report S2-C09-RW-2), and a web application. The appendices to the Practitioner's Guide provide—in one location—a wealth of data and methods that can be used to estimate the impacts of greenhouse gas-reducing strategies. The SHRP 2 Report S2-C09-RR-1 contains eight case

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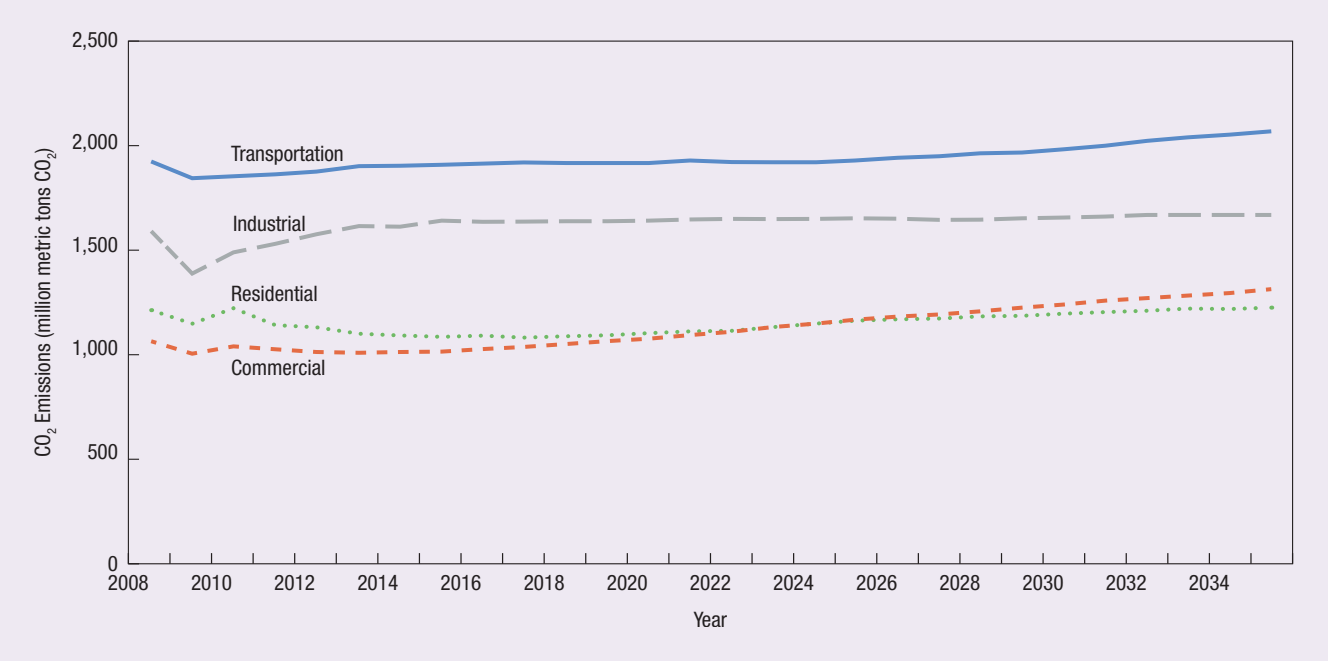
Figure 1. Forecasted CO_2 Emissions, by Sector



Source: US Department of Energy's Annual Energy Outlook 2011 Early Release

studies describing how state departments of transportation, metropolitan planning organizations, and local governments have been addressing the issue.

Intended Audience

The products of this research are useful to transportation agencies, especially state transportation agencies and metropolitan planning organizations that lead and manage decision-making processes. These organizations can use the practitioner's guide or the web application to identify critical points in the planning process at which GHG emissions should be considered and to identify which tools and data will be necessary to undertake meaningful GHG emissions analysis. Both agency managers and analysts can find useful information for the types of decisions they are likely to face.

Given that GHG emissions analysis is a process that could include a wide variety of interests, this research could be useful to a large number of stakeholders who participate in various decision-making processes. For example, environmental resource agencies, nongovernmental organizations, elected officials, and the business community might be interested in the results of GHG emissions analysis from a variety of perspectives, including the specifics of how many tons of GHG emissions might be emitted under particular strategies and the cost effectiveness of different strategies to mitigate this impact.

Final Report

Incorporating Greenhouse Gas Emissions into the Collaborative Decision-Making Process (SHRP 2 Report S2-C09-RR-1) provides background research on GHG emissions and energy consumption, information that is important for understanding where the transportation sector fits into an overall policy or program for reducing GHG emissions. Up-to-date information on the types of transportation-related strategies that can be considered as part of a GHG emissions reduction program is also presented. A technical framework (Table 1) is described that can be used for considering GHG emissions in different transportation planning and decision-making contexts. The framework is organized around questions that guide analysts to the tools and data that are necessary to conduct a GHG analysis. Case studies are used to illustrate GHG analyses that have been undertaken for highway and transit projects.

The GHG-reducing strategies examined in this report that are most directly under the influence of transportation agencies include the following:

- Infrastructure provision (including the design, construction, and maintenance of highway, transit, and other transportation facilities and networks);
- Management and operation of the transportation system (including technologies and operational

practices to improve traffic flow, and transportation system pricing policies); and
- Provision of transportation services and demand management measures to encourage the use of less carbon-intensive modes (including transit service improvements, rideshare and vanpool programs, and worksite trip reduction).

Other strategies that may be influenced by transportation agencies include the following:

- Land use planning, for which transportation agencies may provide regional coordination, funding, or technical assistance to support state and local efforts to develop more efficient land use patterns;
- Pricing strategies (including tax and insurance policies, mileage-based pricing, or registration fees), for which transportation agencies may provide analysis support and encourage state-level policy changes; and
- Provision of alternative fuels infrastructure, as well as direct purchase of alternative fuel vehicles for agency fleets.

The impacts of any single transportation system strategy (system efficiency and travel activity) are generally modest, with most strategies showing impacts of less than (and usually considerably less than) 1 percent of total transportation GHG emissions in 2030. A few strategies, however, show larger impacts (greater than 1 percent), including reduced speed limits, compact development (metropolitan development that uses less land than traditional development), various pricing measures, and ecodriving; but the ability to implement these strategies at sufficiently aggressive levels is uncertain due to institutional and/or political barriers. Despite the modest individual strategy impacts, the combined effects of all transportation system strategies may be significant—on the order of 5 to 20 percent of transportation GHG emissions.

Availability: *Incorporating Greenhouse Gas Emissions into the Collaborative Decision-Making Process* (SHRP 2 Report S2-C09-RR-1) is available at http://www.trb.org/Main/Blurbs/166936.aspx or by searching the title of the report at www.TRB.org.

Practitioner's Guide

Practitioner's Guide to Incorporating Greenhouse Gas Emissions into the Collaborative Decision-Making Process (SHRP 2 Report S2-C09-RW-2) suggests approaches for considering greenhouse gas emissions in transportation planning and decision making. The material is structured around the Decision Guide, which was the basis for the Transportation for Communities—Advancing Projects through Partnerships (TCAPP) web tool. The Decision Guide is a framework of key decisions, which are required by law or regulation or which have become part of successful practice. These decisions require action by those empowered to make the final decisions about plan adoption, funding priorities, or project implementation. To better inform decision makers, TCAPP provides technical information for each of the key decision points.

The guidebook presents the Decision Guide, showing where and how GHG emissions can be considered in planning and decision making. After determining which decision context (long-range planning, programming, corridor planning, or project development/permitting) is most relevant to their situation, users can find the information most relevant to them.

Table 1. GHG Analysis Framework

ANALYSIS STEP	KEY QUESTIONS
I. Determine information needs	1. Which stakeholders should be included in GHG strategy development and evaluation? 2. What is the scope of GHG emissions analysis?
II. Define goals, measures, and resources	3. Which goals, objectives, and policies relate to GHG reduction? 4. Which GHG-related evaluation criteria and metrics will be used? 5. What are the baseline emissions for the region or study area? 6. What is the goal or target for GHG reduction? 7. How will GHG considerations affect funding availability and needs?
III. Define range of strategies for consideration	8. Which GHG reduction strategies should be considered? 9. Are strategies and alternatives consistent with a long-range plan or other relevant plans that meet GHG reduction objectives?
IV. Evaluate GHG benefits and impacts of candidate strategies	10. Which calculation methods and data sources will be used to evaluate the GHG impacts of projects and strategies? 11. What are the emissions and other impacts of a particular project, strategy, or design feature?
V. Select strategies and document overall GHG benefits and impacts of alternatives	12. What GHG-reducing strategies should be part of the plan, program, or project? 13. What are the net emissions impacts for the overall plan, program, corridor, or project alternatives considered, or for the alternative selected?

Table 2. Example Fuel Economy for 2000 to 2007

VEHICLE TYPE	2000	2001	2002	2003	2004	2005	2006	2007
Passenger cars	21.9	22.1	22.0	22.2	22.5	22.1	22.5	22.5
Light-duty trucks	17.4	17.6	17.5	16.2	16.2	17.7	17.8	18.0
Heavy-duty trucks	6.01	6.12	6.01	6.91	6.85	6.28	6.17	6.20

Source: Bureau of Transportation Statistics (2009), Tables 4-13, 4-14, 4-15, and 4-23.

Note: Fuel economy is expressed in miles per gallon of gasoline equivalent.

At each decision point, information is presented to the user. The specific consideration of GHG emissions in that particular decision point is explained, and the linkage between the GHG role in that decision point and how it relates to other decision points in the framework is described. Key questions that an analyst should consider are then presented. Finally, the type of information that will be necessary to answer these questions is provided. In this way, guidebook users can focus on a particular decision point and obtain information on how GHG emissions can be considered in that decision, or alternatively, they can trace the role of GHG emissions analysis through different decision-making processes.

Table 3. Example Fuel Economy for Future Years

VEHICLE TYPE	2015	2020	2025	2030	2035
Passenger cars	25.29	27.73	29.79	31.46	32.68
Light-duty trucks	19.47	21.05	22.57	23.93	25.08
Heavy-duty trucks	6.30	6.62	6.82	6.95	7.03

Source: Energy Information Administration (2010), Supplemental Tables 59 and 67.

Note: Fuel economy is expressed in miles per gallon of gasoline equivalent.

The guidebook describes methods and approaches that can be used for considering GHG emissions in different decision-making contexts. It also allows users to identify how GHG emissions can be considered through the planning process and pinpoints specific approaches for individual planning tasks.

An annotated bibliography is included. The bibliography provides a description of useful references for those researching more specific approaches and methods for analyzing GHG emissions. For users who wish to have more information on different technical aspects of GHG emissions analysis, a technical reference document is included as an appendix.

Availability: *Practitioner's Guide to Incorporating Greenhouse Gas Emissions into the Collaborative Decision-Making Process* (SHRP 2 Report S2-C09-RW-2) is available at http://www.trb.org/Main/Blurbs/166940.aspx or by searching the title of the report at www.TRB.org.

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A SHRP 2 Capacity Project Brief

New Tool for Estimating Economic Impacts of Transportation Projects:

Transportation Project Impact Case Studies (T-PICS)

MAY 2012

Strengthening the economic vitality of a region is one of the primary reasons for investing in highway capacity. Better access to markets and labor force, reduced cost of delay, less congestion, improved safety, lower pollution levels, and a better quality of life are all elements of improving economic vitality. However, the ways in which new and improved highway capacity influences economic vitality are complex and often indirect, which complicates decisions about transportation projects. Understanding what changes in productivity result from improvements in market accessibility, intermodal connectivity, scheduling, logistics, and international competitiveness helps communities and transportation agencies identify transportation options to meet their goals.

Excellent economic impact assessment tools for highway capacity planning are available, but they tend to be relatively time-consuming and expensive to use. Until now, this has meant that the economic impacts of potential projects often have not been considered in the early stages of planning and programming when many possible project alternatives are being considered. With a new web-based tool, Transportation Project Impact Case Studies, or T-PICS, economic impacts can more easily be considered during community visioning for transportation or during public and stakeholder involvement for long-range system planning or corridor planning.

The Capacity focus area of SHRP 2 is broadly based on the concept that systematically considering the social, environmental, and economic effects of highway projects as they are planned, programmed, and carried out will result in better projects that can be delivered faster. The T-PICS tool provides planners with a quick and easy way to match their project criteria to case studies of similar projects (including economic and land development data both before and after project completion) so the best options can be identified early.

Because not every proposed project will have the same results as the average observed from past projects of a similar type, local data are collected and models are developed in later stages of the planning process, to identify expected changes in local traffic characteristics and subsequent economic development. Thus, this project should be viewed as a complement to and not a replacement for local-specific transportation and economic impact analysis that may be necessary in later phases of the planning process.

T-PICS, its documentation, and the final report are resources for transportation planners and others interested in better understanding the long-term economic impacts of highway capacity projects. Although highway projects are the primary focus, a number of intermodal projects have been included in the database and web tool, e.g., transit-oriented development projects with a substantial highway component and freight terminals. The database and web tool have been designed so that additional highway case studies and, potentially, economic impact case studies involving other modes of transportation can be added as they are documented and become available.

The web tool and final report are based on a series of 100 detailed case studies that document the long-term, before-and-after economic impacts of a variety of highway capacity invest-

ments, mainly from around the United States. For this project, the long-term impacts on performance metrics such as employment, income, real estate values, and tax revenues have been documented. Temporary, construction-phase impacts were not considered in the report or the database.

Web Tool

T-PICS is a web-based viewing and analysis system for the case studies. This system includes three parts: (a) a *search function* that allows for user-defined screening and selection of relevant cases; (b) a *case study viewer* that provides user access to impact measures, discussion text, maps, and related documents; and (c) an *impact estimation calculator* that shows the average and expected range of impact associated with any user-defined project profile. By providing agency staff and interested stakeholders with a means for establishing the range of job, income, and development impacts typically associated with various types of transportation projects in different settings, the T-PICS system can assist transportation agencies in project planning and evaluation.

The T-PICS web tool provides transportation planners with a way to search for relevant case studies by type of project and type of location setting. Details of the projects, their impacts, and factors affecting those outcomes are all provided in the case studies. The web tool also provides users with an option to specify a given type of proposed project, and then see the range of impacts that would be expected based on case study experience to date. These features are most useful in the following phases of planning:

1. Early-stage policy or strategy development—T-PICS can identify the magnitude and types of impact tradeoffs to be considered;
2. Early-stage "sketch planning" processes—T-PICS can identify the types of local barrier and success factors that will need to be addressed in later, more detailed planning steps; and
3. Public hearings—the case studies provide a way of responding to the hopes of proponents and fears of opponents, with information on the range of impacts that have actually occurred in the real world.

The tool's user interface is structured around two different approaches to analyzing projects: *Case Search* and *My Project Tools*. Case Search lets users access the database of highway projects, allowing users to perform the following functions:

1. Filter the cases they want to see based on many factors (e.g., type, region, and cost);
2. Select cases to view separately or compare based on the user's criteria;
3. View pre- and post-project conditions, project area settings, project characteristics, intermodal volume (if applicable), and economic impacts for each case;
4. Read a short narrative on the case that provides background on how the project came to be built, its influence on the local area, and other non-transportation factors that enhanced or mitigated the economic impacts of the project; and
5. View a Google map image of where the project is located.

My Project Tools provides an estimate of economic impacts for a hypothetical project based on the following factors:

1. The type, length, and setting of the project chosen by the user;
2. The magnitude of average annual daily traffic, miles, and project cost—which are all estimated based on the type, length, and setting, but can be changed by the user; and
3. The extent to which there are supporting business climate, infrastructure, and land-use policies to encourage economic development.

Availability: T-PICS can be accessed through two URLS:

1. http://transportationforcommunities.com/t-pics/
2. http://www.tpics.us

Case Studies Database

The most notable accomplishment of this project was the development of 100 case studies of highway projects, which (a) compared pre- and post-project changes in economic and land development conditions, (b) contrasted them with corresponding conditions for a base of comparison, and (c) included both quantitative impact measures and qualitative assessments based on local interviews.

Completed in 2010, this collection of case studies was compiled with the goal of including all known pre- and post-highway impact studies in the United States, plus available English language studies from Canada and abroad. Additional quantitative and qualitative data collection and analysis brought all of the cases up to a similar standard of comparability.

The study sought to include all major project types, including intercity highways, urban beltways, and local access roads, as well as bridges, highway interchanges, and intermodal road/rail terminals. The projects spanned all regions of the continental United States—both urban and rural settings, and different economic distress levels. A small number of English language studies from Canada and abroad were also included in a format that would enable

TABLE 1. Number of Cases by Project Type

PROJECT TYPE	TOTAL CASES
Beltway	8
Bridge	10
Bypass	13
Connector	8
Interchange	12
Industrial Access Road	7
Major Highway (Limited Access Route)	14
Widening	9
Freight Intermodal Terminal	10
Passenger Intermodal Terminal	9
Total	**100**

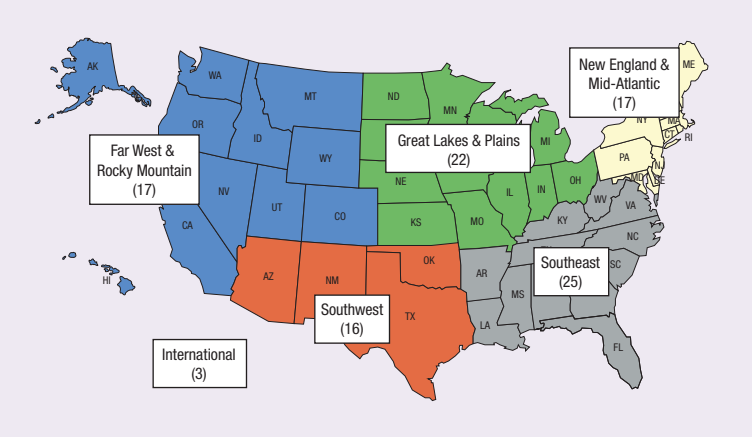
continuing expansion over time. Five categories of data were assembled for each case study:

1. *Project characteristics*—type of facility, years built, cost, and size and level of use;
2. *Project objectives*—congestion reduction and access enhancement;
3. *Impact metrics*—pre- and post-change in employment, income, business output, land values, building development, and tax revenues;
4. *Quantitative explanatory data*—location (region, metro/rural), topography, and economic distress level; and
5. *Qualitative explanatory data*—local interview findings on land use plans and policies, business climate and support programs, and other factors affecting outcomes.

Regional location is an important consideration in determining the comparability of projects. The region can affect the observed impact of a project due to differences in climate, topography, land-use patterns, highway network density, and travel distances in different parts of the United States. This factor can help users compare cases in similar areas or those with characteristics similar to their own. The regions are defined on the basis of the US Department of Commerce's Bureau of Economic Analysis regions, which classifies the country into eight regions. The number of regions used for this study was reduced to five, as three pairs of regions were combined together (Far West and Rocky Mountain, Great Lakes and Plains, Mid-Atlantic and New England). These regions are shown in Figure 1.

Availability: The case studies can be accessed through the T-PICS web tool.

FIGURE 1. Number of Cases by Geographic Region (total 100)



Final Report

The research report describes the background of the research project, documents how the case studies were selected and developed, introduces the accompanying web-based tool, and provides a meta analysis of the key relationships between factors such as project types, traffic volumes, project locations, and non-transportation policies put in place to help foster economic development. The findings

Table 2. Project Motivation, by Project Type

CATEGORY OF MOTIVATION	HIGHWAY PROJECTS	FREIGHT INTERMODAL	PASSENGER INTERMODAL	TOTAL
Enhance Access				
Improve Access to Airports	18	2	0	20
Improve Access to Rail	4	6	0	10
Improve Access to Int. Border	2	1	0	3
Improve Access to Marine Port	7	2	0	9
Improve Labor Market Access	26	0	4	30
Improve Delivery Market Access	29	3	0	32
Any of the above				*58*
Promote Economic Development				
Facilitate Site Development	42	2	8	52
Facilitate Tourism	26	0	0	26
Any of the above				*65*
Reduce Congestion				
Mitigate Congestion	47	0	7	54
All Projects	**78**	**10**	**9**	**97**

from the meta analysis can help serve as a high-level guide to transportation agencies in their selection of programs of highway capacity projects that will provide a larger return on investment in terms of long-term economic impacts. For instance, the meta analysis indicates that the type of project (e.g., an interchange versus a ring road) and the settings of project (e.g., areas that are economically distressed versus those that are not) matter considerably more than the amount of money spent to build the project. The final report also describes the study design that underlies the data collection and database development processes; presents findings from analysis of the dataset; and presents lessons learned for interpreting existing case studies, developing future case studies, and using the web tool for planning and decision making.

Availability: Summer 2012

Data Dictionary

The Data Dictionary provides an overview of the data gathered for the case studies that are presented on the T-PICS website. It outlines sources of data, range of values, hierarchical classifications, and overall definitions in order to assist the user to properly understand and use the data. It provides a summary of dataset content and properties, and an in-depth explanation of data field including the field type, source, missing values, and definition. It also includes guidance on using impact estimates, an explanation of how economic impact estimates were derived, and guidance on how to use this information.

Availability: *Summer 2012*

User Guide

As part of this project, a user guide to the T-PICS web tool was developed. The guide is an instruction manual that explains the logic of the T-PICS web tool and how the system should be used. It contains instructions for using the Case Search page, including searching with basic and other criteria, viewing case search results, comparing case search results, and viewing a case. The guide also describes how the My Project Tools page can be used to estimate a range of potential economic impacts for a planned transportation project.

Availability: July 2012

Pilot Tests

A pilot test of T-PICS is currently being conducted by the Minnesota Department of Transportation. The objective of this project is to test the utility of T-PICS as a tool for enhancing decision making in the planning of highway capacity additions and whether it produces results that are credible and reasonable. The results of this work will include an assessment of T-PICs; additional guidance for future T-PICS users; and recommendations for improving and extending T-PICS.

Status: The pilot test began in 2012.

Webinar

In May 2010, a webinar was held on T-PICS. The webinar included a description of T-PICS and a demonstration of the web tool.

Availability: A recording of the webinar and a PDF of the slides are available on the Recorded Capacity Webinars page, which can be accessed at TRB.org/SHRP2/webinars.

Video

A 14-minute video was made to demonstrate how the web tool can be used to conduct before-and-after assessments of a range of projects, compare case studies developed for each project to other similar projects in the database, and view a wide range of information about each of the case studies. The video also demonstrates how to estimate a range of possible economic impacts that might result from constructing a project.

Availability: The video is available at vimeo.com/34680932.

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A SHRP 2 Capacity Project Brief

Planning Transportation Projects for Better Environmental Outcomes

A new institutional framework and tools makes it easier

MAY 2013

Ecosystem approaches to environmental conservation are becoming more widely accepted and increasingly practiced by federal, state, and local resource agencies. From a highway perspective, the Federal Highway Administration document *Eco-Logical: An Ecosystem Approach to Developing Infrastructure Projects* (2006) provides a conceptual groundwork for integrated conservation plans and mitigation activities that transcend individual agency jurisdictional boundaries and encourages an outcome-based ecosystem approach to conservation. However, *Eco-Logical* stops short of providing the institutional framework and tools to implement the principles. SHRP 2 reports *An Ecological Approach to Integrating Conservation and Highway Planning: Volumes 1 and 2* are intended to provide the structure and tools needed to implement the ecological approach.

Transportation and natural resource agencies recognize the ecological and economic benefits of integrating landscape-scale environmental considerations into highway planning, but the barriers to achieving the goal are high. Ecosystem-based approaches to highway planning need to be easier and more practical if they are going to be widely implemented. SHRP 2 has developed a structure called the Integrated Ecological Framework ("the Framework" or IEF) that builds on the principles of *Eco-Logical*, providing a step-by-step approach to reaching consensus on environmental goals, identifying and protecting conservation areas, and thereby speeding the delivery of transportation projects. The research also identifies tools for carrying out the analytical steps in the Framework using a cumulative effects assessment and alternatives (CEAA) process.

The Framework can help transportation agencies and resource agencies work together during long-range, corridor, and project planning to identify transportation program needs, their potential environmental impacts, and conservation/advanced mitigation opportunities. The purpose of the Framework is to build or refresh inter-agency relationships and discuss upcoming environmental issues well in advance of the National Environmental Policy Act (NEPA) process. Within the Framework, a CEAA process provides guidance for the analytical steps to help transportation and natural resource practitioners bring the right expertise, data, methods, and tools to the table. By engaging during the long-range or corridor planning process, there is more flexibility in roadway alignment and design and, therefore, more opportunity to avoid and minimize impacts.

The essence of the Framework is to agree in advance on conservation priority areas and avoid them as much as possible, and for unavoidable impacts, to begin agreement on mitigation sites that enhance and enlarge contiguous conservation areas. The benefits of using the Framework include better environmental outcomes through reduced impacts, identification of high-quality mitigation and enhancement opportunities, and the potential for accelerated completion of the NEPA and 404 permitting process (which regulates the discharge of dredged or fill material into waters of the United States, including wetlands) through proactive inclusion of resource considerations early in the transportation planning process.

SHRP 2
STRATEGIC HIGHWAY RESEARCH PROGRAM
Accelerating solutions for highway safety, renewal, reliability, and capacity

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

Table 1. Steps of the Integrated Ecological Framework (IEF)

Both the cumulative effects assessment alternatives (CEAA) process and the Regional Ecosystem Framework (REF) are part of the IEF. The CEAA process applies to the analytical steps. The REF is a spatial and nonspatial database of resources and scenarios with planning objectives and conservation criteria; this is the core of the IEF.

STEP	PURPOSE
Step 1: Build and Strengthen Collaborative Partnerships and Vision	**Build support among a group of stakeholders** to achieve a statewide or regional planning process that integrates conservation and transportation planning.
Step 2: Characterize Resource Status. Integrate Conservation, Natural Resource, Watershed, and Species Recovery and State Wildlife Action Plans	Develop an overall conservation strategy that integrates conservation priorities, data, and plans, with input from and adoption by all conservation and natural resource stakeholders identified in Step 1 that addresses all species, all habitats, and all relevant environmental issues.
Step 3: Create Regional Ecosystem Framework (Conservation Strategy + Transportation Plan)	Integrate the conservation and restoration strategy (data and plans) prepared in Step 2 with transportation and land use data and plans to create the Regional Ecosystem Framework **(REF).**
Step 4: Assess Land Use and Transportation Effects on Resource Conservation Objectives Identified in the REF	Identify preferred alternatives that meet both transportation and conservation goals by analyzing transportation and/or other land use scenarios in relation to resource conservation objectives and priorities utilizing the REF and models of priority resources. (This is the step in which the **Cumulative Effects Assessment and Alternatives [CEAA]** process, described below, is applied.)
Step 5: Establish and Prioritize Ecological Actions	**Establish mitigation and conservation priorities** and rank action opportunities using assessment results from Steps 3 and 4.
Step 6: Develop Crediting Strategy	Develop a consistent strategy and metrics to measure ecological impacts, restoration benefits, and long-term performance—with the goal of having the analyses in the same language throughout the life of the project.
Step 7: Develop Programmatic Consultation, Biological Opinion, or Permit	Develop memoranda of understanding, agreements, programmatic 404 permits, or Endangered Species Act Section 7 consultations for transportation projects in a way that documents the goals and priorities identified in Step 6 and the parameters for achieving these goals.
Step 8: Implement Agreements and Adaptive Management. Deliver Conservation and Transportation Projects	Design transportation projects in accordance with ecological objectives and goals identified in previous steps—incorporating programmatic agreements, performance measures, and ecological metric tools to improve the project.
Step 9: Update Regional Integrated Plan/Ecosystem Framework	Update the effects assessment to determine if resource goal achievement is still on track. If goal achievement gaps are found, reassess priorities for mitigation, conservation, and restoration in light of new disturbances that may impact the practicality/utility of proceeding with previous priorities. Identify new priorities if warranted.

The Framework

State departments of transportation, metropolitan planning organizations, and resource agencies can use the steps of the Framework (Table 1) to work together during long-range, corridor, and project planning. Doing so will help identify strategic transportation program needs, their potential environmental impacts, and conservation opportunities. Using the Framework enables programmatic tools to increase regulatory predictability during project development while furthering regional conservation goals. It is a comprehensive, dynamic process designed to promote the integration of regulatory and nonregulatory authorities, as well as better environmental outcomes.

Cumulative Effects Assessment and Alternatives Process—*Familiar Methods in a Cohesive Approach*

The foundation for the analytical steps in the Framework is a step-by-step CEAA process that identifies emerging methods to achieve regulatory assurances and environmental accounting. The methods include geospatial tools for updating wetlands maps, inductive species modeling that predicts where sensitive species are most likely to be located based on habitat and observation, and development of credits based on the value of ecosystem services. Ecosystem services include items of value to society like clean water, outdoor recreation, agriculture, fisheries, and species diversity. With these tools, transportation planners can more easily value and avoid sensitive resources early in the planning process and be more confident of setting projects where impacts will be minimized.

Rather than a radical new approach, the CEAA process brings together a variety of well-tested methods, data, and tools into a cohesive ecological assessment approach. Specifically, the CEAA process guides a scientifically rigorous ecological assessment that includes the following: (1) evaluating direct and cumulative effects on resources from any potential planning alternative or project; (2) assisting in the identification or creation of alternatives; and (3) identifying the best mitigation and enhancement opportunities.

The CEAA is intended to be highly scalable to the time, resources, data, and expertise available; and it can be used at the regional, corridor, or project level. Undertaking a CEAA requires transportation and resource agencies and other stakeholders to work collaboratively to agree on targets and goals for an area of interest. This ensures that relevant expertise, data, tools, and methods are considered in the development of a regional ecosystem framework (REF). As noted in Table 1, the REF is basically a set of overlays that map both transportation and conservation priorities. The REF can then be used to assess and guide transportation decision making at all stages of transportation planning and development; it also allows impacts to be assessed and quantified early in the transportation planning and project delivery process.

Within this process, practitioners can begin at any transportation decision point and use the CEAA to help identify and incorporate the necessary questions, data, and analysis needed to support better environmental and transportation decision making. The online version includes references that provide in-depth reading of the concepts and case studies that illustrate real-life applications, as well as useful technical tools and data sources to support its use and implementation.

The major outputs of the CEAA include the following:

- A unified map of transportation, land use, conservation, and restoration priorities;
- Maps of each potential transportation scenario that show an assessment of direct and cumulative effects at a landscape level with supporting data;
- Identification of affected resources and the quantification of the cumulative effects for each transportation scenario being considered; and
- Identification and evaluation of potential mitigation and enhancement areas within a region.

Regulatory Assurances and Ecological Accounting Strategies

Within the overall Framework, two actions are critical. First, transportation planners and project managers must address regulatory requirements, ideally as early in the transportation planning and development process as possible. Second, environmental accounting strategies can be used to reach agreement with regulatory agencies on project impacts and mitigation requirements.

Regulatory Assurances

This SHRP 2 research focused on regulations under the Endangered Species Act (ESA) and the Clean Water Act (CWA). To address regulation under the ESA, species distribution models using inductive modeling methods can create reliable maps that can be used by transportation planners early in the planning process, before significant investments have been made in road design. The maps are also useful in identifying mitigation opportunities and assisting in recovery planning. This information is equally important for improving transportation and conservation outcomes related to wetlands, streams, rivers, and other resources regulated under the CWA.

In many areas of the United States, however, data needed to avoid and minimize impacts to wetlands and to assess mitigation options are currently lacking. Transportation planners need access to digital wetland maps covering the entire country to find the best options. The National Wetlands Inventory (NWI), which is the baseline database for the United States, only covers about 80% of the country digitally, and much of the NWI is based on scanned imagery that is almost 30 years old (Figure 1).

This research project examined case studies that created digital data where such information was lacking in Oregon, and to improve it in Michigan and Virginia. Methods (including collaboration between state agencies; a mix of funding from federal, state, and nonprofit sources; imagery analysis, and modeling) were used in these states to dramatically increase digital wetlands coverage. These strategies have the potential to create wetlands data for the entire country in a few years.

Ecological Accounting Strategies

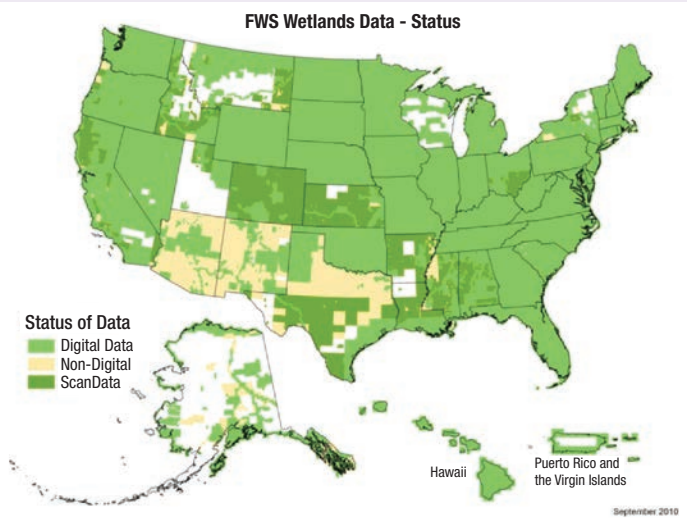
The Framework and CEAA process provide the ability to link and correlate ecological measurements at a landscape scale with measurements of similar resource is sues at a site level. In practice, linking the measurement scales provides the following outcomes:

- A better ability to maintain continuity between early transportation planning and project specific planning,
- Improved regional goal setting and a better ability to track the effect of specific projects on the progress toward those goals,
- A framework for understanding and presenting cumulative effects analyses, and
- An improved understanding of the opportunity and need for using programmatic approaches in project planning, as well as an improved ability to develop them.

Incorporation into TCAPP

Transportation for Communities—Advancing Projects through Partnerships (TCAPP) is a web portal that delivers the content of a number of SHRP 2 projects. TCAPP includes an interactive database developed in this ecological work to

Figure 1. 2010 Status of digital wetlands data for the United States in the NWI



provide access to the CEAA technical guidance and supporting strategies for regulatory assurances and environmental crediting. The database is integrated into the Applications section of the TCAPP (www.transportationforcommunities.com).

Pilot Projects

The IEF process and supporting strategies were tested in three pilot projects in Oregon, Michigan, and Colorado. The objective was to see if the new approach would result in different decisions and outcomes, and how time and cost savings compared to the traditional transportation planning and project-delivery system. The pilots also tested the usability of the new processes. Results showed that the new methodology produced results similar to traditional approaches in the evaluation and mitigation of direct impacts, and the new approach provided better results than the traditional approach for cumulative impact analysis and selection of mitigation options.

Some key findings and conclusions from testing the process include the following:

- **Better Outcomes**: The most significant changes were in the areas of mitigation site selection, evaluation of multiple corridors, and development of transportation plans. The pilot test results led to the selection of mitigation sites with more ecological benefits, and they provided more accurate and comprehensive scenario assessments that identified corridors with the least number of direct and cumulative impacts.
- **Benefits of Modest Investments in Data:** Usefulness of the CEAA for planning and project development is dependent on the accuracy and resolution of available data. A relatively modest investment in process changes and data development up front can help practitioners identify potential impacts and mitigation opportunities earlier in the transportation process—which can vastly improve planning, corridor evaluation, and consideration of mitigation opportunities.
- **Increased Credibility:** Decisions have more credibility because the CEAA process ensures the use of a standardized, scientifically based, peer-reviewed process that applies the best available suite of methods, data, and tools.
- **Savings in Time and Resources:** The CEAA approach can save time and resources by reducing impacts and mitigation requirements, as well as supporting more targeted field studies for assessment of alternatives.
- **Standard Data Management Practices:** Better data management and data-sharing practices contribute to better application and accessibility of data collected during transportation alternative assessments; this can enhance future decision making not only by transportation agencies, but by natural resource agencies as well.

Reports

An Ecological Approach to Integrating Conservation and Highway Planning, Volume 2, (SHRP 2 Report S2-C06-RW-2) includes descriptions of the project approach, the ecological process in transportation planning, the Framework, the pilot projects, the development of the web tool, and a symposium. The appendices include a description of the wetlands workflow and data development, a description of predictive modeling for at-risk species, reports on the pilot projects, an example function of natural flow regulation, the ecosystem-based tools database, and ecosystem service accounting tools. The report is available at http://www.trb.org/Main/Blurbs/166938.aspx.

Two additional reports are expected in 2013: *An Ecological Approach to Integrating Conservation and Highway Planning, Volume 1*, (SHRP 2 Report S2-C06-RW-1) and the *Guide to the Integrated Ecological Framework. Volume 1* summarizes SHRP 2 Project C06A (Integration of Conservation, Highway Planning, and Environmental Permitting Using an Outcome-Based Ecosystem Approach), which developed an integrated ecological framework for ecological decision making and conservation planning to address ecological concerns during highway capacity enhancement projects. The *Guide* offers an expanded view of the IEF, which is presented in *Volume 2*.

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Improved Models for Better Decisions

Planning Models, Traffic Operations Models, and Activity-Based Models

JANUARY 2012

Decisions about spending public funds for transportation improvements often are informed by estimates and forecasts developed through mathematical models. The more closely these models represent reality and include important influencing factors, the more confidence we can have in spending decisions. Models that can provide a better basis for predicting how highway improvements affect congestion, for example, or that reflect the differences in forecasting freight demand and passenger transportation will provide a more reliable picture of future needs.

The process is neither simple nor inexpensive, which is why taking up the challenge at the national level makes sense. Traffic operations and planning models generally require both demand and supply inputs. Travel demand could be static (for planning models), dynamic (for planning and operational models), or in the form of activity schedules (for activity-based models). In virtually all applications, actual travel demand cannot be perfectly forecast and is subject to a variety of disturbances, including special events, day-to-day variation in individual behavior, (unfamiliar) visitor traffic, and diversion from temporary unavailability of alternative modes. On the supply side, the operational capacity of network elements could be assumed as fixed, random, or systematically varying with traffic conditions through actuated signal controls, ramp metering, dynamic tolls, and so forth. Unreliability sources that affect supply-side attributes consist of incidents, work zones, weather, traffic control, dynamic pricing, and variation in individual driving behavior. To address these and other concerns, several projects from the SHRP 2 Capacity and Reliability focus areas are working to improve existing planning models, operations models, and activity-based models.

Models for Predicting Nonrecurring Congestion

How can we predict what effect an improvement will have on travel time reliability? Alternately, how can we characterize reliability as a function of highway, traffic, and operating conditions? To answer these questions, the research team in SHRP 2 Project L03: Analytic Procedures for Determining the Impacts of Reliability Mitigation Strategies developed models for predicting nonrecurring congestion, which is caused by events such as traffic incidents and weather conditions.

Three methods were used to estimate nonrecurring congestion, all based on empirical procedures: The first involved before-and-after studies; the second was termed a "data poor" approach and resulted in a lean and easy-to-apply set of models; and the third was called a "data rich model" and used cross-section inputs including data on selected factors known to directly affect nonrecurring congestion.

Much of the effort for the study went into the creation of a cross-sectional dataset from which statistical models could be developed. The final analysis data set for statistical modeling is highly aggregated: each record represents reliability, traffic, and event data summarized for a section for a

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year. Reliability is measured as the variability in travel times over the course of a year. As such, the cross-sectional model is a macroscale model: It does not seek to predict the travel time for a particular set of circumstances; rather, the overall travel-time characteristics of a highway section in terms of both mean and reliability performance. The cross-sectional model is, therefore, appropriate for adaptation to many existing models and applications with the same aim, and can serve as the basis for conducting cost/benefit analysis; however, it is not appropriate for real-time travel-time prediction.

Status: Project L03 is complete. The final report, currently in publication, will be available on the SHRP 2 website and as a printed document.

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Incorporating Travel Time Reliability Performance Measures into Traffic Simulation Models and Planning Models

Project L04 has dual objectives: to develop the capability of producing measures of reliability performance as output in traffic simulation models and planning models; and to determine how travel demand forecasting models can use reliability measures to produce revised estimates of travel patterns.

Addressing reliability in models, particularly operations, generally requires three elements. First is a scenario manager which captures outside sources of reliability such as special events, bad weather, work zones, and daily variation in travel demand. Second are simulation tools (micro or macro) that internally account for unreliability (e.g., flow breakdown, accidents). Third is a vehicle trajectory processor, which derives vehicle trajectories or paths from the simulation output. Trajectories can be used to develop travel time distributions, which in turn can be the basis for travel time reliability metrics.

The project team is currently adapting and calibrating existing traffic simulation models and applying them to an urban network. A mesosimulation model will provide a regional perspective and a microsimulation model will provide a close-up portrayal. To accomplish this, the project team is working with a regional transportation agency. The simulation models are expected to use random seeds, reflect the basic variability in travel time due to operations at saturation (such as recurring congestion), and produce one or more reliability performance measures as output.

The models are being developed for two primary sets of users: (1) practitioners and researchers, who may have a keen interest in the fundamentals of the modeling application to incorporate reliability in the analysis; and (2) operations managers and planners in transportation agencies, who may be interested primarily in the procedures employed to estimate reliability and the practical outcome of actions to improve reliability.

As part of this project, a guide is being written that will define the state of the art for incorporating travel time reliability in simulation-based operational studies. The guide will not be limited strictly to microscopic traffic simulation models, but rather will include any simulation that can produce individual vehicle trajectories.

Status: This project is active. The expected completion date is September 2012.

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Freight Demand Modeling

Freight is growing in volume, economic importance, and complexity—particularly in relation to sophisticated modal and information technology advances. Understanding freight flows and forecasting them is critical to determining the need for future transportation capacity on the nation's highways or other modal infrastructure. However, most existing freight demand forecasting models and data sources are based on methods and tools developed for passenger transportation, which are not well suited for forecasting freight movements or volumes. The overall objective of SHRP2 project C20: Freight Demand Modeling and Data Improvement Strategic Plan is to foster fresh ideas and new approaches to designing and implementing freight demand modeling.

In this project, a Freight Demand Modeling and Data Improvement Strategic Plan was developed to advance a broad new direction for improving freight planning; promoting continuous innovation for breakthrough solutions to freight analytical and data needs; and fostering a collaborative approach for private, public, and academic stakeholders. The plan was developed through an inclusive process of public and private stakeholders from the U.S. and international freight planning communities, culminating in the Freight Modeling and Data Innovation Symposium conducted in September 2010. A robust approach was followed to define needs and innovations, and to shape the long-term goals. The hallmark of this effort was considering the current state of the practice to maximize input from practitioners and decision makers. This entailed a review of research conducted on freight modeling and data improvement as well as analysis of current practices within the industry (both domestic and international).

The Freight Demand Modeling and Data Improvement Strategic Plan identifies a compelling direction for the freight planning community centered on meeting the

immediate needs of decision makers. The pragmatic focus on application and results also recognizes the parallel need to foster continued innovation and breakthroughs among researchers. This confluence of steady improvements in practice and continued research focus will be the basis for long-term improvements to freight modeling and data. This research project focused on defining the critical gaps in models, data, and decision making as the means to formulate a strategic and cohesive road map to guide the long-term initiatives identified throughout the research process.

Project Status: This project is complete. The final report and the strategic plan, currently in publication, will be available on the SHRP 2 website and as printed documents.

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Integrated, Advanced Travel Demand Models

SHRP 2 has two projects (C10A: Partnership to Develop an Integrated, Advanced Travel Demand Model and a Fine-grained, Time-Sensitive Network [Jacksonville, Florida]; and C10B: Partnership to Develop an Integrated Advanced Travel Demand Model with Mode Choice Capability and Fine-Grained, Time-Sensitive Networks [Sacramento, California]) that will improve modeling and network processes and procedures in order to address policy and investment questions, and to facilitate further development, deployment, and application of these procedures. In addition, these models will produce a transferrable product, process, and sample data set that can be adapted for use elsewhere or used for research; incorporate SHRP 2 Capacity products from projects on pricing and operations into the model capabilities; incorporate travel time reliability into the modeling capabilities; demonstrate the application of outputs of the integrated model to estimate greenhouse gas emissions; and demonstrate the dynamic integrated model set in a real-world environment. Both model sets will reflect changes in the nature of demand, mode choice (including "new modes" such as work or shopping at home and nonmotorized travel), destination choice, timing, route of travel as a response to highway network congestion, roadway management strategies, road pricing, transit service, parking policies, and other public policies aimed at reducing congestion. Both sets will also deal with the consideration of reliability in travel choice.

Jacksonville, Florida: An Advanced Travel Demand Model and a Fine-grained, Time-Sensitive Network

In project C10A, the project team has partnered with the North Florida Transportation Planning Organization, whose region covers the Jacksonville metropolitan area. Jacksonville is the fifth most populous of Florida's 26 metropolitan planning organization (MPO) regions and is anticipated to grow to 1.6 million people by 2030. Jacksonville is the eastern terminus of Interstate 10, and Interstate 95 passes through the city, leading to substantial freight and interregional passenger car volumes on the region's transportation backbone. This local, regional, and interregional travel demand, when coupled with a road network that includes five major downtown bridges, leads to challenging traffic dynamics and interesting time-of-day and route choices.

The model system being tested comprises three primary components: DaySim, the TRANSIMS Router and Microsimulator, and the Motor Vehicle Emission Simulator (MOVES). DaySim is a travel demand forecast model that predicts household and person travel choices at a parcel-level on a minute-by-minute basis. The TRANSIMS Router and Microsimulator are dynamic traffic assignment and network simulation software that tracks vehicles on a second-by-second basis. MOVES is the next generation mobile source emission model being developed by the U.S. EPA. MOVES will estimate emissions from mobile sources and will replace MOBILE as the approved model for state implementation plans and regional or project-level transportation conformity analyses. The integrated model system will be established by enhancing and linking these model components in order to provide sensitivity at greater level of spatial and temporal resolution to the key policies.

The travel demand model to be used for this project is coded in a software framework called DaySim. DaySim was initially implemented in Sacramento, California, by the Sacramento Area Council of Governments (SACOG). It is being enhanced in Jacksonville to interface with the TRANSIMS Router. In addition, the project was amended to test transferability of model parameters to other cities (Tampa, Florida).

Status: This project is active. The expected completion date is February 2012.

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Sacramento, California: An Integrated Advanced Travel Demand Model with Mode Choice Capability and Fine-Grained, Time-Sensitive Networks

In project C10B, the project team has partnered with SACOG, the designated MPO for the Sacramento metropolitan area. Sacramento has light rail in addition to a bus system, providing a more varied modal environment for model development.

The project team will combine capabilities of an activity-based travel demand model with a traffic simulation model. The integrated model will combine the SACSIM activity-based model, the DynusT traffic microsimulation model, and the MOVES mobile source emission model. The Sacramento model will include a schedule-based transit simulation for assigning transit trips.

SACSIM is a complete modeling system that includes a disaggregate activity simulator called DAYSIM. DynusT is a recently-released, open-source license traffic simulation package already used in a number of areas, and it lends itself well to the integration with both SACSIM and MOVES. DynusT is a true disaggregate simulation model that tracks individual vehicles and transit travelers through the network—consistent with tracking traveler activities in a travel demand model. MOVES is designed to estimate emissions at scales ranging from individual roads and intersections to large regions.

The software architecture provides users the capability to access the integrated system from any web browser. The goal is to ensure that the integrated model software is efficient, modular, and maintainable so as to reduce the risk that changes to one model component will affect the operation of the model as a whole. The complete, integrated model will be available to the transportation community under open-source licenses.

Status: This project is active. The expected completion date is February 2012.

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A SHRP 2 Capacity Project Brief

Innovations in Freight Demand Modeling and Data

JULY 2013

Freight traffic has been growing faster than passenger traffic on the nation's highway network. This has exacerbated bottlenecks, not only near ports and intermodal facilities but throughout the network. Travel forecasts are beginning to show the effects on congestion of growing freight traffic on urban freeways, urban arterials, and some cross-country routes in rural areas. Understanding freight flows and being able to forecast freight demand are taking on increasing importance.

To improve the nation's ability to plan for increased freight-related traffic and to begin to address the growing issue of freight bottlenecks, the second Strategic Highway Research Program (SHRP 2) conducted a research project to assess the state of the practice of freight demand modeling and freight data as they relate to highway capacity planning and programming. This project, Freight Demand Modeling and Data Improvement Strategic Plan (Capacity Project C20), produced *Freight Demand Modeling and Data Improvement* (SHRP 2 Report S2-C20-RR-1), which documents the state of the practice for freight demand modeling; *Freight Demand Modeling and Data Improvement Strategic Plan* (SHRP 2 Report S2-C20-RW-2), which outlines seven strategic objectives that are designed to serve as the basis for future innovation in freight travel demand forecasting and data, and to guide both near- and long-term implementation; and a speaker's kit, which is intended to be a "starter" set of materials for use in presenting the freight modeling and data improvement strategic plan to a group of interested professionals. SHRP 2 Project C20 also hosted the 2010 Innovations in Freight Demand Modeling and Data Symposium, which was conducted as a means of discovering the sorts of innovation that were occurring internationally in terms of both freight demand modeling and freight data. Based on the success of this symposium, planning for a second innovation symposium is under way in SHRP 2 Project C43 (Second SHRP 2 Freight Modeling and Data Innovation). This project brief gives an overview of SHRP 2 projects C20 and C43.

Freight Demand Modeling and Data Improvement

The SHRP 2 Project C20 research initiative provides a strategic framework for continuous improvement and innovative breakthroughs in freight transportation forecasting, planning, and data. With more realistic and reliable freight demand models and data sources, public- and private-sector leaders will have the tools to make better-informed decisions related to transportation infrastructure, land use, economic development, and other policies fundamental to prosperity and quality of life. Relevant information includes the current movement of goods, modal mix and variations, shipping costs, time in transit, consumption rates, logistics chains, and other factors critical to the freight industry.

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Freight Demand Modeling and Data Improvement (SHRP 2 Report S2-C20-RR-1) documents the state of the practice for freight demand modeling and the process used to develop a strategic plan aimed at improving it. The report explores fundamental changes in freight modeling and in data and data collection that could provide public- and private-sector decision makers with a clearer picture of the dynamics that affect their decisions. This report can be found at http://www.trb.org/Main/Blurbs/167628.aspx or by searching the report title at www.TRB.org.

Freight Demand Modeling and Data Improvement Strategic Plan

The *Freight Demand Modeling and Data Improvement Strategic Plan* (SHRP 2 Report S2-C20-RW-2) was developed through an inclusive process of public and private stakeholders from U.S. and international freight planning communities that culminated in the Innovations in Freight Demand Modeling and Data Symposium conducted in September 2010.

The Strategic Plan identified seven strategic objectives to encourage and support future innovation in freight travel demand forecasting and data and to guide both near- and long-term implementation. The objectives reflect the desired directions for enhanced freight planning, forecasting, and data analysis identified by the many stakeholders who participated in this project. The objectives aim to stimulate innovation through the approaches laid out in the Strategic Plan and will provide the basis for evaluating progress over time.

These are the seven strategic objectives:

1. Improve and expand the knowledge base for planners and decision makers;
2. Develop and refine forecasting and modeling practices that accurately reflect supply-chain management;
3. Develop and refine forecasting and modeling practices based on sound economic and demographic principles;
4. Develop standard freight data (such as Commodity Flow Survey, Freight Analysis Framework, and possible future variations of these tools) to smaller geographic scales;
5. Establish methods for maximizing the beneficial use of new freight analytic tools by state transportation agencies and metropolitan planning organizations in their planning and programming activities;
6. Improve the availability and visibility of data among agencies and between the public and private sectors; and
7. Develop new and enhanced visualization tools and techniques for freight planning and forecasting.

The sample research initiatives represent a near-term opportunity to advance research that addresses freight-related decision-making needs. These ideas for short-term research have been vetted by a range of stakeholders.

The future directions lay out an organizational approach to continue to identify freight modeling and data priority needs, spur innovative ideas, and foster breakthrough solutions for wide application. The Global Freight Research Consortium (GFRC) identified as part of this research effort is seen as an effective means for making continued analytic breakthroughs and targeting future supporting research.

The ultimate long-term goal for the research is to build on Strategic Objectives 2 and 3.This research is designed to lead to the development of a full network-based freight forecasting model that incorporates all modes of freight transport and accurately reflects the various factors related to the supply of freight infrastructure and services (Strategic Objective 2) and the underlying demand for these services (Strategic Objective 3). This model has the potential to effect a dramatic change in current freight planning and forecasting. It is a highly ambitious endeavor because of the complexity of freight transportation and the numerous elements that are necessary to achieve this long-term goal.

The other five strategic objectives are tied to this goal through the development of the applicable knowledge base needed to further the goal (Strategic Objective 1), the development and dissemination of data necessary to support it (Strategic Objectives 4 and 6), and the development of enhanced methods for disseminating information from

these analytic tools for public stakeholders (Strategic Objective 5) and decision makers (Strategic Objective 7).

The Strategic Plan is available at http://www.trb.org/Main/Blurbs/167629.aspx or by searching the full report title at www.TRB.org.

Speaker's Kit

SHRP 2 Project C20 developed a speaker's kit, which is intended to be a "starter" set of materials for use in presenting the freight modeling and data improvement strategic plan to a group of interested professionals. It includes a PowerPoint presentation and a brochure that highlight the process of why and how the strategic plan was developed and its key points. The brochure and presentation are available at http://www.trb.org/Main/Blurbs/167629.aspx.

2010 Innovations in Freight Modeling and Data Symposium: A Foundation for Moving Forward

The Innovations in Freight Modeling and Data Symposium held in September 2010 provided a solid foundation for future efforts. The symposium's success rested on several factors:

- The symposium provided a low-cost approach to generating a variety of research concepts;
- The competitive nature of the symposium generated numerous excellent ideas and promising research concepts;
- The symposium brought together academic, private-sector, and public-sector perspectives; and

Tetsuro Hyodo, Tokyo University of Marine Science and Technology, receives an award for his work on Modeling Truck Route Choice Behavior by Traffic Electronic Application Data. The award was presented at the 2010 Innovations in Freight Demand Modeling and Data Symposium by James Brock, chair of the symposium planning team.

- The symposium fostered a greater shared understanding of the issues and requirements for improved freight modeling and planning.

The focus and emphasis areas of future symposia will vary, but the principles of collaboration, competition, and communication represent significant building blocks for successful symposia.

This symposium featured 18 presentations selected to address the challenge of developing the next generation of freight demand models. It was characterized by a combination of modeling data and ideas presented by U.S. and international practitioners and academics, followed by open and direct dialogue and debate. It provided a strong foundation for moving forward because the symposium

- Generated ideas;
- Attracted international attention and participation;
- Resulted in the identification of several promising areas of research; and
- Provided a forum for public- and private-sector stakeholders, as well as university expertise.

Papers presented at the 2010 symposium are available at http://www.trb.org/Main/Blurbs/167629.aspx.

2013 Symposium: Innovations in Freight Modeling and Data: Integrating Supply-Chain Models and Data into Public-Sector Freight Demand Modeling

To build on the success of the 2010 symposium, SHRP 2 Project C43 (Second SHRP 2 Freight Modeling and Data Innovation) is planning a second symposium on innova-

tions in freight modeling and data. This symposium will provide a forum to explore how transportation planners, by focusing on freight flows, can benefit from using private-sector techniques to amplify existing freight demand forecasting models, data, and methods.

Through a public- and private-sector dialogue, the symposium will examine modeling approaches that are used in the private sector, particularly those that are applicable to public-sector planners and modelers. The meeting seeks to have practitioners from both private industry and public agencies share and learn new knowledge and tools that can help public- and private-sector decision makers improve transportation infrastructure and operations, thereby driving economic growth for the nation.

In addition, one of the primary expected outcomes of the conference is to initiate an ongoing "Community of Practice" to further the science of freight demand modeling and forecasting and to enhance the dialogue between the public and private sectors. During the course of the symposium, participants will be asked to provide input and feedback to assist in identifying and advancing priority research topics for the future.

A call for papers has been issued, and short papers and abstracts are due by August 15, 2013. The symposium will be held October 21–22, 2013, at the Crowne Plaza Hotel—Washington Dulles International Airport, Herndon, Virginia.

More information about the 2013 symposium is available at http://www.trb.org/Calendar/Blurbs/169110.aspx.

Contact

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