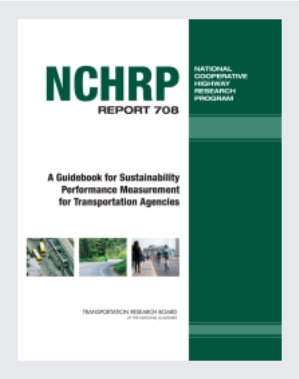

A Guidebook for Sustainability Performance Measurement for Transportation Agencies

DETAILS

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

NCHRP REPORT 708

A Guidebook for Sustainability Performance Measurement for Transportation Agencies

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TRANSPORTATION RESEARCH BOARD

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

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The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

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FOREWORD

By Lori L. Sundstrom
Staff Officer
Transportation Research Board

This guidebook provides state departments of transportation (DOTs) and other transportation agencies with a practical and easy-to-use approach to identify and apply sustainability-related performance measures, some number of which may already be integrated into agency business practices, to produce a new lens through which decision makers can view their agency's performance. It describes the underlying principles of sustainability as it relates to transportation, possible goals that can be used to address those principles, and performance measures that can be used to address those goals. Aspects of sustainability-related performance measures, including data sources and examples of use, are discussed. A reference compendium of performance measures has also been provided.

This guidebook should be of immediate use to those who have mastered the basics of performance measurement and who are familiar with their own agencies' performance measurement program, but who are challenged with providing useful information to agency leadership on how effectively their organization is meeting or can meet sustainability goals. Examples from DOTs, private industry, and Europe illustrate how sustainability can be successfully added to an agency's extant performance measurement system.

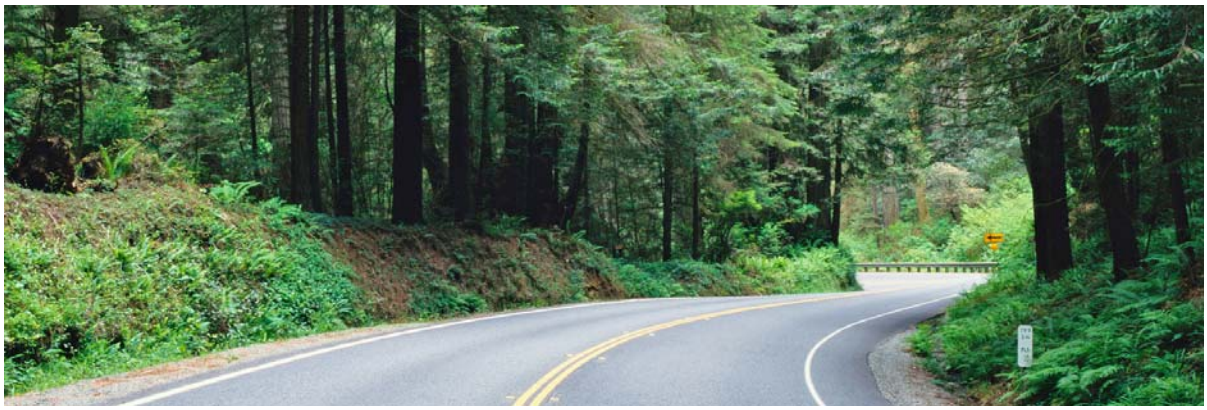
State DOTs are mission-driven organizations that strive to simultaneously achieve multiple strategic goals. Goals such as improving safety, reducing congestion, enhancing economic opportunity, contributing to community vitality, improving air quality, improving reliability, preserving system assets, and accelerating project delivery can and often do reflect the principles of sustainability—preserving and restoring environmental and ecological systems, fostering community health and vitality, promoting economic prosperity, and ensuring equity between and among population groups and over generations, to some degree. This research shows how progress toward achieving a DOT's goals can contribute to a sustainable transportation system and provides an easy-to-use approach that DOTs—or other transportation agencies—can tailor to meet their self-defined sustainability goals.

Performance measurement has evolved over the decades into an effective methodology for quantifying goals and objectives and communicating progress toward their attainment. Working with performance measures, however, can be a daunting task due to the large number of possible measures, the extensive and potentially expensive data that might be required, and computational complexity that is often introduced. Under NCHRP Project 8-74, the Texas Transportation Institute at Texas A&M University was asked to develop a guidebook for state DOTs to demonstrate how they can implement performance measurement to assess the relative sustainability of their transportation networks and corridors over space and time.

In addition to this guidebook, the contractor's project Final Report that contains the results of the literature review, surveys of the state of the practice, case study interviews, detail on research methodology and findings, and a discussion of future research needs is available on the NCHRP Project 8-74 website. The CD-ROM included with this guidebook contains an Excel-spreadsheet-based version of the performance measures compendium located in Appendix B of the guidebook. The spreadsheet allows the existing measures to be modified, and macros enable the user to generate and export a custom list of measures. Instructions for using the spreadsheet are found in Appendix C.

CONTENTS

Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the Web at www.trb.org) retains the color versions.



Chapter 1

Welcome to the Sustainability Performance Measures User's Guide

Many transportation agencies are recognizing the importance of sustainability—in terms of concern for the environment, community health and vitality, and economic development, now and into the future.

ABOUT THIS GUIDE

Many transportation agencies are recognizing the importance of sustainability—in terms of concern for the environment, community health and vitality, and economic development, now and into the future. However, these agencies often struggle to apply sustainability in their core activities. This guidebook provides a flexible framework through which transportation agencies can apply the concepts of sustainability through performance measurement. NCHRP Project 8-74, "Sustainability Performance Measures for State DOTs and Other Transportation Agencies," includes this guidebook, the enclosed CD-ROM, and a research report. The research report forms the basis for the research approach and is available at the NCHRP Project 8-74 website. The research report offers

- Background on sustainability definitions and issues,
- Theory on how to apply sustainability,
- Performance measurement for sustainability, and
- Detailed references and resource material.

The guidebook will help you, your partners who are familiar with how sustainability applies to your work and are ready to design performance measures, and other transportation professionals:

- Establish and use sustainability performance measures to evaluate your programs and

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- Gauge the effectiveness of these strategies in implementing sustainability.

HOW IS IT ORGANIZED?

Every transportation agency brings different resources, goals, and challenges to incorporating sustainability. This guidebook allows you to quickly find the information and resources you need to implement and evaluate sustainability. Highlights from case studies are located throughout the chapters to provide real-world examples of how agencies are incorporating sustainability performance measures. The appendices contain full case studies as well as other supplemental materials that you may find useful, including a glossary of terms and examples of performance measure use. The CD-ROM accompanying this guidebook contains an electronic compendium of performance measures as well as a PowerPoint presentation and materials that you may want to use to introduce sustainability concepts to your agency. These electronic materials are also available on the NCHRP Project 8-74 website. Following is a description of the remaining chapters of the guidebook:

- **Chapter 2: What Does Sustainability Mean to Transportation Agencies?** – This chapter provides an overview of the basics of sustainability, explains how these basics relate to the work of transportation agencies, and orients any user to the principles of sustainability.
- **Chapter 3: Getting Organized—Setting Yourself Up for Success** – This chapter discusses how to take a practical, phased approach to implementing performance measurement and offers questions to assess how you can take advantage of the data and processes you may already have in place.
- **Chapter 4: Understanding the Sustainability Performance Measurement Framework** – This chapter explains the general, applicable framework that you can use to design your agency's performance measurement system.
- **Chapter 5: Using the Sustainability Performance Measurement Framework** – This chapter provides a step-by-step explanation of how to use each of the components of the framework to fit your agency's needs. You can turn to the step that matches where your agency is in the process.
- **Chapter 6: Resources for Performance Measure Development and Application** – This chapter presents an overview of the compendium of objectives and performance measures.
- **Chapter 7: Sustainability Measures Checklist** – This chapter provides a checklist to make sure your goals, objectives, and measures are consistent with the principles of sustainability and that the approach you have designed will give you the information you need.
- **Chapter 8: Examples of Practice in Sustainability Measurement** – This chapter gives an overview of the variety of work other agencies have under way and gives links to other examples.
- **Chapter 9: Summary and Additional Resources** – This chapter summarizes what has been presented in the guidebook, lists other resources, and gives an overview of material incorporated as appendices.

Chapter 2

What Does Sustainability Mean to Transportation Agencies?

Transportation agencies should apply the general sustainability principles within their specific transportation context. They can set their own goals to support broader sustainability and play their part in promoting a sustainable future.

GUIDING PRINCIPLES OF SUSTAINABILITY

What is sustainability? What is a transportation agency's role in supporting sustainability? While attention to sustainability has grown, defining and incorporating sustainability into day-to-day business presents a challenge to agencies.

In general, sustainability encompasses a holistic consideration of economic, social, and environmental progress—usually referred to as sustainability dimensions—with a long-term perspective. Sustainability includes not only conditions today but addresses the needs of future generations as well. And sustainability incorporates equity among socioeconomic and demographic groups, both today and over time. The fundamental principles of sustainability as envisioned in this guidebook are that sustainability entails meeting human needs for the present and future while:

- Preserving and restoring environmental and ecological systems,
- Fostering community health and vitality,
- Promoting economic development and prosperity, and
- Ensuring equity between and among population groups and over generations.

This guidebook follows the traditional triple bottom line approach to sustainability as expressed by the environmental, social, and economic dimensions. Additionally, the researchers view the principle of equity as reinforcing the other sustainability dimensions, as a support to the three-legged

sustainability stool (see Figure 1). Equity is not seen as a separate leg of the stool; instead, it is seen as an overarching principle that plays a major part in each of the other principles. Achieving sustainability should not be a trade-off among the principles, but rather an intersection of all of these principles. As communities strive for sustainability, they work to make decisions that will promote, rather than diminish, progress in each of these principles.

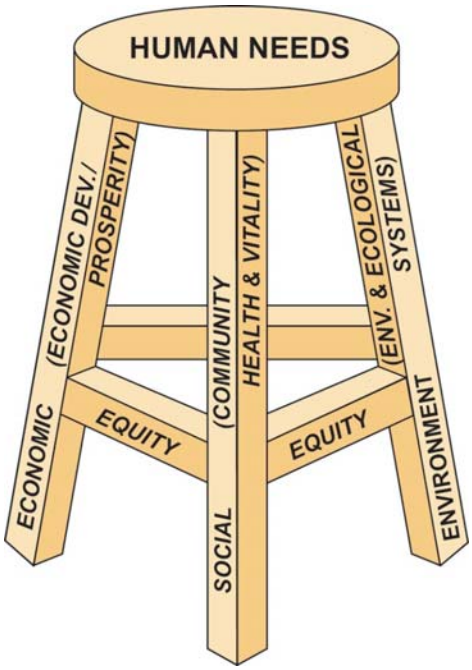

Figure 1. Principles of sustainability and the significance of equity.

SUSTAINABILITY AND SUSTAINABLE TRANSPORTATION

Globally, sustainability requires a comprehensive, multidisciplinary approach and the participation of a wide set of actors. The transportation sector can be viewed as a major contributor to the bigger picture of sustainability. Transportation agencies can set their own goals to support broader sustainability and play their part in promoting a sustainable future.

This guide can help transportation agencies assess their goals relative to the higher level principles of sustainability, while recognizing that each agency—from any sector—is constrained by its mission and scope of authority. The aim is to help transportation agencies do their part—to operationalize the general sustainability principles within their specific transportation context.

How Can Transportation Agencies Apply Sustainability Concepts?

Transportation sustainability extends beyond the organizational boundaries of national, state, and local transportation agencies, and it cuts across the various divisions and departments that are part of a transportation agency. Sustainability applies to every stage of decision-making: planning, design, and implementation of projects and infrastructure, as well as day-to-day

operations and maintenance. Therefore, to make progress in incorporating sustainability, agencies need to acknowledge the overlaps among their organizational boundaries and be willing to collaborate. In addition, the presence of an authorizing environment or the specifics of legislative mandates influence how sustainability is implemented.

Many agencies, across all levels of government, are responsible for transportation infrastructure in the United States:

- National level
  - Congress and the Executive Branch
  - U.S. Department of Transportation (U.S. DOT)
  - FHWA
  - Federal Transit Administration
- State level
  - State DOTs
  - Independent state toll authorities
- Regional and local level
  - Metropolitan planning organizations
  - Local public works and transportation departments
  - Public transit agencies
  - Local-level toll authorities

Given this broad set of transportation agency actors, sustainability performance measures are needed that can support the work of individual agencies and provide insight into progress on a broader scale.

Within any transportation agency, sustainability can be influenced by decisions that are made at several different points in the project development process—usually by separate organizational units that are often compartmentalized. For example, protection of watersheds depends—in equal measure—on choices made by different agency offices that are responsible for which projects get built, how they are designed and constructed, and how they will be maintained over their lifespans. Typically, transportation decisions include long-range planning, programming, environmental review, project design, construction, maintenance, and operations. Ultimately, each of these steps in project development and infrastructure management affects sustainability and can be used as opportunities to develop and confirm sustainability goals and actions. These steps and their roles in an agency's sustainability approach are discussed in the following.

- **Long-range transportation planning –** State DOTs and metropolitan planning organizations (MPOs) use the long-range planning process to develop a vision for state or regional transportation investment—building on a variety of complex national, state, and local transportation interests and considering the levels of funding anticipated. States and regions use different approaches to develop their long-range transportation plans (LRTPs),

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and the outcomes are different as well. Transportation plans vary from broad policy statements to specific and detailed preferred investment strategies. An LRTP will often help quantify long-term needs, revenues, and funding gaps; identify and define investment strategies; and/or establish a framework, priorities, or other guidance to drive shorter-term investment decisions. The LRTP can also reflect the state and local sustainability objectives, policies, and programs.

While state DOTs and MPOs have significant leeway in how they develop and use their LRTPs, all agencies must comply with federal planning laws, regulation, and guidance. States must self-certify their long-range transportation planning process in conjunction with the submittal of a Statewide Transportation Improvement Plan (STIP) at least once every four years. States also must develop plans around planning factors that establish various considerations that must be incorporated into state planning processes. *Long-range planning is a point at which expectations for sustainability performance can be discussed—particularly in terms of desired sustainability outcomes—and broad performance goals established that drive subsequent investment patterns.*

- **Short-range transportation programming –** State and local transportation departments use capital programming to match priority transportation project needs with the funds to fulfill them. The short-range capital program is a generic term used to describe (1) an agency's list of high-priority transportation projects with well-developed scopes and precise budgets to be built in a defined time frame, and (2) the process used by a state to arrive at the list by deciding how money for transportation will be spent among competing project needs. An effective capital program will combine many short-term, project-level spending decisions in order to make progress in achieving long-term transportation goals. Development of a state or local capital program is usually a collaborative effort between the state DOT and their local and federal partners. *Therefore, transportation programming is a point at which broad expectations about sustainability established in long-range planning can be translated into explicit targets associated with implementation of a specific set of projects.*

- **Project-level planning –** Once a transportation project is identified in a capital program, project delivery begins with planning, which takes place before environmental documents are prepared. In general, planning efforts are most extensive for major projects with potential for significant environmental impacts. Minor projects—such as guardrail replacement, acquisition of new buses, or roadway resurfacing—may involve little or no planning activity. The planning phase helps agencies to identify project needs, community concerns, and potential solutions. In many states, early consideration of environmental issues before an environmental document is prepared is an increasingly common part of project planning. *Project-level sustainability performance measures may be used to inform project-level planning decisions*.

- **Project-level environmental review** – Transportation infrastructure projects that receive federal support must follow an elaborate environmental review process to ensure that the impacts of federal actions on the environment are considered before the project goes forward. Federal environmental review procedures are guided by the National Environmental Policy Act (NEPA), which also functions as an umbrella process for

assuring compliance with numerous other media-specific environmental laws and regulations that include permitting and consultation activities involving a variety of federal agencies. Some states have their own, more stringent environmental review procedures that exceed NEPA in certain aspects. Frequent federal partners in the environmental/NEPA process include the U.S. Army Corps of Engineers (U.S. ACE), the U.S. Fish and Wildlife Service, the Advisory Council on Historic Preservation, the U.S. Environmental Protection Agency (U.S. EPA), and others. Most commonly, state DOTs lead the environmental process, but transit agencies or large local transportation departments may also manage these processes. NEPA establishes three classes of environmental review actions for transportation projects. These classes are based on the magnitude of their anticipated environmental impacts. An environmental impact statement (EIS) is required for major projects where a significant environmental impact is anticipated, such as construction of a new segment of controlled access freeway. *As in planning, project-level sustainability performance measures may be used to inform project-level environmental decisions.*

- **Design, land acquisition, and permitting** – Once the NEPA process is complete and basic horizontal and vertical alignments for the project are agreed upon, detailed engineering plans can be prepared. Most design work is unrelated to environmental mitigation. Design work may include environmental compensation or enhancement features, such as storm-water control facilities, wetland mitigation, or noise walls. Permits from natural resources agencies, such as the U.S. ACE, may also be required at this phase during project delivery and require time to prepare and approve. Permits may be required for wetland restoration, storm-water runoff control, conservation of historic resources, or special construction management techniques. Sustainability may also find its way into design and right-of-way (ROW) determination related to such components as aesthetics, compatibility, multimodal accommodations, construction requirements, and materials and equipment selection. *Design, land acquisition, and permitting are points at which the predictions made during planning and environmental review can be verified and translated into outcome measures of sustainability.*

- **Construction, maintenance, and operations** – During construction, DOTs use contractors to build projects and typically retain an overall project management and oversight role. There can be major sustainability considerations in construction, maintenance, and operations. Construction and staging footprints can affect the amount of land affected by construction. Many projects require erosion control practices and storm-water management that can reasonably be described as environmental costs. Decisions are made on many reconstruction projects to work at night or on weekends, to reclaim or recycle materials from the existing facilities, and to preserve portions of a facility that can continue to serve satisfactorily for the project life. Many of the considerations described also apply to maintenance. Disruption of service, regardless of mode, can be a major sustainability consideration. Sustainability also influences selection of materials and methods and frequency of maintenance; operations affect the ultimate performance of the transportation facilities and services. DOTs at all levels use many tools to deliver efficient and safe operations. *How construction, maintenance, and operations work is done can be designed to support an agency's sustainability goals.*

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What About Legislative Mandates?

The concept of sustainability presents a legislative and organizational challenge because its broad environmental, social, and economic reach cuts across organizational and disciplinary lines that exist within the federal, state, and local governments. These divisions of expertise exist in the private sector as well, which also responds to the legislative frameworks created by government. The authorizing environments of state DOTs and other transportation agencies are driven by their mission statements, strategic goals, and other mandates—and today these may include a focus on sustainability. For agencies to legitimately address concerns related to sustainability, their authorizing environment should enable them to do so.

In the United States, there is currently no federal regulation that explicitly focuses on sustainability. However, the social and environmental regulations that do exist—such as NEPA, the Americans with Disabilities Act (ADA), and the Safe, Accountable, Flexible, and Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU)—provide a patchwork framework for state DOTs and other transportation agencies to address components or elements of sustainability. Indeed, SAFETEA-LU and its two predecessors (ISTEA and TEA-21) called for transportation agencies to promote economic development while protecting the environment and sustaining the quality of life. Further, while there is currently no regulation on sustainable development itself, important elements of the concept are expressed in existing environmental, social, and sector-specific regulation. In effect, transportation agencies are already operating under a nonintegrated form of sustainability agenda, whether this is explicitly recognized or not.

The lack of federal legislation on sustainable development or sustainable transportation provides states the opportunity to take the lead in creating an authorizing environment conducive to sustainability. Many states and state DOTs have created authorizing environments to pursue sustainability goals. While these legislative frameworks establish the motivation for change, it is important that state DOTs and other transportation agencies invest time in understanding how sustainable development manifests itself in their particular case; that is, each region is likely to face a different combination of environmental, social, and economic challenges that will shape the agency response to these challenges.

USING PERFORMANCE MEASURES FOR SUSTAINABILITY

Performance measures are broadly defined as quantifiable criteria that can be used to track progress toward specific goals or objectives. Ideal performance measures are easily understood, provide a clear indication of moving toward an established goal, and can be tracked using accessible and available data. Sustainability performance measures are those that have been selected or organized by a set of sustainability goals and objectives. Sustainability performance measures can be freshly created to specifically support the defined objectives. However, many conventional performance measures that DOTs use to monitor and track progress may also be useful to track sustainability. Some are likely to have stronger links to sustainability than others. *Recognize that it is the application of a collective set of measures, aligned with the objectives and goals and viewed within the context of the sustainability principles, that make them relevant to a sustainability framework.*

Using Performance Measures

Performance measures can be used in a variety of ways:

- **Description** – They can help describe the effect of your program or policy.
- **Evaluation** – They can be used to assess your progress and diagnose what problems or barriers you are encountering that need to be addressed.
- **Accountability** – They can be used to set targets for specific staff or programs and can measure how well they are doing in reaching those goals.
- **Decision-support** – They can help inform which approach would support the most sustainable outcomes.
- **Communication** – They can be used to explain to your partners or the public what your program or policy is achieving.

While most performance measures can generally be applied for the applications listed above, some types may be uniquely suited to certain applications. Knowing what you want to accomplish with the results of your performance tracking will help you define measures that best fit the purposes you have in mind.

Applying Performance Measures in Different Contexts

Performance measures can be applied over different time frames at different levels and types of operation within your agency. Applying measures at any of these different levels can provide useful information, but they will be used in different ways. For example, measures to assess the sustainability of your right-of-way vegetation-management program over a one-year cycle will be defined differently than measures to assess the sustainability of your agency's long-range plan.

Some agencies have found it useful to start by designing measures for one component of their overall program and building from there. Others begin with an agency-wide, multiyear perspective and drill down. Performance measures should add value to your decision making. The following chapter guides you through some questions you can ask to design a successful performance measurement approach.

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Chapter 3

Getting Organized: Setting Yourself Up for Success

A phased approach to developing sustainability performance measures involves defining what you want to accomplish and understanding where you are starting from. The approach to sustainability performance measurement should evolve over time.

Before diving in to the actual tasks of defining performance measures, it's important to make sure that you are well organized, the people you will need to get the job done are involved, and your working group and managers have a common understanding of where you're beginning and what you want to accomplish.

This chapter discusses the usefulness of a phased approach to developing sustainability performance measures and provides a few questions that will help you assess where you're starting from.

UNDERSTAND WHY YOU ARE DOING THIS

Before you begin, it's useful to define what you want to accomplish with the sustainability performance measurement system. A discussion with key managers and partners can help clarify your primary purpose(s) and what you have to work with to get there. Some questions to consider include

- *What do you want to accomplish by using sustainability performance measurement?* For example, do you want to reduce long-term costs? Build public support? Address energy consumption? Respond to regulatory requirements? Clarifying your reasons for tracking sustainability progress will help you design an effective approach.
- *In what phase(s) of decision making do you want to use sustainability performance measurement?* For example, are you most interested in integrating sustainability

considerations into the planning process, or is your agency's focus mainly on operational issues?

- *How will you use the results?* Performance measures can be used to help you understand and describe what effect your activities and programs are having; assess what's working, not working, and why; hold staff and programs accountable; make solid decisions; and communicate the value of your work. How does your agency intend to use the results of the measures?

Case Study Summary: Colorado Department of Transportation

The Colorado Department of Transportation (CDOT) has taken the lead in addressing sustainability through its interagency Transportation and Environmental Resource Council (TERC). TERC has representatives of transportation agencies and resource agencies from throughout the state. TERC established a sustainability subcommittee to encourage sharing between agencies working on sustainability. The subcommittee focuses on

- Sharing best practices between agencies;
- Creating a sustainability template that addresses NEPA;
- Creation of a potential coordinated certification system (e.g., Greenroads™, GreenLITES);
- Attempting to create a sustainability policy that can be adopted by all members; and
- Developing performance measures, potentially a statewide baseline.

In addressing sustainability through the TERC, the aim is not to define sustainable transportation, but rather to get a consensus on what certain common sustainability principles are and how they can be applied in the transportation sector.

UNDERSTAND WHERE YOU ARE STARTING FROM

Different agencies have different levels of experience and different resources available. In addition to identifying why a sustainability performance measurement process is being initiated, take into account the resources you have on hand and potential restrictions and requirements. Some questions to consider include

- *Is this a new process for your agency?* Measuring sustainability is a new concept for many agencies even if they are familiar with more traditional performance measures. Some staff may question the value of introducing a new set of metrics or may have concerns about how the findings may be used or affect their programs. Others will have questions about how the objectives and measures are defined. If this is a new process for your agency, it will take time to develop internal buy-in, build consensus on what process is used to design the measurement program, and agree on what will be the final measures.
- *Have you defined goals?* An agency's current long-range or strategic plan typically has defined goals that provide a starting point for developing sustainability objectives and

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measures. These goals will need to be reassessed to ensure that they address the sustainability principles.

- *Are there external requirements?* Some agencies are required to develop sustainability performance measurement programs to meet legislative or executive requirements set at the state or local levels. These agencies need to ensure that the approach they design meets external requirements while supporting the agency's goals and management processes.
- *What partners are you working with?* Defining your sustainability goals and objectives requires a collaborative approach—drawing on partners from other disciplines that bring their knowledge and perspectives to the table. Who you engage in the process of developing your sustainability measurement approach will depend on the focus of your sustainability measurement program.
- *Are you integrating this into an existing performance measurement process?* Many agencies already have a performance measurement system for some aspects of their business operation. Typical measures have focused on system performance, facility levels of service, incident frequency, and so forth. In order to expedite data collection, coordinate staff efforts, and promote a comprehensive view of agency performance, it can be most effective to integrate your sustainability performance measurement approach into your agency's existing process. However, some agencies choose to manage their sustainability assessment as a parallel activity, depending on their specific objectives.

Case Study Summary: California Department of Transportation

The California legislature has passed a set of bills that have required agencies to consider topics correlated with sustainability. Much of the California Department of Transportation's (Caltrans) work related to sustainability is in response to this legislation.

- **Assembly Bill 32: Global Warming Solutions Act (AB32)** – Signed in 2006, this bill set the 2020 greenhouse gas emissions bill into law. The Air Resources Board (ARB) was charged with developing actions to reduce greenhouse gas (GHG) emissions. The goal is to reach 1990 levels by 2020 and 80% of 1990 levels by 2050.
- **State Bill 375** – Signed into law in September 2008, this bill furthers the GHG-related activities proposed in AB32. Caltrans expects to see performance measures come out of this bill. The bill addresses three areas:
  - The ARB must develop regional emission reduction targets for each of the 18 MPO areas.
  - Each MPO is required to develop plans to meet its GHG reduction target.
  - The California Environmental Quality Act requirements are streamlined for specific residential and mixed-use developments.
- **State Bill 391** – Signed into law in March 2009, this bill requires Caltrans to prepare a state plan similar to the regional blueprints. Specifically, the bill must address how the state will reduce GHG emissions to 1990 levels by 2020 and provide a plan to outline the multimodal transportation system needed to achieve the AB32 reductions.

PHASING IN A PERFORMANCE MEASUREMENT APPROACH

Start with what you have. A comprehensive approach to sustainability performance measurement and management evolves over time as your agency builds understanding of how your work contributes to sustainability, as staff awareness of sustainability concerns grows, and as your agency undertakes new initiatives to promote sustainability. Focusing on a few key objectives and measures and adding additional measures over time can be an effective way to begin. Some measures of sustainability can be based on data your agency is already collecting; in fact, one data set may support measurement of multiple objectives. As your measurement approach takes shape, you can identify gaps in information and add additional measures or collect different types of data.

- *What data do you have available?* An inventory of existing data sources is an important step to assess the types of information that your agency already has. While in some cases you may decide to collect new data, often the data you have at hand can be used to support many of the sustainability measures you define.
- *How much/how soon?* A sustainability performance measurement program needs to be sustainable. A well-designed approach to measuring sustainability will support and inform your agency's work without placing unnecessary burdens on your staff or budget. As you design your performance measurement system, keep in mind that the approach needs to be useful, feasible, and manageable over time.
- *Are you ready to do this?* Having organizational support and a strong team is essential to developing an effective performance measurement program. Senior management needs to endorse the development of sustainability performance measures and provide clear direction on the purpose(s) for which the measures will be used. A working group could be established that has a clear mandate, schedule, and resources required to do the job, with an understanding of the approval process that will be used to review and accept its recommendations. You may want to include external partners and stakeholders directly on the working group and/or establish a process through which the group can get ideas and input as it goes along.

Case Study Summary: Metropolitan Washington Council of Governments

The Metropolitan Washington Council of Governments (COG) is a regional organization of 21 governments that surround the nation's capital. The National Capital Region Transportation Planning Board is part of COG and is the federally designated MPO for the Washington, DC, region.

At COG, explicit incorporation of the term "sustainability" into its programs is in the beginning stages. Inclusion of sustainability terminology in the *Region Forward* report (a policy study that outlines desirable attributes for the Washington region) signals that COG's leaders accept the concepts embodied by sustainability. Development of the report was guided by a group of COG stakeholders called the Greater Washington 2050 Coalition, which was established in 2008 by COG to build agreement among its members about a long-term vision for tackling issues of growth, transportation, and the environment. The coalition is composed of public officials and business, civic, and environmental leaders from across the region.

Chapter 4

Understanding the Sustainability Performance Measurement Framework

The fundamental components of the sustainability performance measurement framework include understanding sustainability; developing goals, objectives, and performance measures; implementing performance measures; refining the framework; and applying continuous feedback.

The sustainability performance measurement (SPM) framework was developed to address the question: *What does a transportation agency need to be equipped with in order to successfully address sustainability issues through performance measurement?* The SPM framework consists of three types of components, termed as fundamental components, overarching components, and auxiliary components. Figure 2 illustrates the basic components of the SPM framework. A description of the framework components follows. See the research report for a more detailed description of the SPM framework. You may also want to use the overview presentation provided (Appendix G) as you talk with colleagues, introduce the framework to your agency, and orient your working group.

FUNDAMENTAL COMPONENTS

Applying the framework in a step-by-step manner requires these components (described in detail in the next chapter):

Step 1 – Understanding sustainability,

Step 2 – Developing transportation sustainability goals,

Step 3 – Developing objectives,

Step 4 – Developing performance measures,

Step 5 – Implementing performance measures, and

Step 6 – Refining the framework and applying feedback.

OVERARCHING COMPONENTS

Overarching components of the framework are items that need to be taken into consideration throughout the framework application process, and include aspects such as the engagement of stakeholders, partners, and external agencies.

AUXILIARY COMPONENTS

Auxiliary components are related but optional components that supplement the framework application process but are not central to it. These include items such as (1) developing a working definition of sustainability, (2) organizational sustainability initiatives that are independent of a transportation agency's functions (e.g., energy efficient buildings, recycling of office waste), and (3) organizational application of broader transportation sustainability performance measures (such as carpooling or ridesharing) specifically for the agency's employees.

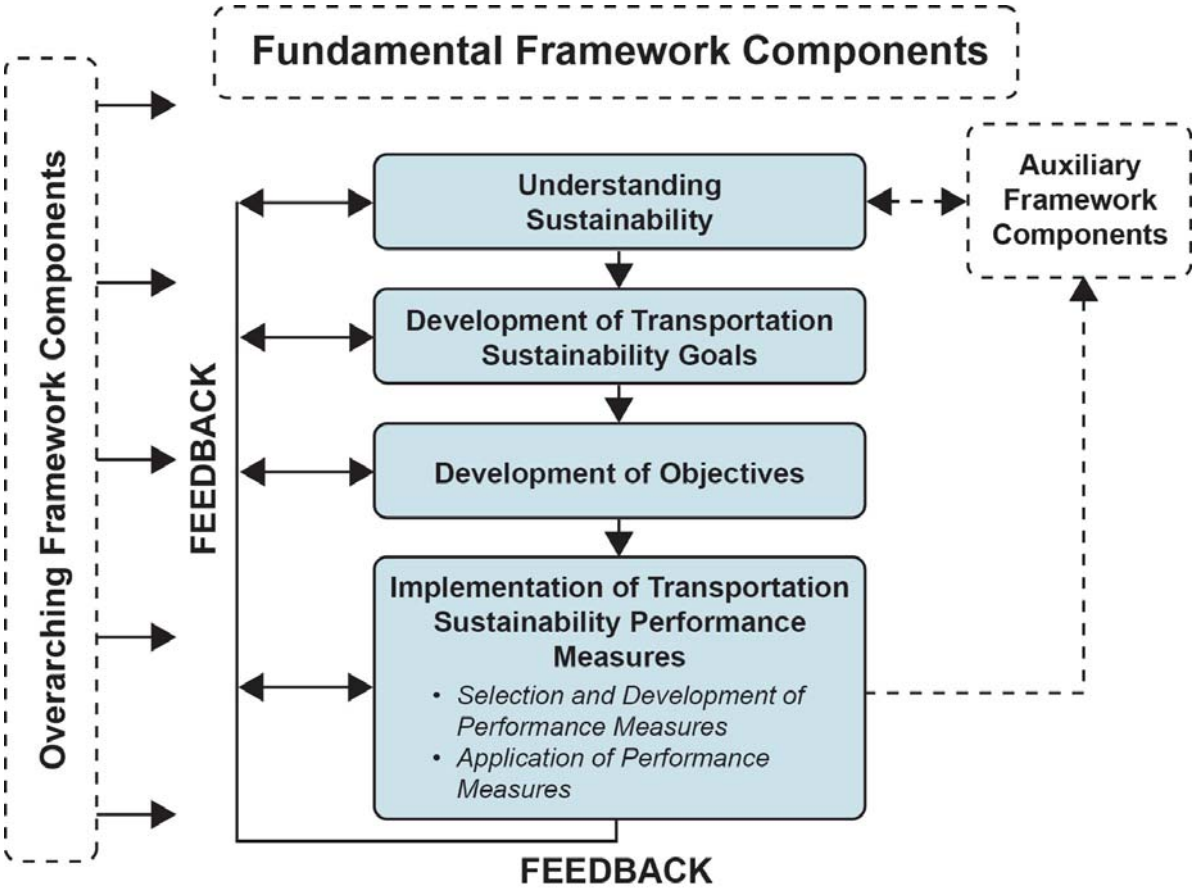

Figure 2. Simplified framework diagram.

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Chapter 5

Using the Sustainability Performance Measurement Framework

Successful implementation of the sustainability performance measurement framework requires an agency to consider the overall context in terms of the type and scale of performance measurement application.

This chapter details how to apply the fundamental steps of the sustainability performance measurement framework. This guidebook discusses the application of the framework through the following steps:

Step 1 – Understanding sustainability,

Step 2 – Developing transportation sustainability goals,

Step 3 – Developing objectives,

Step 4 – Developing performance measures,

Step 5 – Implementing performance measures, and

Step 6 – Refining the framework and applying feedback.

Chapters 6 and 7 of this guide introduce the compendium of objectives and performance measures and a sustainability checklist—resources for further applying and reviewing the SPM framework.

STEP 1 – UNDERSTANDING SUSTAINABILITY

Understanding what sustainability means is the first step in being able to apply the framework for sustainability. This framework defines a set of general, inclusive principles of sustainability that become the foundation for all subsequent decisions (Figure 1). The four sustainability principles are

1. Preserving and enhancing environmental and ecological systems,
2. Fostering community health and vitality,

3. Promoting economic development and prosperity, and
4. Ensuring equity between and among population groups and over generations.

Developing a Definition of Sustainability

Sometimes a definition or statement on sustainability is taken as the starting point for an agency to apply sustainability through goals and performance measures. While defining sustainability is a valuable exercise, it does not form the basis for the application of this guidebook's SPM framework, which is instead rooted in the sustainability principles. Consider defining sustainability as a supporting component in this framework. See Appendix A for more guidance on how to define sustainability for your agency.

STEP 2 – DEVELOPING TRANSPORTATION SUSTAINABILITY GOALS

To address and promote the four sustainability principles, 11 key goals have been defined for transportation agencies (Table 1). While the principles are general and are not transportation specific, these goals:

- Can relate the principles of sustainability to the transportation sector;
- Can be adapted, expanded, or customized, and can help your agency align its programs with sustainability principles;
- Can be revised to better align with your agency's current or existing goals or your agency's particular mission; and
- Can frame your collaborative work with other agencies (transportation and non-transportation related).

By focusing on common goals, you and your agency partners decide how to leverage each other's work through joint projects and shared expertise. Explore how to share resources and potentially save money by matching funds or collaborating on common activities.

Defining Sustainability Goals

First, define your sustainability goals. The four fundamental sustainability principles provide guidance. A set of goals that cover these principles ensures that you have considered all aspects of sustainability. This framework and the compendium can be easily used in focused areas (e.g., the environmental aspect) if your agency chooses. Incorporating all the principles helps agencies fully understand the impacts and benefits of sustainability.

The process that you take for defining and/or confirming your agency's sustainability goals will depend on whether your agency has established and adopted goals or is in the process of defining, redefining, or adopting a set of goals.

Working with Established Goals

Next, line your agency goals up with the four sustainability principles. You may find that all goals are relevant to one or more principles, or it may be that some are not relevant to any of the

principles. To assess if you need to add or revise your goals, determine if your agency addresses all of the principles within its current goals.

Once you have organized your goals by principle, use this organization to relate them to the example goals in Table 1. There is no requirement that the example goals match yours, but linking them will help identify where additional goals could help round out your sustainability program. These goals will be directly supported by your measures, so it is critical that you select goals that reflect your agency's overall mission and relationship to sustainability in order to build a solid framework.

Case Study Summary: New York State Department of Transportation

The New York State Department of Transportation (NYSDOT), as part of the development of their GreenLITES sustainability effort, uses a set of six principles (similar to the goals as defined in this framework) to organize the context of sustainability:

1. Protect and enhance the environment;
2. Conserve energy and natural resources;
3. Preserve or enhance the historic, scenic, and aesthetic project setting characteristics;
4. Encourage public involvement in the transportation planning process;
5. Integrate smart growth and other sound land-use practices; and
6. Encourage new and innovative approaches to sustainable design and how facilities are operated and maintained.

Defining New Goals

The 11 goals in the framework can serve as guidance as your agency selects and refines a set of sustainability goals. They can be edited and revised to any extent that creates a version that best fits your agency. You can also review the goals that other agencies have developed to get ideas; some agencies have chosen to use an even broader set of goal categories (e.g., public health, location efficiency) than are covered by the 11 goals in this framework. If you are in the process of identifying goals through a long-range transportation plan or other agency-wide document, these goals may become part of a larger set. They can also stand on their own as a set of sustainability goals.

Table 1. Recommended transportation sustainability goals.

Sustainability Goal	Definition
1. Safety	Provide a safe transportation system for users and the general public.
2. Basic accessibility	Provide a transportation system that offers accessibility that allows people to fulfill at least their basic needs.
3. Equity/equal mobility	Provide options that allow affordable and equitable transportation opportunities for all sections of society.
4. System efficiency	Ensure that the transportation system's functionality and efficiency are maintained and enhanced.
5. Security	Ensure that the transportation system is secure from, ready for, and resilient to threats from all hazards.
6. Prosperity	Ensure that the transportation system's development and operation support economic development and prosperity.
7. Economic viability	Ensure the economic feasibility of transportation investments over time.
8. Ecosystems	Protect and enhance environmental and ecological systems while developing and operating transportation systems.
9. Waste generation	Reduce waste generated by transportation-related activities.
10. Resource consumption	Reduce the use of nonrenewable resources and promote the use of renewable replacements.
11. Emissions and air quality	Reduce transportation-related emissions of air pollutants and greenhouse gases.

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Case Study Summary: Oregon Department of Transportation

The Oregon Department of Transportation (ODOT) has created a sustainability plan that is organized around seven focus areas. These focus areas are similar to the goals developed for this project:

1. Health and safety,
2. Social responsibility/workforce well-being and development,
3. Environmental stewardship,
4. Land use and infrastructure,
5. Energy/fuel use and climate change,
6. Material resource flows, and
7. Economic health.

Within each of these seven focus areas, ODOT has developed goals, indicators, strategies, and actions. For more information, go to http://www.oregon.gov/ODOT/SUS/sustainability_plans.shtml#Sustainability_Plan__Volumes_I__II__III_.

Mapping Goals to Sustainability Principles

The sample goals in Table 1 reflect general sustainability principles as they apply to the transportation sector. All of your goals that form part of the final agency goal set should relate to at least one principle of sustainability. Often, a goal will support more than one principle. *Yet no one goal in itself is sufficient to achieve sustainability—it takes multiple goals, pursued in concert, to promote sustainability*. When a final set of goals is defined, it's important to cross-check the package of goals to ensure that all of the principles are well addressed. In doing so, take care not to force-fit the goals to make them map to the principles. A balanced goal set, however, achieves comprehensive coverage of the basic principles of sustainability.

Addressing Equity

Equity takes special consideration; as discussed in Chapter 2 and illustrated in Figure 1, it is an overarching consideration for the principles of sustainability. Even if a goal successfully supports one or more of the first three sustainability principles (environmental, community health and vitality, economic prosperity), it could still have a negative impact on equity. For example, the economic and environmental benefits of a program could be distributed inequitably across wealthier and lower-income communities or have a negative effect on certain areas.

In approaches that are not sustainable, these equity impacts are sometimes neglected for economic and environmental gain. To avoid this pitfall, each goal should be examined in terms of potential equity and distributional impacts. Your agency may already address these issues in terms of environmental justice requirements. This assessment should examine these factors of

equity, and they should be looked at in intragenerational (i.e., present-day) and intergenerational (i.e., future) contexts of

- Income,
- Age,
- Race and ethnicity,
- Disabled/handicapped populations,
- Gender, and
- Geography (spatial).

STEP 3 – DEVELOPING OBJECTIVES

These objectives provide specific actions to meet each of your agency's established goals. Chapter 6 includes a compendium of objectives and performance measures. Table 2 shows how the objectives are organized into focus areas. The focus areas represent generic transportation agency functions that cover the range of activities associated with their core business.

While these focus areas may not completely align with the structure of your organization, they will help point you toward activities that are similar to those in your organization. If your agency has used the 11 goals in the framework as guidelines, many of the objectives listed in the compendium may be relevant or a good place to start. If your goals are quite different from those in the framework, the objectives in the compendium may provide examples of tone and level of specificity.

Using these focus areas, consider how your goals affect all agency activities and how objectives and measures may vary in the context of different agency activities. For example, many of the measures and objectives can be used in the context of both construction and maintenance. By thinking these things through, you may find it efficient to use one measure in multiple focus areas. The objectives you set may be different for different stages of your agency's work or for different units of your organization. For example, the objectives for the planning process differ from those for construction.

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Table 2. Transportation focus areas for objectives and performance measures.

Focus Area	Objective/Performance Measure
1. Planning	Planning activities include the development of long-range plans, strategies, and frameworks intended to improve one or more functional areas of the transportation system (or the entire system). Documentation resulting from planning activities may highlight a general or categorical set of problems, outline a general program of projects or activities calculated to effect change over time, and provide an estimate of the resources required; it rarely will delve into specific project parameters. Examples may include regional transportation plans, master plans, strategic highway safety plans, and long-range thematic studies or plans. Transportation planning has strong links to land-use planning and comprehensive planning, which could be taken into consideration where possible.
2. Programming	Programming is the process of determining which set of projects will be funded and the timing of that investment. These decisions are based on the policies, strategies, and other plans identified in the planning focus area. Funding availability must be considered for this process, and it may include a project prioritization tool and often requires broad input from throughout an agency and its partners. Example outcomes may include transportation improvement programs and unified planning work programs.
3. Project development	Project development involves defining the specific attributes of the projects selected during the programming area, including alternatives analysis, engineering, design, specifications, environmental and regulatory analysis, and required mitigation. Example outcomes may include alternatives analysis, environmental impact assessments, and project designs.
4. Construction	Construction involves building new transportation facilities, the addition or removal of ramps or flyovers, the addition or removal of lanes, and the addition or demolition of bridges, tunnels, or other integrated infrastructure.
5. Maintenance	Maintenance activities are broad ranging and include routine and preventive maintenance. Significant maintenance and improvement activities such as paving/repaving and major infrastructure improvements such as re-decking are also included.
6. System operations	Operations include all active or passive nonconstruction activities or systems dedicated to sustaining or improving the functionality of the transportation network. System operations include network monitoring, signalization and signage, traffic/driver information systems, tolling and managed lanes, speed control and enforcement, parking management, turning and merging permissions and restrictions, incident management, public transportation routing and management, and the management of integrated transportation and non-transportation infrastructure.

STEP 4 – DEVELOPING PERFORMANCE MEASURES

Your performance measures serve to assess your agency's progress toward each objective and provide the ongoing data to help your agency further improve performance. The measures should directly support the objectives, and building them out from your selected objectives is essential. However, your agency will have a greater chance of successful implementation if you build on the measures that you are currently tracking and using. In general, the performance measures can be classified as outcome, output, and process measures, as defined in the following.

- **Outcome measures** provide information on the achievement of broad goals such as transportation sustainability goals. These measure the result or impact of a program, policy, infrastructure decision, and so forth.

- **Output measures** relate to results or changes in terms of the transportation system and its functioning. These measure a product or concrete item that results from a process action.
- **Process measures** relate to inputs or products related to a transportation agency's activities. These measure components of an agency practice that are deemed to support the related goal or objective.

Table 3 shows examples of outcome, output, and process measures that support the same sustainability goal.

Table 3. Example of outcome, output, and process measures.

Goal: Reduce waste generated by transportation-related activity	
Measure	**Example**
Outcome	Change in the amount of waste generated by type, weight, or volume
Output	Change in the percentage of operational activities with a recycling plan or waste diversion goal
Process	An asset management system exists

While it might be easier for your agency to track process measures (since they relate most directly to actions taken by your agency), it is important to include output and outcome measures in order to truly address the goals of sustainability in terms of the transportation system performance and community level impacts.

Case Study Summary: Florida Department of Transportation

Florida DOT has not officially created a sustainability plan, but the concept and principles are interwoven throughout many agency and partner agency activities. Performance measures play a significant role in all of these programs and documents.

The department's overarching approach to sustainability is embodied within the Florida Transportation Plan, the Strategic Intermodal System, mandates on the MPOs, recent regional visioning exercises, the agency's Efficient Transportation Decision Making process, and a 2007 executive order calling for the creation of a Florida Governmental Carbon Scorecard to track and report the reduction of greenhouse gases.

Inventory Existing Measures

1. Gather a list of all performance measures currently in use across the agency (include data sources, method of tracking, frequency of reporting, etc.).
2. Match these measures with your established objectives (and by proxy, goals).
3. Identify areas where there are measures lacking. Measures can be lacking to support principles, goals, or focus areas. They can also be inadequate to support the application(s)

that your agency has chosen as the purpose of your sustainable performance measurement program.

Depending on your agency resources, this may be as far as you get. But when/if you are ready to select additional measures, the following should build on the areas that are lacking (as described previously).

Select Additional Measures

The measures listed in the compendium (Chapter 6) can provide examples your agency may want to consider. The selection and implementation of measures can be an additive process. Your agency may have a higher rate of success if only a few measures are added at a time. While there is no ideal number of performance measures, the total number of performance measures your agency selects should be kept to a manageable level. The following is a list of things to consider when selecting measures:

1. How will you calculate the measure?
2. What data are needed? What other measures can benefit from the data?
3. Where will you get the data? (Note: It is best to begin with data your agency has on hand or can access without further collection activities. Once the process of using data to calculate measures is underway, your agency can begin to consider additional data sources and collection.)
4. How many departments/agencies will benefit from the use of the measure?
5. Who will be in charge of tracking and reporting the data?

STEP 5 – IMPLEMENTING PERFORMANCE MEASURES

Application of Performance Measures

The real value of performance measures comes when they are integrated and implemented to support the daily activities of your agency. Applications of performance measures include

- **Description** – Understand aspects of agency business or actions in terms of current status and trends. Determine at what level its programs, facilities, and services are performing through measures of relevance.
- **Evaluation** – Introduce a value judgment with respect to current performance and trends. Involve the use of targets, benchmarks, or trends. Help agencies identify what is wrong, the causes of a particular problem, and how it can be remedied.
- **Accountability** – Identify performance for which an agency or unit is responsible, specifically poor performance in a key area that needs to be improved. Identify agency units that need to improve to meet performance target levels.
- **Decision support** – Help evaluate, compare, prioritize, and select among alternatives and options in terms of sustainability considerations. Determine whether to proceed with a proposed action or to select among alternatives.

- **Communication** – Communicate to internal and external stakeholders through indices, numbers, tables, graphs, scorecards, and other display tools such as dashboards. Most frequently used methods show conditions, comparisons, trends, and adherence to targets, goals, and objectives.

As shown in Figure 3, these applications of performance measures are interrelated. Some applications derive logically from one another. (For example, evaluation can be viewed as an extension of description; similarly, accountability or decision support follows logically from an evaluation exercise.) Communication, on the other hand, is more an overarching application that is implied in the use of other applications, but is also an application in itself.

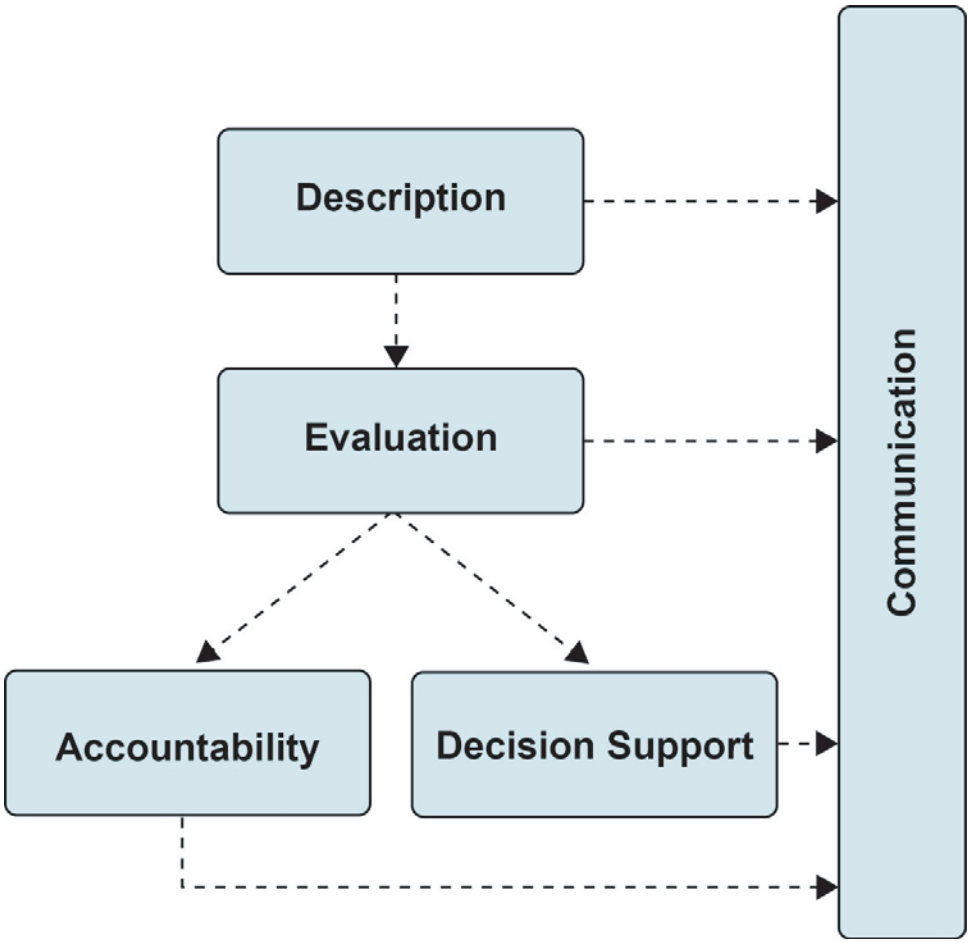

Figure 3. Relationship between application types.

Your agency's purpose for use of the measures should be a consideration in previous steps of the framework application. However, it is at this step that the logistics of how your agency will collect and report the data are determined and then put into practice.

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Steps to Successful Implementation

Your implementation process depends on the applications that your agency picks. The following steps provide the groundwork for successful implementation and integration. Depending on the number of measures, who is involved, and the application outcomes, these steps can be done per measure, per focus area, or per goal.

1. Determine appropriate scale (e.g., by department, agency).
2. Determine appropriate applications (if more than one) for each measure, goal, or focus area.
3. Establish a reporting system and schedule with roles and responsibility for data collection, analysis, and reporting. Will this be included in an existing annual reporting process, or will your agency establish a new sustainability dashboard of some kind?
4. Your agency can set benchmarks and targets at the level of goals, objectives, or measures. However, in the SPM framework, these benchmarks and targets need to be tracked at the level of performance measures. For example, if an agency sets a target of zero waste, this would need to be tracked for a set of measures that relate to the individual waste-generating activities.

Case Study Summary: Chicago Metropolitan Agency for Planning

The staff at the Chicago Metropolitan Agency for Planning (CMAP) is very aware that all aspects of its work involve sustainability. In fact, the work of defining sustainability performance measures not only involved every division of the agency, but went beyond the subject areas that CMAP traditionally engages in. Because sustainability involves not sacrificing in the present the needs of future generations, the core work toward sustainability occurs in CMAP's planning and programming division through long-range comprehensive planning efforts.

CMAP has an extensive sustainability performance measurement program. For example, measures are a central element as CMAP considers major transportation projects for inclusion in its long-range transportation plan (GO TO 2040). CMAP is using a subset of 23 indicators to evaluate each project's sustainability. The measures are organized into the following 11 categories, with each category having between one and four measures associated with it:

1. Long-term economic development,
2. Congestion,
3. Work trip commute time,
4. Mode share,
5. Job-housing access,
6. Air quality,
7. Energy use,
8. Natural resource preservation,
9. Infill and reinvestment,
10. Peak period utilization, and
11. Facility condition (highways only).

For this analysis, each measure is reported individually. The performance measures are not weighted, and the results are not converted into any type of overall score. The results of each project evaluation are presented to the sponsors and will be used to prioritize the list of projects for inclusion in the GO TO 2040 plan.

STEP 6 – REFINING THE FRAMEWORK AND APPLYING FEEDBACK

Applying the framework described in this chapter is not a linear, one-off process. Instead, it requires constant feedback and refinements to ensure that progress toward sustainability is achieved. Chapter 7 provides a sustainability checklist for reviewing the framework, which can help your agency consider whether the goals, objectives, and measures identified comprehensively address the principles of sustainability. Other parameters relating to the design and implementation of the framework can also be evaluated to provide feedback that can be applied to refine the framework.

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Chapter 6

Resources for Performance Measure Development and Application

The electronic compendium offers an extensive list of objectives and performance measures for each focus area that can be used to achieve each recommended goal.

COMPENDIUM OF OBJECTIVES AND PERFORMANCE MEASURES

Appendix B contains a performance measures compendium, an electronic version of which is included on the CD-ROM accompanying this guidebook. For step-by-step instructions on how to use this electronic compendium, refer to the user instructions in Appendix C.

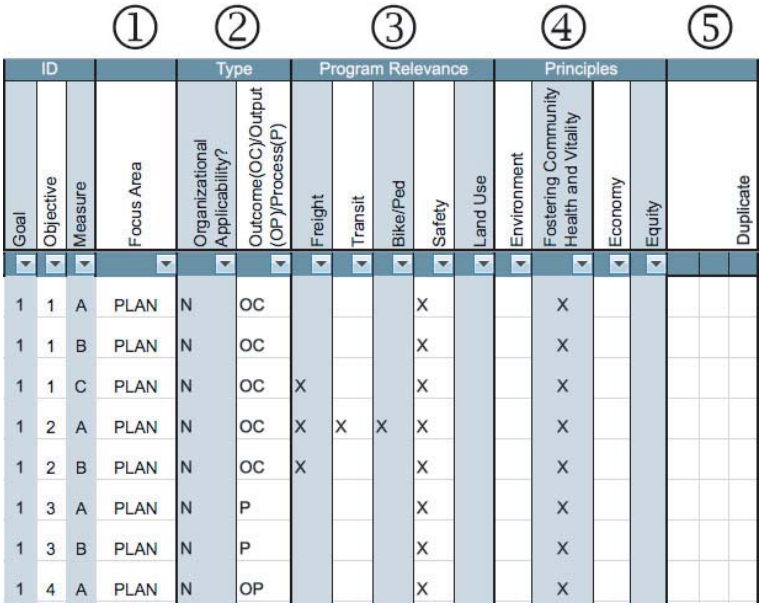
The compendium provides a useful resource to help identify objectives and performance measures. It is designed to support you in identifying the right objectives and measures for your performance measurement system, consistent with the goals set by your agency to promote sustainability. As shown in Figure 4, the electronic compendium is organized by each of the 11 goals, broken out by focus areas, objectives, and measures. The spreadsheet-based format allows for filtering of measures in order to sort and organize them, as shown in Figure 5.

The compendium also offers an extensive list of objectives for each focus area that you can review as you define objectives to achieve each goal, and offers as well measures that could be used to assess each objective. Alternatively, the examples of measures provided in the compendium provide ideas that you can draw on as you craft your own objectives and measures.

	A	B	C	D	E	F	G
1	7/5/11		TITLE	ID			
2	RESET / EXPORT ② Goal ①	Objective ③	Measure ④	Goal	Objective ⑤	Measure	Focus Area
3							
4	1. Safety	Reduce the number and severity of crashes	*Change in the number and severity of crashes*	1	1	A	PLAN
5	1. Safety	Reduce the number and severity of crashes	Change in the number of crashes by crash type and contributing factor	1	1	B	PLAN
6	1. Safety	Reduce the number and severity of crashes	Change in the number and severity of truck crashes	1	1	C	PLAN
7	1. Safety	Ensure safety considerations are addressed for all modes	Change in the number and severity of crashes by user type (e.g., pedestrian, bicycle, transit user, freight)	1	2	A	PLAN
8	1. Safety	Ensure safety considerations are addressed for all modes	Change in the number of grade crossing collisions/incidents	1	2	B	PLAN
9	1. Safety	Ensure safety is considered early in project planning	Change in percentage of projects where safety of a project was reviewed in each of the project development stages by a multidisciplinary review team	1	3	A	PLAN
10	1. Safety	Ensure safety is considered early in project planning	Change in the percentage of projects implementing predictive methods of the AASHTO Highway Safety Manual	1	3	B	PLAN
11	1. Safety	Ensure projects consider the 4Es (engineering, education, enforcement, EMS) of safety	Change in the percentage of projects where non-infrastructure based safety countermeasures were selected as part of the project	1	4	A	PLAN
12	1. Safety	Ensure projects consider the 4Es (engineering, education, enforcement, EMS) of safety	Number of projects incorporating the use of innovative TSM and ITS solutions that address human factors considerations	1	4	B	PLAN
13	1. Safety	Plan road networks that are predictable and recognizable	Existence of a functional class system of highways	1	5	A	PLAN
14	1. Safety	Plan road networks that are predictable and recognizable	Existence of a system that adjust speeds based on the presence of alternative modes and context	1	5	B	PLAN
15	1. Safety	Develop programs that maximize return on safety investment	Change in return on investment (reduction in the number and severity of crashes for the expenditure)	1	6	A	PROG
16	1. Safety	Develop programs that maximize return on safety investment	Change in the number and proportion of projects evaluated on substantive safety versus nominal safety	1	6	B	PROG
17	1. Safety	Develop a performance based safety improvement program	Number and proportion of projects evaluated for impact on crashes	1	7	A	PROG
18	1. Safety	Develop a performance based safety improvement program	Number and cost of projects that address safety concerns at the system, corridor, and local levels ⑥	1	7	B	PROG
19	1. Safety	Prioritize projects with explicit safety considerations	*Change in number of programmed projects with highest reduction in crashes out of all alternatives*	1	8	A	PROG
20	1. Safety	Develop projects that meet maximum safety requirements	Return on investment for individual project (reduction in the number and severity of crashes for the expenditure)	1	9	A	PROJ
21	1. Safety	Develop projects that meet maximum safety requirements	Project is evalauated on substantive safety versus nominal safety	1	9	B	PROJ
22	1. Safety	Apply a performance based safety improvement program	Number and proportion of projects evaluated for impact on crashes	1	10	A	PROJ
23	1. Safety	Apply a performance based safety improvement program	Number and cost of projects that address safety concerns at the system, corridor, and local levels	1	10	B	PROJ
24	1. Safety	Develop projects with explicit safety considerations	*Change in number of programmed projects with highest reduction in crashes out of all alternatives*	1	11	A	PROJ
25	1. Safety	Reduce crash risk in work zones	*Change in number of crashes per time unit within a particular work zone*	1	12	A	CONS
26	1. Safety	Reduce crash risk in work zones	Change in number of crashes as a portion of total time of work zones by functional class, county, and district/region - where possible, distinguish between active and	1	12	B	CONS

1. Goals that state the overall purpose of your program, keeping in mind the sustainability principles.
2. You can export customized worksheets from the compendium.
3. Specific objectives describe what will be done to achieve each goal.
4. Quantifiable measures assess progress in meeting objectives. Some measures may apply to multiple objectives.
5. Each measure has a unique ID.
6. Measures in italics are those described further as example measures in Appendix D.

Figure 4. The compendium of objectives and measures.



	①	②		③					④				⑤
ID		Type		Program Relevance					Principles				
Goal	Objective	Measure	Focus Area	Organizational Applicability?	Outcome(OC)/Output (OP)/Process(P)	Freight	Transit	Bike/Ped	Safety	Land Use	Environment	Fostering Community Health and Vitality	Economy	Equity	Duplicate
1	1	A	PLAN	N	OC				X			X			
1	1	B	PLAN	N	OC				X			X			
1	1	C	PLAN	N	OC	X			X			X			
1	2	A	PLAN	N	OC	X	X	X	X			X			
1	2	B	PLAN	N	OC	X			X			X			
1	3	A	PLAN	N	P				X			X			
1	3	B	PLAN	N	P				X			X			
1	4	A	PLAN	N	OP				X			X			

1. Filtering by focus area helps identify appropriate objectives and measures.
2. Filtering by measure type helps you understand the role of the selected measure:
   a. Organizational Applicability: Is the measure implemented within the agency (Y) or specific to the agency's transportation function (N)?
   b. Outcome/Output/Process: Does the measure express the outcome of an action, the output or product of an action, or illustrate the process leading to action?
3. Filtering by program relevance provides the option to focus on one or more of five key program areas that may be of interest.
4. Filtering by principles helps you identify measures that provide information related to one or more of the four sustainability principles.
5. The duplicate function identifies similar or duplicate measures associated with other goals (by measure ID number).

Figure 5. Filter functions in the compendium help the user sort and organize measures.

EXAMPLES OF USE AND DATA SOURCES

In addition to the example objectives and performance measures contained in the compendium, Appendix D of this guide provides a set of examples in practice for a selected set of performance measures from the compendium. For each goal, one measure per focus area has been illustrated by an example of a similar measure in use by a transportation agency. (The measures selected for use as examples are denoted in the compendium through the use of italicized text.) Many of the measures are not exact duplicates of those contained in the compendium but retain the same value or intention. In some cases the way the example measure is used by an agency differs slightly from the measure it is being matched to illustrate. These were included either because they were the closest real-world examples found or they are an interesting example of how a measure *could* be used. Appendix E lists some generic resources for data that may be used to support many of the performance measures included in the compendium. Only data sources that may be relevant for a large number of agencies have been included.

WORKSHOP MATERIALS TO FACILITATE PERFORMANCE MEASUREMENT DEVELOPMENT

This guidebook provides transportation agencies with the tools required to understand and apply sustainability through performance measurement. As a part of the research project, the research team presented interactive practitioner workshops that aimed to present an overview of the project findings and to test the application of the SPM framework in practice. The CD-ROM accompanying the guidebook contains a modified version of the presentation and workshop materials, which can be adapted for use in your agency to provide an overview of the guidebook and allow you to work through the process of understanding sustainability in the transportation context and develop goals and performance measures to suit your agency's needs. Appendix G provides a further description of the presentation materials and a generic structure for the workshop.

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Chapter 7

Sustainability Measures Checklist

The sustainability checklist is a self-assessment tool that can be used to evaluate the application of the framework, make refinements, provide feedback, and identify areas for follow-up.

Once you have selected your set of goals, objectives, and measures, use the sustainability checklist (Table 4) to evaluate the SPM framework as applied and to make refinements and provide feedback as described in Chapter 5. The yes/no questions in the checklist provide a self-assessment tool that will identify any areas that may need further work or follow-up. The checklist can be used to evaluate your product, ensuring that your set of measures gives a valid and complete picture of your sustainability progress. The checklist helps answer the following questions:

- Does your set of goals, objectives, and measures work?
- Are all four sustainability principles addressed in a balanced way?
- Will these measures give you the information you need?
- Do you have the data you need to implement these measures?

Table 4. Sustainability measures checklist.

	YES	NO	FOLLOW UP
GOALS			
The final set of goals addresses the four sustainability principles 1. Preserving and enhancing environmental and ecological systems.			
2. Fostering community health and vitality.			
3. Promoting economic development and prosperity.			
4. Ensuring equity between and among population groups and over generations.			
The four sustainability principles are well balanced across the final set of goals.			
The final set of goals has been reviewed and approved.			
OBJECTIVES			
The objective is clearly stated and easy to communicate.			
Meeting the objective will help achieve progress in meeting the related goal.			
Progress in meeting the objective can be measured with credible data.			
MEASURES			
The measure is clearly stated and easy to communicate.			
The measure as defined will give useful information about progress in meeting the objective.			
The set of measures defined for an individual objective will give enough information to evaluate progress.			
The set of measures focuses on outcomes as well as key outputs.			
The data required to support the measure are available and credible.			
DESIGN AND IMPLEMENTATION			
Key partners and stakeholders have been engaged in defining the goals, objectives, and measures.			
Responsibility for implementing each objective has been assigned.			
Responsibility for collecting data and reporting on performance has been assigned.			
The necessary staff time and resources are available.			
Management responsibility is clear for reviewing performance and recommending follow-up action.			
A process and schedule are in place for measurement, internal reporting, assessment, and future action.			
A communication plan is in place to keep stakeholders and partners informed and engaged.			

Chapter 8

Examples of Practice in Sustainability Measurement

Many agencies implement programs for sustainability and performance measurement, including rating systems for sustainability. The case studies illustrate the wide variety of approaches to address sustainability, as well as common themes and challenges.

Many transportation agencies currently implement various programs for sustainability and sustainability performance measurement. Fourteen transportation agencies were selected for detailed case studies as part of this research. Another emerging topic in sustainability performance measurement application deals with the development of rating systems for sustainability. The first part of this chapter describes the findings from the case studies. The second part summarizes existing rating systems in practice.

WHAT ARE SOME AGENCIES DOING?

In developing this user's guide, the following agencies were interviewed to learn about how they were integrating the concept of sustainability into their programs and policies:

- **State Departments of Transportation**
  - California Department of Transportation
  - Colorado Department of Transportation
  - Florida Department of Transportation
  - Minnesota Department of Transportation
  - New York State Department of Transportation
  - Oregon Department of Transportation
  - Washington State Department of Transportation

- **Metropolitan Planning Organizations**
  - Chicago Metropolitan Agency for Planning (CMAP)
  - Mid-Ohio Regional Planning Commission (MORPC)
  - Metropolitan Washington Council of Governments (MWCOG)
- **Other Agencies or Municipalities**
  - Hampton Roads Transit
  - City of Alexandria, VA
- **International Agencies**
  - Swedish Road Administration
  - United Kingdom Highways Agency

These agencies represent a range of agency types, sizes, and geographic coverage. Table 5 summarizes how each agency defines sustainability, the related programs described in the case studies, and any highlights or unique attributes. These case studies served as the foundation for the development of the sustainability performance measures framework. They illustrate the wide variety of approaches that different agencies are using to address sustainability; they also point to common themes and challenges.

As illustrated in Table 5, the agencies have adopted a range of different working definitions of sustainability. Several agencies focus on the long-range effect of program decisions, specifically on an assessment of the impact on future generations. While some agencies use some version of the triple bottom line to gauge sustainability (i.e., assessing outcomes by environmental, economic, and social criteria), others consider sustainability as primarily an environmental metric. Finally, agencies vary in the scope and scale of consideration of sustainability, ranging from a focus on project-level assessments to more program-level or landscape-scale reviews.

The following text provides an overview of these agencies' approaches, looking first at agencies in the United States and then at some international organizations. Appendix F provides more detailed information on each agency in the case study summaries. The research report further documents the screening process employed to identify the case studies, case study approach, and methodology.

Domestic Agencies and Sustainability: Trends and Conditions

Perspectives on sustainability are in flux across agencies in the United States, marked by a surge in support and new initiatives as well as some skepticism.

- **The public is getting on board** – Public opinion and awareness are shifting toward an understanding and support of sustainability. This shift will help encourage more DOTs to begin to program and measure sustainability.
- **Legislative mandates are common** – In many states, legislative direction is the impetus for sustainability program development. Agencies also report that support from the leadership is a key to success, and commonly these two go hand in hand.

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Table 5. Summary of sustainability efforts at selected U.S. and international agencies.

Agency	Definition of Sustainability	Programs/Offices Highlighted	Notes/Highlights
California Department of Transportation	Ensuring that environmental, social, health, and economic considerations are factored into decisions about transportation activities.	• Smart Mobility Framework • California Transportation Plan • Regional Blueprints • California Progress Report • Strategic Growth Council • Transportation System Information • Office of Strategic Planning and Performance Measurement	Caltrans is managing many programs that relate to aspects of sustainability and span regional and statewide levels. They are relatively well advanced in measuring these concepts. The agency is working to begin to implement projects that will bring to fruition those goals and objectives identified in the strategic planning and policy documents.
Colorado Department of Transportation	No official agency definition, but following general concept of the United Nations Brundtland Commission definition (i.e., meeting the needs of the present without compromising the ability to meet future needs).	• Environmental Stewardship Guide • TERC's Sustainability Subcommittee • Greening Council– greening government initiative • I-70 corridor – sustainability applications	CDOT is engaged with an interagency working group, TERC, which has established a sustainability subcommittee. The group is attempting to establish the principles of sustainability for all state agencies, and from there determine how they should affect transportation policies and programs.
Florida Department of Transportation (FDOT)	As defined in the 2025 Florida Transportation Plan: "Meeting the needs of the present without compromising the ability to meet the needs of the future."	• Florida Transportation Plan • Strategic Intermodal System • Metropolitan Planning • Regional Visioning • Efficient Transportation Decision Making • Executive Order 07-126	FDOT has been on the forefront of tracking and measuring performance; however, the agency has not yet classified any current measures as sustainability measures. Throughout agency practices there are many activities that could fall under a sustainability umbrella.

Table 5. Continued.

Agency	Definition of Sustainability	Programs/Offices Highlighted	Notes/Highlights
Minnesota Department of Transportation (MnDOT)	No official definition, although the agency's vision refers to a "safe, efficient, and sustainable transportation system."	• State transportation plan • Internal strategic planning	MnDOT is a leader in performance-based planning. Many of the existing measures relate to sustainability, but the agency has not grouped them as such.
New York State Department of Transportation	A transportation system that supports a sustainable society is one that: • Allows individual and societal transportation needs to be met in a manner consistent with human and ecosystem health, with equity within and between generations. • Is safe, affordable, accessible, operates efficiently, offers choice of transport mode, and supports a vibrant economy. • Protects, preserves, and enhances the environment by limiting transportation emissions and wastes, minimizes the consumption of resources, and enhances the existing environment as practicable.	GreenLITES	GreenLITES was designed as a certification program for new highway miles. However, NYSDOT realized that this program has limited impact, and a new program-level approach is under way.

Table 5. Continued.

Agency	Definition of Sustainability	Programs/Offices Highlighted	Notes/Highlights
Oregon Department of Transportation (ODOT)	Using, developing, and protecting resources in a manner that enables people to meet current needs while providing for future generations to meet their needs, from the joint perspective of environment, economic, and community objectives.	• Sustainability Plan and Implementation • ODOT Sustainability Council • Oregon Transportation Plan Goal • Environmental Management System • Office of Innovative Partnerships and Alternative Funding	ODOT is institutionalizing the concept of sustainability through the development of an integrated strategic sustainability program and an implemented sustainability plan. Through these actions, sustainability will become a guiding principle for the agency. ODOT does not view sustainability as an impact, but instead as an opportunity to improve efficiency. The sustainability plan identifies the need for measuring the agency's progress on implementation and identifies measures, but much of the data required for tracking are not currently being collected.
Washington State Department of Transportation (WSDOT)	In the process of defining sustainability.	All programs relate to sustainability, but three offices lead the effort: Public Transportation, Strategic Planning and Programming, and Environmental and Engineering Programs	WSDOT has a significant history of tracking performance measures in their Grey Notebook. However, they are only currently developing sustainability performance measures and determining ways to measure them and implement them into decision making.

Table 5. Continued.

Agency	Definition of Sustainability	Programs/Offices Highlighted	Notes/Highlights
Chicago Metropolitan Agency for Planning	Can be used in one of three ways: • Sustainability requires that any public policy or investment meet certain environmental, economic, and social equity goals. • Sustainability meets the needs of the present without compromising the needs of the future. • Sustainability regards the total wealth of society as capital that should be preserved or increased, including natural capital, human capital, and man-made capital, in addition to financial wealth.	CMAP believes that sustainability cuts across all program areas. GO TO 2040 is the specific program area highlighted for this case study.	CMAP defines all 250 performance measures as sustainability measures. Evaluation of the sustainability of planned projects and ongoing monitoring of the region's sustainability are now central to CMAP's way of doing business.
Mid-Ohio Regional Planning Commission	Meeting the needs of the present without compromising the ability of future generations to meet their own needs.	• The Green Pact Program, run by the Center of Energy & Environment • Complete Streets • Public Policy Agenda • State of the Region reports • Long-Range Plan	• MORPC reports that it has been considering sustainability for decades, calling it "good planning." In recent years, MORPC has promoted sustainability performance indicators through its annual State of the Region reports.

Table 5. Continued.

Agency	Definition of Sustainability	Programs/Offices Highlighted	Notes/Highlights
Metropolitan Washington Council of Governments	No agency-wide definition, but as one of the guiding principles in a recent policy study: healthy air, water, and land; abundant renewable energy sources; and a smaller carbon footprint.	Region Forward report	Region Forward is a policy-level visioning study that identifies the region's shared goals for land use, transportation, environment, climate and energy, economy, housing, education, health, and public safety. The concepts have yet to be integrated into actual planning and policy decisions, but are meant to provide guidance and encourage new ways of thinking about those processes.
Hampton Roads Transit (HRT)	Sustainability to HRT is about making a more livable community now and in the future by providing accessible, efficient, and environmentally friendly public transportation services and operating their vehicles and facilities according to policies and procedures that promote pollution prevention, climate protection, and energy and resource conservation.	• Environmental management system (EMS) • APTA's Sustainability Commitment • International Association of Public Transport Charter on Sustainable Development • Hybrid Vehicles & Clean Fuel • Energy Reduction Lighting Program	The EMS has been developed to guide all agency practices toward sustainability. The EMS is new, and HRT has set modest goals and plans to build upon them each year as the initial goals are met. APTA's Sustainability Commitment is helping to guide HRT's programs.

Table 5. Continued.

Agency	Definition of Sustainability	Programs/Offices Highlighted	Notes/Highlights
City of Alexandria, VA	Sustainability is progress that meets the needs of the present without compromising the ability of future generations to meet their needs. A sustainable community is an environmentally, economically, and socially healthy place where people can live, work, and play for decades to come.	Environmental Action Plan 2030	Alexandria is working to use the Environmental Action Plan to incorporate the concepts of sustainability into its Master Plan and Area Plans.
Swedish Road Administration	No official agency definition; one of six goals is a sustainable environment: a good environment where the design and performance of the road transport is to contribute to achieving environmental quality targets.	• Strategic Plan • Annual Score Cards • Goals and Metrics Database • Annual Report • Annual Sectoral Report • Annual Action Plan	Sustainability has been part of the transport policy in Sweden since the late 1980s and is incorporated into all aspects of planning and programming.
Highways Agency (England, UK)	The agency's actions must support five overarching goals of the UK-wide strategy: • Living within environmental limits; • Ensuring a strong, healthy, and just society; • Achieving a sustainable economy; • Promoting good governance; and • Using sound science responsibly.	• Sustainable Development Action Plan (SDAP) • SDAP Progress Report • Business monthly report card • Corporate Social Responsibility Report	Sustainable development has been considered in management goals since 2005 when the agency began corporate responsibility reporting. The agency has efforts that cut across all program areas related to sustainability, and it sees this focus as a realignment rather than a revolution.

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- **Sustainability has roots in many program areas** – Sustainability programs are emerging out of other, long-standing efforts. Agencies are beginning to see the benefit of bringing the concepts under a single umbrella of sustainability. For example, Colorado DOT's environmental stewardship guide is expanding to include concepts such as livability and is thus getting closer to the concept of sustainability.
- **Sustainability is just a new word** – On the other hand, some agencies see the concept of sustainability as simply a new trend, repackaging long-standing concepts. Some argue that it has always been important; it used to simply be called "good planning."

Domestic Agency Challenges

As agencies work to incorporate sustainability principles, several themes have emerged about the challenges these agencies face.

- **Turning goals into measurable actions** – Many agencies are able to identify, agree upon, and set goals that include concepts of sustainability but are finding it more difficult to implement programs that will help lead to achieving these goals. Identifying ways to effectively track progress toward these goals is also challenging.
- **Understanding trade-offs** – Agencies are struggling with how to understand, measure, and track the interrelationships among aspects of sustainability and how to determine the implications of these trade-offs.
- **Outside agency scope** – Achieving sustainability requires the cooperation of many agencies and entities with a range of responsibilities. Transportation agencies are contending with how to make an impact when the outcomes sought are tied to a set of conditions with many inputs and causes. For example, DOTs feel that many of the issues need to be addressed by local government agencies and are not within their jurisdiction. There is still a lack of understanding of how transportation agency policy and practices fit into the broader concept of sustainability and disagreement about what should be the appropriate institutional roles of transportation agencies.
- **Measurement at the project level** – Agencies find that it is easier to consider impacts to sustainability on a regional scale and difficult to measure on a project-by-project basis.
- **Data consistency** – The availability of consistent and reliable data among jurisdictions can be a limiting factor in sustainability performance measurement.
- **Prioritization** – In the recent economic downturn, some agencies concluded that they had no choice but to put sustainability on the back burner as they struggled with budget cuts and other competing priorities.

Domestic Agency Best Practices

The growing experience and success of transportation agencies in integrating sustainability into their work provide several lessons that can be useful guidance to other agencies.

- **Start with a big-picture perspective** – Since sustainability is a comprehensive concept and has a wide span of effects, agencies find it useful to step away from the DOT perspective and take a wide view. For example, some agencies start by establishing a

definition of a sustainable society. From there they can look for ways to measure whether the transportation system is supporting a sustainable society rather than trying to use their established procedures within a set of sustainability principles. Agencies have found that it can be more effective to begin at the programmatic level and have the policies affect the project level. For example, the New York State Department of Transportation (NYSDOT) has decided to build on its project-level experience with the GreenLITES (Green Leadership in Transportation Environmental Sustainability) initiative to develop more programmatic approaches. CMAP defines all of its 250 performance measures as sustainability measures and considers all of its activities within that framework. A regional perspective can also alleviate the issue that some areas of a region are going to more easily meet some targets (e.g., environmental targets), while other targets (e.g., housing) are easier for other areas. This regional perspective can be critical to achieving sustainability goals.

- **Provide strong, committed leadership** – Agency leadership, in addition to a commitment from the political and business stakeholders, is critical to success.
- **Use interagency working groups** – Bringing together representatives from state agencies can be an effective way to establish an overarching set of accepted sustainability principles and coordinate interrelated activities across the state. For example, Colorado DOT (CDOT) participates in the state's Transportation and Environmental Resource Council (TERC), which is attempting to establish the overall principles of sustainability. CDOT will then determine how these principles apply to transportation and revise their programs and policies in accordance.
- **Establish intra-agency coordination** – All agencies in the case studies identified the fact that addressing sustainability does not fit neatly into one department's responsibility. Establishing clear coordination among agency departments is critical. For example, Washington State DOT has designated the departments of Public Transportation, Strategic Planning and Programming, and Environmental and Engineering Programs as leaders in the effort to integrate sustainability.
- **Serve as a technical resource** – DOTs are in a prime position to provide technical assistance to local agencies that are required to track certain measurements. Florida DOT serves in this capacity for MPOs in their measurement of greenhouse gases.
- **Commit sufficient resources** – It is essential to have at least one dedicated staff member who can focus on sustainability. Additional resources must be dedicated at an appropriate level. These resources do not necessarily have to be significant, but they must be in line with the agency's program goals. Expecting too much out of too little will ensure failure.
- **Commit to a long-term sustainability effort** – Over time, priorities may shift, strategies are likely to need modification, and measures may change. Agencies need to be flexible and continue to evaluate their tracking and measurement programs as their experience grows, as they evaluate the effectiveness of their efforts, and as the conditions in which they work evolve.
- **Link sustainability to funding** – Successful implementation programs are linked to funding requirements. Agencies struggle to achieve progress using voluntary programs that lack meaningful incentives for regional or local agency participation.

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- **Reach high** – It can be appropriate to have aspirational performance targets; they may require a major change in behavior, but at least they provide the basis to push for change and move away from the status quo.
- **Adopt targets** – Goals and indicators should be accompanied by targets, which give agencies and the public a sense of where they are headed and how close they are to getting there.

International Agency Trends and Conditions

The sustainability state of practice varies in countries around the world. The following summarizes the lessons learned from the international agencies that were looked at.

- **Sustainability has been around** – In the United Kingdom, the sustainability program simply repackages a lot of what has been going on for a long time.
- **Sustainability is used as an organizing principle** – The Swedish Road Administration (SRA) merged with other agencies in April 2010 and is now part of the very large Swedish Transport Administration. This new agency will likely rely heavily on performance measurement for management and will consider sustainability a central organizing principle.
- **Internal agency acceptance is widespread** – Adoption of sustainable practices has been well received internally and is in line with the interest of creating a healthier workplace and a more satisfied workforce.

International Agency Challenges

International agencies identified a few challenges that they find continue to hamper progress and need additional work.

- **Difficult concepts to measure** – Agencies are still struggling with how to measure everything in a meaningful way. For example, it is difficult to effectively measure gender equality in transport.
- **Implementing the information** – Sustainability performance measures are often cited by decision makers, but it is still unclear how much they actually influence the decisions that are made. Many staffers understand the overall mission but do not clearly understand how it relates directly to their work.
- **Cost** – In some cases it can be difficult to prove that the higher cost to achieve a sustainability outcome is worth the trade-off; in other cases sustainable practices are synonymous with cost savings.

International Agency Best Practices

Looking at the experience of international agencies provides some additional lessons that may be applicable to U.S. agencies.

- **Full implementation is a goal** – Sustainability has been implemented by agencies as both a top-down and bottom-up approach; now agencies are moving toward a fuller integration

of sustainability in their work so that it becomes business as usual. Sustainability is not considered in isolation but is found within all areas of the agency's programs and policies. SRA has attempted to report performance on the transport policy objective as a whole, capturing all aspects of sustainability within one metric. In the United Kingdom, agencies are attempting to tie in transport practices with the general sustainability program for all agencies. They are finding useful synergies among the business units.

- **Neutrality promotes trust** – A neutral body compiles the data and provides a report on performance. This ensures that all involved trust that the performance measures are accurate.
- **Measurement is the key to progress** – Objectives are easy and important to establish since they lay out the big picture. However, defining performance measures is crucial. Measures capture whether conditions are changing and point to needed modifications.
- **Sustainability takes an ongoing, long-term perspective** – Adoption of sustainable development is a process, not a decision.
- **Involving the private sector promotes success** – Success has come from early and active engagement with the private sector supply chain. Setting clear goals and requirements allows the supply chain to innovate before new regulations disrupt practices.
- **Agency objectives can be distinguished as functional and impact objectives** – To address the confusion between those goals that can be directly changed by agency activities and those that are a result of those changes, SRA has created two types of objectives: functional and impact. Functional objectives are those immediately within the control of the agency (e.g., improved accessibility as a result of the design and function of the transport system); impact objectives are the resulting benefits of those design changes (e.g., health, safety, and environmental benefits as a result of those same adjustments).

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RATING SYSTEMS FOR SUSTAINABILITY

The following eight transportation sustainability systems were reviewed as part of this research:

- FHWA's Sustainable Highways,
- Sustainable Transportation Access Rating System (STARS),
- Greenroads,
- GreenLITES,
- Illinois Livable and Sustainable Transportation System and Guide (I-LAST™),
- Green Guide for Roads,
- BE^{2}ST-in-Highways™, and
- GreenPave.

The sustainability rating systems were selected for review based on the following criteria: (1) the rating system primarily focuses on transportation, (2) the rating system is owned and/or was developed by an agency, university, or nonprofit organization, and (3) the rating system has or will undergo some form of peer review.

Rating systems with a broader land development or civil infrastructure component [such as Leadership in Energy and Environmental Design for Neighborhood Development (LEED-ND), ASCE's rating system, the Civil Engineering Environmental Quality Assessment and Award Scheme (CEEQUAL), and the Sustainable Sites Initiative] or that apply only to a specific mode (such as APTA's Transit Sustainability Guidelines) were not selected for review. Table 6 summarizes the existing systems. Appendix F provides further information.

Table 6. Existing sustainability systems.

System Name	System Owner	Launch Date	Type of Rating System
FHWA Sustainable Highways	FHWA	October 2010	Self-evaluation
STARS	The North American Sustainable Transportation Council	Expected mid-2012	Third-party certification
Greenroads	Greenroads Foundation	January 2010	Third-party certification
GreenLITES	NYSDOT	2008	State DOT administered self-evaluation system
I-LAST	Illinois Department of Transportation	2010	Self-evaluation
Green Guide for Roads	Transportation Association of Canada	Expected September 2011	Self-evaluation
BE^{2}ST-in-Highways	University of Wisconsin	2010	Self-evaluation
GreenPave	Ministry of Transportation of Ontario	2010	Self-evaluation

Chapter 9

Summary and Additional Resources

This guidebook provides a flexible framework through which transportation agencies can apply the concepts of sustainability through performance measurement. The guidebook and accompanying materials provide the resources needed to successfully implement the framework.

SUMMARY

While many transportation agencies recognize the importance of sustainability, they often struggle to apply the concepts of sustainability in their core activities. This guidebook provides a flexible framework through which transportation agencies can apply the concepts of sustainability through performance measurement. The guidebook provides the resources needed to establish and use sustainability performance measures and to gauge the effectiveness of strategies to address sustainability. The guidebook was developed keeping in mind that every transportation agency has different resources and goals and faces different challenges to incorporating sustainability. The topics covered include

- Understanding the principles of sustainability and its relevance to transportation agencies;
- Understanding the use of performance measurement for sustainability;
- Describing how an agency can get organized and take a practical, phased approach to implementing performance measurement for sustainability, keeping the resources they have in mind; and
- Understanding and applying the sustainability performance measurement framework.

Various other tools and resources, such as a compendium of performance measures (included in Appendix B and as an electronic spreadsheet on the CD-ROM that accompanies this

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guidebook), a sustainability checklist, and information about existing performance measurement programs and best practices further support the guidance provided. The presentation materials included on the CD-ROM can also be used by your agency to develop an interactive workshop or gathering of a working group to develop performance measures. The final research report that accompanies this guidebook documents the theory, literature, and methodology of the research conducted in developing this user-friendly guidebook.

ADDITIONAL RESOURCES

Some resources you can refer to as you use this guidebook include the detailed research report, the electronic material on the CD-ROM accompanying the guidebook (including the compendium of performance measures and presentation materials), and the appendices to this guidebook. Each of the appendices is described briefly in the following.

Appendix A. Defining Sustainability for Your Agency – As discussed in this guide, developing a specific definition of "sustainability" or "sustainable transportation" is not a fundamental part of the SPM framework. This appendix provides a generally applicable approach that agencies can use if they wish to develop a context-specific sustainability definition.

Appendix B. Performance Measures Compendium – The objectives and performance measures contained in the electronic compendium are provided in text format in this appendix. The objectives and measures are organized by goal and focus area for ease of use.

Appendix C. Electronic Compendium User Instructions – This appendix contains detailed instructions and screen captures to help users navigate the electronic compendium and filter, sort, and export objectives and performance measures to meet their specific requirements.

Appendix D. Sustainability Performance Measure Examples – This appendix provides examples in practice for a selected set of performance measures from the compendium. For each goal, one measure per focus area has been illustrated by an example of a similar measure in use by a transportation agency.

Appendix E. Data Sources – This appendix lists some generic resources for data that may be used to support many of the performance measures included in the compendium. Only data sources that may be relevant for a large number of agencies have been included since many others are likely specific to a particular agency or state.

Appendix F. Case Studies and Rating Systems Summaries – This appendix contains one-page summaries of the 14 case studies conducted as part of this research project, along with detailed descriptions of eight popular transportation sustainability rating systems that were studied.

Appendix G. Project Overview and Interactive Workshop Material – This appendix provides an overview of the presentation and materials included on the CD-ROM of electronic materials accompanying the guidebook. The materials are based on those used by the research team to introduce the main concepts contained in the guidebook and provide hands-on training in using the compendium to identify and develop performance measures.

Appendix H. Glossary – A glossary of terms used throughout the guidebook and report is provided to assist readers and practitioners.

Appendix A

Defining Sustainability for Your Agency

Here we propose a generally applicable approach to defining sustainability that transportation agencies can easily implement. The approach is shown graphically in Figure A-1, followed by a description of the individual steps and an example of how the guidance can be used to develop a definition of sustainability. The approach can also be used for entities within an agency (such as a district, department, or division) to define sustainability as it relates to them.

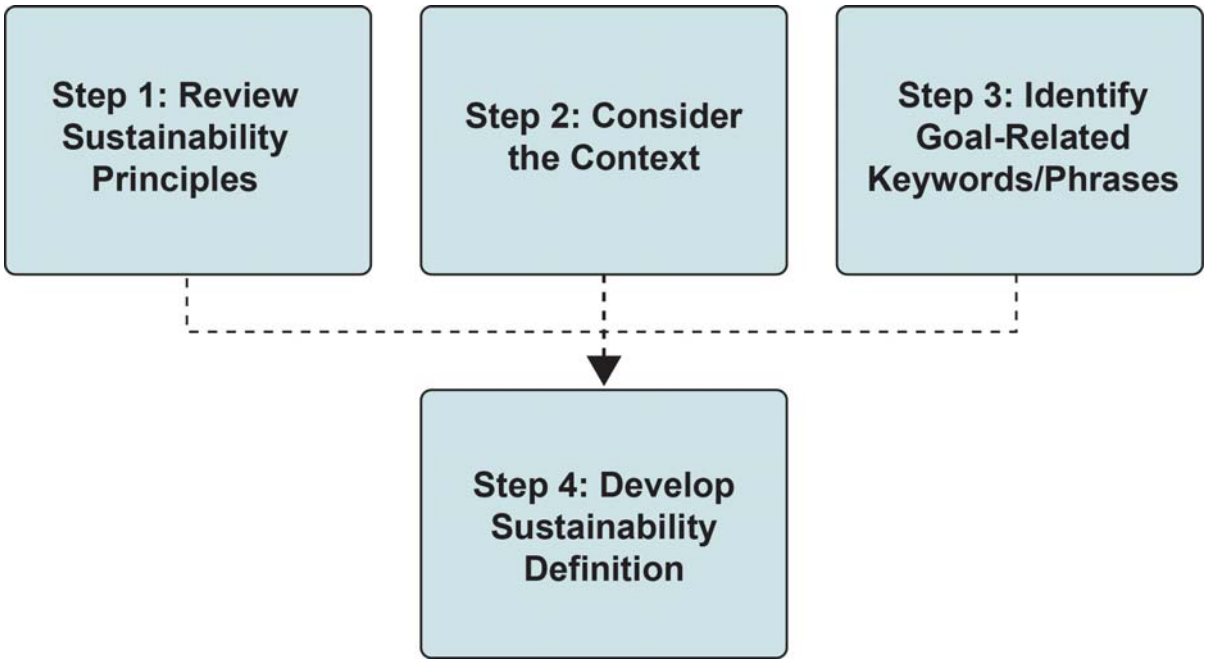

Figure A-1. Steps to develop a sustainability definition.

Step 1 – Review Sustainability Principles

Any definition of sustainability should be grounded in the basic principles of sustainability, which have been defined in this research as shown in the following.

Sustainability entails meeting human needs for the present and future while:

- Preserving and restoring environmental and ecological systems,
- Fostering community health and vitality,
- Promoting economic development and prosperity, and
- Ensuring equity between and among population groups and over generations.

While working all aspects of sustainability into a single definition may sometimes be difficult, it is recommended that elements from all four principles be reflected in the definition. In this first step, agencies should review and understand the basic principles of sustainability as a starting point to developing a definition.

Step 2 – Consider the Context

The context in which sustainability is being considered is important in setting boundaries and context for the definition being developed. These considerations include

- Function,
- Scope, and
- Stakeholders.

Step 3 – Identify Goal-Related Keywords/Phrases

Table A-1 shows the 11 goals for sustainability in transportation defined as part of the framework. These goals help define a set of keywords (also shown in Table A-1) that agencies can select from and incorporate based on their specific context, concerns, and priorities. The list of possible keywords is not meant to be exhaustive but to provide an idea of issues that agencies may want to highlight in their definitions.

Table A-1. Transportation sustainability goals and keywords/phrases.

Transportation Sustainability Goals
1. **Safety** – Provide a safe transportation system for users and the general public. 2. **Basic accessibility** – Provide a transportation system that offers accessibility that allows people to fulfill at least their basic needs. 3. **Equity/equal mobility** – Provide options that allow affordable and equitable transportation opportunities for all sections of society. 4. **System efficiency** – Ensure that the transportation system's functionality and efficiency are maintained and enhanced. 5. **Security** – Ensure that the transportation system is secure from, ready for, and resilient to threats from all hazards. 6. **Prosperity** – Ensure that the transportation system's development and operation support economic development and prosperity. 7. **Economic viability** – Ensure the economic feasibility of transportation investments over time. 8. **Ecosystems** – Protect and enhance environmental and ecological systems while developing and operating transportation systems. 9. **Waste generation** – Reduce waste generated by transportation-related activities. 10. **Resource consumption** – Reduce the use of nonrenewable resources and promote the use of renewable replacements. 11. **Emissions and air quality** – Reduce transportation-related emissions of air pollutants and greenhouse gases.
Goal-Related Keywords/Phrases
• Safety • Accessibility • Options/equity • Efficiency • Security • Support for economic development • Feasibility • Reduce emissions • Affordability • Choices • Health • Trade • Environmental sensitivity • Efficient use of resources • Use of renewable resources

Step 4 – Develop Sustainability Definition

Developing a definition of sustainability involves putting the elements identified in Steps 1 through 3 together into a statement that encapsulates the agency's understanding of what sustainability is and the agency's intent in applying concepts of sustainability.

Example of Developing a Sustainability Definition

Agency Y is a small MPO serving an area of 60,000 people, focused mostly on multimodal transportation planning.

Step 1 – Agency Y reviewed the principles of sustainability to develop an understanding of the subject.

Step 2 – Agency staff identified the following issues of relevance: (1) small urban area, (2) bus, bike, pedestrian facilities in addition to motor vehicles, (3) focus on planning, (4) include local stakeholders.

Step 3 – The following were identified as goal-related keywords to be incorporated into the definition: accessibility, economic development, and the environment.

Step 4 – The agency staff developed the following definition/statement:

"The Y area MPO pursues sustainability by providing a multimodal transportation system for all citizens while working with local and regional stakeholders to promote accessibility for all, to support economic development, and to protect the environment for current and future generations."

Another example, for a design division within a hypothetical DOT, can be as follows:

"The design division supports DOT Z in moving toward sustainability by incorporating safety, economic feasibility, and environmental considerations into our work as we design long-lasting and quality projects."

Appendix B

Performance Measures Compendium

Note: Italicized entries are featured as examples in Appendix D.

Goal 1: Safety—Provide a Safe Transportation System for Users and the General Public						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 1: Planning						
1.1	**Reduce the number and severity of crashes**	*Change in the number and severity of crashes*	Change in the number of crashes by crash type and contributing factor	Change in the number and severity of truck crashes		
1.2	**Ensure that safety considerations are addressed for all modes**	Change in the number and severity of crashes by user type (e.g., pedestrian, bicycle, transit user, freight)	Change in the number of grade crossing collisions/incidents			
1.3	**Ensure that safety is considered early in project planning**	Change in percentage of projects where safety of a project was reviewed in each of the project development stages by a multidisciplinary review team	Change in the percentage of projects implementing predictive methods of the *AASHTO Highway Safety Manual*			

Goal 1: Safety—Provide a Safe Transportation System for Users and the General Public						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 1: Planning						
1.4	**Ensure that projects take into consideration the 4Es (engineering, education, enforcement, EMS) of safety**	Change in the percentage of projects where non-infrastructure-based safety countermeasures were selected as part of the project	Number of projects incorporating the use of innovative TSM and ITS solutions that address human factors considerations			
1.5	**Plan road networks that are predictable and recognizable**	Existence of a functional class system of highways	Existence of a system that adjust speeds based on the presence of alternative modes and context			

Goal 1: Safety—Provide a Safe Transportation System for Users and the General Public						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 2: Programming						
1.6	**Develop programs that maximize return on safety investment**	Change in return on investment (reduction in the number and severity of crashes for the expenditure)	Change in the number and proportion of projects evaluated on substantive safety versus nominal safety			
1.7	**Develop a performance-based safety improvement program**	Number and proportion of projects evaluated for effect on crashes	Number and cost of projects that address safety concerns at the system, corridor, and local levels			
1.8	**Prioritize projects with explicit safety considerations**	*Change in number of programmed projects with highest reduction in crashes out of all alternatives*				

Goal 1: Safety—Provide a Safe Transportation System for Users and the General Public						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 3: Project Development						
1.9	**Develop projects that meet maximum safety requirements**	Return on investment for individual project (reduction in the number and severity of crashes for the expenditure)	Project is evaluated on substantive safety versus nominal safety			
1.10	**Apply a performance-based safety improvement program**	Project is evaluated for effect on crashes	Project addresses safety concerns at the system, corridor, and local levels (as relevant)			
1.11	**Develop projects with explicit safety considerations**	*Selected project has highest reduction in crashes out of all alternatives*				

Goal 1: Safety—Provide a Safe Transportation System for Users and the General Public						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 4: Construction						
1.12	**Reduce crash risk in work zones**	*Change in number of crashes per time unit within a particular work zone*	Change in number of crashes as a portion of total time of work zones by functional class, county, and district/region—where possible, distinguish between active and passive work zone time periods	Change in number and severity of work zone truck crashes		
1.13	**Reduce the risk to construction and maintenance personnel working in work zones along roadways**	Change in number of crashes involving one or more construction and maintenance personnel and/or vehicles per time unit that the work zone exists	Number of construction and maintenance personnel killed at work zones by functional class, county, and district/region	Number of construction and maintenance personnel injured at work zones by functional class, county, and district/region	Change in the number of grade crossing collisions/incidents due to new construction (removal of grade crossing)	
1.14	**Provide improved work zone traffic control activities**	Change in the number of traffic control supervisors that are trained and on-site	Change in the number of annual traveler safety complaints	Change in the number of workers injured during the course of traffic control activities	Change in the percentage of construction or maintenance projects that use traveler information systems to provide public information on alternative routes and modes during construction or maintenance	
1.15	**Maintain safe facilities**	Change in time duration to correct potential roadway safety concerns that require construction and/or maintenance action	Change in the time taken to carry out repairs to roadside safety hardware (by category, e.g., guardrail, guardrail end-treatment, cable barrier, cable barrier end treatment)	Change in the percentage of construction and maintenance projects providing accessible routes during construction and maintenance (where applicable)		

Goal 1: Safety—Provide a Safe Transportation System for Users and the General Public						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 5: Maintenance						
1.16	**Reduce crash risk in work zones**	*Change in number of crashes per time unit within a particular work zone*	Change in number of crashes as a portion of total time of work zones by functional class, county, and district/region—where possible, distinguish between active and passive work zone time periods	Change in number and severity of work zone truck crashes		
1.17	**Reduce the risk to construction and maintenance personnel working in work zones along roadways**	Change in number of crashes involving one or more construction and maintenance personnel and/or vehicles per time unit that the work zone exists	Number of construction and maintenance personnel killed at work zones by functional class, county, and district/region	Number of construction and maintenance personnel injured at work zones by functional class, county, and district/region	Change in the number of grade crossing collisions/incidents due to new construction (removal of grade crossing)	
1.18	**Provide improved work zone traffic control activities**	Change in the number of traffic control supervisors that are trained and on-site	Change in the number of traveler safety complaints annually	Change in the number of workers injured during the course of traffic control activities	Change in the percentage of construction or maintenance projects that use traveler information systems to provide public information on alternative routes and modes during construction	
1.19	**Maintain safe facilities**	Change in time duration to correct potential roadway safety concerns that require construction and/or maintenance action	Change in the time taken to carry out repairs to roadside safety hardware (by category, e.g., guardrail, guardrail end-treatment, cable barrier, cable barrier end treatment)	Change in the percentage of scheduled maintenance safety activities delivered on time	Change in the percentage of construction and maintenance projects providing accessible routes during construction and maintenance (where applicable)	

Goal 1: Safety—Provide a Safe Transportation System for Users and the General Public						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 6: System Operations						
1.20	**Reduce crash risk on two-lane rural highways**	Change in number of crashes by crash type on two-lane rural highways	Change in number and severity of truck crashes in a corridor/segment due to operational improvements	Change in the number of grade crossing collisions/incidents due to operational improvements (e.g., traffic control and warning devices)		
1.21	**Reduce the crash risk to the traveling public using transit**	Change in transit crashes as a proportion of total crashes on the highway network	*Number of fatal and disabling injuries sustained by transit users as a portion of 100 million passenger miles travelled or of 100,000 riders*			
1.22	**Reduce the crash risk to vulnerable road users**	Change in the total number of pedestrian and bicyclist crashes, and fatal and disabling crashes, by 100,000 population	Change in the percentage of signal systems with active pedestrian devices (e.g., crosswalks, signals meeting ADA standards)			
1.23	**Reduce the risk to the traveling public on freeways during incidents**	Change in the total time taken to clear an incident scene (e.g., crash, hazardous material spill) from the time of the incident	Change in the total number and severity of secondary crashes (crashes occurring as a result of queuing or disruptions in traffic flow as a result of an incident)			
1.24	**Reduce crashes related to intersection and ramp operations**	Change in the percentage of signals coordinated along each major arterial	Change in the percentage of expressway/freeway ramps metered in a corridor where severe congestion exists			
1.25	**Reduce crashes related to network operations**	Change in the percentage of signs meeting retroreflectivity criteria	Change in the percentage of edge lines meeting retroreflectivity criteria	Change in percentage of system meeting curve warning, speed, and signing criteria	Change in the percentage of intersections providing turn pockets and associated protected left-turn phasing when warranted	Change in percentage of system providing accessible routes

Goal 2: Basic Accessibility—Provide a Transportation System That Offers Accessibility That Allows People to Fulfill at Least Their Basic Needs						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 1: Planning						
2.1	**Ensure accessibility to jobs**	*Change in the number of jobs within reasonable travel time (by mode) for region's population*	Change in jobs/housing balance			
2.2	**Ensure accessibility to essential destinations**	Change in travel time (by mode) to schools, health services, grocery stores, civic and public spaces, recreation	Change in travel time of goods to essential markets (region wide)	Change in number of enterprises in key industries with reasonable access to high-capacity highway or rail facilities		

Goal 2: Basic Accessibility—Provide a Transportation System That Offers Accessibility That Allows People to Fulfill at Least Their Basic Needs						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 2: Programming						
2.3	**Program projects that increase access to job opportunities**	Change in the number of jobs within reasonable travel time (by mode) for region's population due to project				
2.4	**Program projects that increase access to essential destinations**	*Change in travel time (by mode) to schools, health services, grocery stores, civic and public spaces, recreation due to project*	Change in travel time of goods to essential markets due to project	Change in number of enterprises in key industries with reasonable access to high-capacity highway or rail facilities due to project		

Goal 2: Basic Accessibility—Provide a Transportation System That Offers Accessibility That Allows People to Fulfill at Least Their Basic Needs						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 3: Project Development						
2.5	**Develop projects that increase access to job opportunities**	Change in the number of jobs within reasonable travel time (by mode) for region's population due to selected project alternative				
2.6	**Develop projects that increase access to essential destinations**	*Change in travel time (by mode) to schools, health services, grocery stores, civic and public spaces, recreation due to selected project alternative*	Change in travel time of goods to essential markets due to selected project alternative	Change in number of enterprises in key industries with reasonable access to high-capacity highway or rail facilities due to selected project alternative		

Goal 2: Basic Accessibility—Provide a Transportation System That Offers Accessibility That Allows People to Fulfill at Least Their Basic Needs						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 4: Construction						
2.7	**Reduce delay to commuters due to construction activities**	*Change in travel time delay for commuters due to construction activities*				
2.8	**Minimize travel time delay (by mode) for affected population due to construction**	Change in travel time delay (by mode) for affected population due to construction activities	Change in travel time of goods to essential markets due to construction activities			

Goal 2: Basic Accessibility—Provide a Transportation System That Offers Accessibility That Allows People to Fulfill at Least Their Basic Needs						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 5: Maintenance						
2.9	**Reduce delay to commuters due to maintenance activities**	*Change in travel time delay for commuters due to maintenance activities*				
2.10	**Minimize travel time delay (by mode) for affected population due to maintenance activities**	Change in travel time delay (by mode) for affected population due to maintenance activities	Change in travel time of goods to essential markets due to maintenance activities			

Goal 2: Basic Accessibility—Provide a Transportation System That Offers Accessibility That Allows People to Fulfill at Least Their Basic Needs						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 6: System Operations						
2.11	**Reduce travel time to jobs and other essential destinations through operational improvements**	Change in travel time per mode per destination type				
2.12	**Improve travel time reliability to jobs and other essential destinations through operational improvements**	*Change in the reliability of travel time per mode per destination type*	Change in travel time of goods to essential markets due to operational improvements			

Goal 3: Equity/Equal Mobility—Provide Options That Allow Affordable and Equitable Transportation Opportunities for All Sections of Society						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 1: Planning						
3.1	**Ensure comparable transportation system performance for all communities**	Change in level of service (LOS) for disadvantaged and non-disadvantaged neighborhoods				
3.2	**Ensure reasonable transportation options for all communities**	Relative change in the percentage of disadvantaged population with convenient access to high-quality transit service	Relative change in the percentage of streets with sidewalks or walking paths within a community			
3.3	**Ensure accessibility to jobs and essential destinations for all communities**	*Relative change in the level of access for disadvantaged populations to jobs, schools, health services, grocery stores, civic and public spaces, recreation*				
3.4	**Ensure affordable transportation for all communities**	Relative change in the transportation cost index				
3.5	**Ensure that competitive options for freight movements exist for all communities**	Relative change in freight investment servicing disadvantaged populations				

Goal 3: Equity/Equal Mobility—Provide Options That Allow Affordable and Equitable Transportation Opportunities for All Sections of Society						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 2: Programming						
3.6	**Program transportation projects that improve transportation infrastructure equitably**	*Change in ratio of transportation disadvantaged to non-disadvantaged population benefitting from program*	Ratio of disadvantaged to non-disadvantaged population experiencing negative impacts of transportation program (e.g., noise, air quality, neighborhood fragmentation)			
3.7	**Program projects that improve transportation options equitably**	All modes (automobile, transit, pedestrian, bicycle) accommodated or improved by program				
3.8	**Program projects that improve accessibility equitably**	Ratio of disadvantaged to non-disadvantaged people with increased accessibility due to program				
3.9	**Program projects that reduce transportation costs for low-income communities**	Relative change in the transportation cost index due to program				
3.10	**Program projects that increase competitive options for freight movements in all communities**	Change in ratio of transportation disadvantaged to non-disadvantaged population benefitting from freight program				

Goal 3: Equity/Equal Mobility—Provide Options That Allow Affordable and Equitable Transportation Opportunities for All Sections of Society						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 3: Project Development						
3.11	**Develop transportation projects that improve transportation infrastructure equitably**	Change in ratio of transportation disadvantaged to non-disadvantaged population benefitting from project	*Ratio of disadvantaged to non-disadvantaged population experiencing negative impacts of transportation project (e.g., noise, air quality, neighborhood fragmentation)*			
3.12	**Develop projects that improve transportation options equitably**	All modes (automobile, transit, pedestrian, bicycle) accommodated or improved by project				
3.13	**Develop projects that improve accessibility equitably**	Ratio of disadvantaged to non-disadvantaged people with increased accessibility due to project				
3.14	**Develop projects that reduce transportation costs for low-income communities**	Relative change in the transportation cost index due to project				
3.15	**Develop projects that increase competitive options for freight movements in all communities**	Change in ratio of transportation disadvantaged to non-disadvantaged population benefitting from freight project				

Goal 3: Equity/Equal Mobility—Provide Options That Allow Affordable and Equitable Transportation Opportunities for All Sections of Society						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 4: Construction						
3.16	**Reduce delay due to construction activities equitably**	*Ratio of disadvantaged to non-disadvantaged system users experiencing delay due to construction activities*				
3.17	**Maintain or improve transportation options during construction for all communities**	Ratio of disadvantaged to non-disadvantaged system users experiencing fewer transportation options due to construction activities				

Goal 3: Equity/Equal Mobility—Provide Options That Allow Affordable and Equitable Transportation Opportunities for All Sections of Society						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 5: Maintenance						
3.18	**Reduce delay due to maintenance activities equitably**	*Ratio of disadvantaged to non-disadvantaged system users experiencing delay due to maintenance activities*				
3.19	**Maintain or improve transportation options during maintenance for all communities**	Ratio of disadvantaged to non-disadvantaged system users experiencing fewer transportation options due to maintenance activities				

Goal 3: Equity/Equal Mobility—Provide Options That Allow Affordable and Equitable Transportation Opportunities for All Sections of Society						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 6: System Operations						
3.20	**Reduce travel time to jobs and essential destinations through operational improvements equitably and across all modes**	Ratio of disadvantaged to non-disadvantaged system users experiencing reduced travel time due to operational improvements				
3.21	**Improve reliability in travel time to jobs and other essential destinations through operational improvements equitably and across all modes**	Ratio of disadvantaged to non-disadvantaged system users experiencing improved reliability of travel time by mode and destination type				
3.22	**Ensure that transportation costs do not disproportionately affect low-income users**	*Change in incidence of travel costs by income group due to operational improvements*				
3.23	**Increase competitive options for freight movements in all communities through operational improvements**	Relative change in operational investment by freight mode servicing disadvantaged communities				

Goal 4: System Efficiency—Ensure That the Transportation System's Functionality and Efficiency Are Maintained and Enhanced						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 1: Planning						
4.1	**Ensure that the transportation system is functional for all users**	Change in volume/capacity ratio by functional class	Change in multimodal LOS (using HCM measures)	Change in LOS on key freight routes or change in truck volume-to-capacity (V/C) ratio		
4.2	**Ensure that the existing transportation system achieves and maintains a state of good repair**	Change in percentage of roadway/transit infrastructure achieving state of good repair				
4.3	**Ensure that transportation options are efficient for all users**	*Change in travel time index (TTI) by mode*	Change in person hours of recurring delay, by mode			
4.4	**Ensure that reliable transportation options are maintained for all users**	Change in person hours of nonrecurring delay, by mode	Change in buffer time (by mode and freight)	Relative change in hours of nonrecurring delay on key freight corridors and approach network		

Goal 4: System Efficiency—Ensure That the Transportation System's Functionality and Efficiency Are Maintained and Enhanced						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 2: Programming						
4.5	**Program projects that maintain or improve the functionality of the transportation system for all users**	Change in volume/capacity ratio [congestion reduction per unit (lane-mile)] due to program	Change in multimodal LOS due to program	Change in LOS on key freight routes or change in truck V/C ratio due to program		
4.6	**Program projects designed to maintain or achieve a state of good repair for the existing transportation system**	*Change in existing lane/track/sidewalk miles in a state of good repair due to program*				
4.7	**Program projects that maintain or improve the efficiency of the transportation system for all users**	Change in TTI (by mode if applicable) due to program	Change in person hours of recurring delay, by mode, due to program			
4.8	**Develop programs that maintain or improve the reliability of the transportation system for all users**	Change in person hours of nonrecurring delay due to program	Change in buffer time due to program	Relative change in hours of nonrecurring delay on key freight corridors and approach network due to program		

Goal 4: System Efficiency—Ensure That the Transportation System's Functionality and Efficiency Are Maintained and Enhanced						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 3: Project Development						
4.9	**Develop projects that maintain or improve the functionality of the transportation system for all users**	*Change in V/C ratio [congestion reduction per unit (lane-mile)] due to project*	Change in multimodal LOS due to project	Change in LOS on key freight routes or change in truck V/C ratio due to project		
4.10	**Develop projects designed to maintain or achieve a state of good repair for the existing transportation system**	Change in existing lane/track/sidewalk miles in a state of good repair due to project				
4.11	**Develop projects that maintain or improve the efficiency of the transportation system for all users**	Change in TTI (by mode if applicable) due to project	Change in person hours of recurring delay, by mode, due to project			
4.12	**Develop projects that maintain or improve the reliability of the transportation system for all users**	Change in person hours of nonrecurring delay due to project	Change in buffer time due to project	Relative change in hours of nonrecurring delay on key freight corridors and approach network due to project		

Goal 4: System Efficiency—Ensure That the Transportation System's Functionality and Efficiency Are Maintained and Enhanced						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 4: Construction						
4.13	**Maintain the functionality of the transportation system during construction activities**	Change in peak hour persons moved due to construction activities	Change in multimodal LOS due to construction activities	Change in LOS on key freight routes or change in truck V/C ratio due to construction activities		
4.14	**Minimize the impact of construction activities on system efficiency**	*Change in travel time delay for commuters due to construction activities*	Change in person hours of recurring delay due to construction activities			
4.15	**Minimize the impact of construction activities on system reliability**	Change in person hours of nonrecurring delay due to construction activities	Change in buffer time due to construction activity	Relative change in hours of nonrecurring delay on key freight corridors and approach network due to construction		

Goal 4: System Efficiency—Ensure That the Transportation System's Functionality and Efficiency Are Maintained and Enhanced						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 5: Maintenance						
4.16	**Maintain the functionality of the transportation system during maintenance activities**	Change in peak hour persons moved due to maintenance activities	Change in LOS due to maintenance activities	Change in LOS on key freight routes or change in truck V/C ratio due to maintenance activities		
4.17	**Conduct maintenance activities with sufficient frequency to maintain the state of good repair**	Change in existing lane/track/sidewalk miles in a state of good repair due to maintenance activities				
4.18	**Minimize the impact of maintenance activities on system efficiency**	*Change in travel time delay for commuters due to maintenance activities*	Change in person hours of recurring delay due to maintenance activities			
4.19	**Minimize the impact of maintenance activities on system reliability**	Change in person hours of nonrecurring delay due to maintenance activities	Change in buffer time due to maintenance activity	Relative change in hours of nonrecurring delay on key freight corridors and approach network due to maintenance activities		

Goal 4: System Efficiency—Ensure That the Transportation System's Functionality and Efficiency Are Maintained and Enhanced						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 6: System Operations						
4.20	**Implement operational improvements that maintain system functionality**	Change in peak hour persons moved due to operational improvements	Change in LOS due to operational improvements	Change in LOS on key freight routes or change in truck V/C ratio due to operational improvements		
4.21	**Implement operational improvements that minimize the deterioration of transportation infrastructure and assets**	Change in useful life of infrastructure due to operational improvements				
4.22	**Implement operational improvements that enhance or maintain the efficiency of transportation options**	Change in TTI due to operational improvements	Change in person hours of recurring delay due to operational improvements			
4.23	**Implement operational improvements that enhance or maintain the reliability of transportation options**	*Change in person hours of nonrecurring delay due to operational improvements*	Change in buffer time due to operational improvements	Relative change in hours of nonrecurring delay on key freight corridors and approach network due to operational improvements/issues		

Goal 5: Security—Ensure That the Transportation System Is Secure from, Ready for, and Resilient to Threats from All Hazards						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 1: Planning						
5.1	**Prevent incidents within a transportation agency's control and responsibility**	Change in level of redundancy for critical passenger and freight infrastructure				
5.2	**Protect transportation users, agency personnel, and critical infrastructure**	*Change in share of agency staff that have received appropriate emergency training*				
5.3	**Improve the capacity of the transportation system to recover swiftly from incidents**	Change in the capacity of parallel/redundant routes across all modes				
5.4	**Enhance the security of freight transportation assets (e.g., ports)**	Change in the capacity of parallel/redundant routes along major freight corridors	Relative change in funding allocated to disaster/incident response and management			

Goal 5: Security—Ensure That the Transportation System Is Secure from, Ready for, and Resilient to Threats from All Hazards						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 2: Programming						
5.5	**Program projects that prevent incidents within a transportation agency's control and responsibility**	*Change in level of redundancy for critical passenger and freight infrastructure*				
5.6	**Program projects that protect transportation users, agency personnel, and critical infrastructure**	Change in the number/value of projects as part of program designed to protect transportation users, agency personnel, and critical infrastructure				
5.7	**Program projects that improve the capacity of the transportation system to recover swiftly from incidents**	Change in the number/value of projects as part of program designed to improve capacity of the transportation system to recover swiftly from incidents				
5.8	**Program projects that enhance the security of freight transportation assets (e.g., ports)**	Change in the number/value of projects as part of program designed to enhance the security of freight transportation assets (e.g., ports)				

Goal 5: Security—Ensure That the Transportation System Is Secure from, Ready for, and Resilient to Threats from All Hazards						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 3: Project Development						
5.9	**Develop projects that prevent incidents within a transportation agency's control and responsibility**	*Change in level of redundancy for critical passenger and freight infrastructure*				
5.10	**Develop projects that protect transportation users, agency personnel, and critical infrastructure**	Change in the number/value of projects designed to protect transportation users, agency personnel, and critical infrastructure				
5.11	**Develop projects that improve the capacity of the transportation system to recover swiftly from incidents**	Change in the number/value of projects designed to improve capacity of the transportation system to recover swiftly from incidents				
5.12	**Develop projects that enhance the security of freight transportation assets (e.g., ports)**	Change in the number/value of projects designed to enhance the security of freight transportation assets (e.g., ports)				

Goal 5: Security—Ensure That the Transportation System Is Secure from, Ready for, and Resilient to Threats from All Hazards						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 4: Construction						
	N/A	N/A				
Focus Area 5: Maintenance						
	N/A	N/A				

Goal 5: Security—Ensure That the Transportation System Is Secure from, Ready for, and Resilient to Threats from All Hazards						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 6: System Operations						
5.13	**Prevent incidents within a transportation agency's control and responsibility**	Change in level of redundancy for critical passenger and freight infrastructure	Annual number of incidents			
5.14	**Protect transportation users, agency personnel, and critical infrastructure**	Change in the share of agency staff that have received appropriate emergency training				
5.15	**Support regional, state, and local emergency responders with resources including facilities, equipment, and personnel**	Relative change in capital funding allocated to disaster/incident response and management				
5.16	**Help the transportation system recover swiftly from incidents**	Incident clearance time for selected incidents				
5.17	**Implement operational improvements that enhance the security of freight transportation assets (e.g., ports)**	*Relative change in operational funding allocated to disaster/incident response and management*				

Goal 6: Prosperity—Ensure That the Transportation System's Development and Operation Support Economic Development and Prosperity						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 1: Planning						
6.1	**Support growth in jobs and income by improving travel efficiency/reducing congestion**	Change in average truck speed on major freight corridors	*Change in travel delay (e.g., travel time index) at major freight bottlenecks by mode*	Change in corridor/city/commuter-shed-specific travel delay or other congestion-related measure	Change in cost of goods movement in key national modal corridors	
6.2	**Support growth in jobs and income by improving access to markets and factors of production (labor and raw materials)**	Change in population within user-defined distance to four-lane highway facilities, air cargo service, scheduled air service, intercity bus service, intercity rail service, etc.	Change in access to jobs and labor (how many jobs and how much labor can be accessed within various periods of time for an entire region or smaller areas)	Change in regional and shortline trackage with 286,000-lb rating		
6.3	**Support growth in jobs and income**	Net change in jobs/income associated with transportation plan implementation				

Goal 6: Prosperity—Ensure That the Transportation System's Development and Operation Support Economic Development and Prosperity						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 2: Programming						
6.4	**Support growth in jobs and income by improving travel efficiency/reducing congestion through programming**	Change in average truck speed on major freight corridors due to program	Change in travel delay (e.g., travel time index) at major freight bottlenecks by mode due to program	Change in corridor/city/commuter-shed-specific travel delay or other congestion-related measure due to program	Change in cost of goods movement in key national modal corridors due to program	Net change in jobs/income due to program
6.5	**Support growth in jobs and income by improving access to markets and factors of production (labor and raw materials) through programming**	Change in population within user-defined proximity to access-controlled four-lane highway facilities, air cargo service, scheduled air service, intercity bus service, intercity rail service, etc., due to program	*Change in access to jobs and labor (how many jobs and how much labor can be accessed within various periods of time for an entire region or smaller areas) due to program*	Change in regional and shortline trackage with 286,000-lb rating due to program		
6.6	**Program projects that reduce freight transportation costs**	Change in cost of shipment per ton/mile, by mode, due to program	Existence of a process for considering the freight-specific benefits and costs in the programming phase			

Goal 6: Prosperity—Ensure That the Transportation System's Development and Operation Support Economic Development and Prosperity						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 3: Project Development						
6.7	**Develop projects that support growth in jobs and income by improving travel efficiency/reducing congestion**	Change in average truck speed on major freight corridors due to project	Change in travel delay (e.g., travel time index) at major freight bottlenecks by mode due to project	Change in corridor/city/commuter-shed-specific travel delay or other congestion-related measure due to project	Change in cost of goods movement in key national modal corridors due to project	Net change in jobs/income due to project
6.8	**Develop projects that support growth in jobs and income by improving access to markets and factors of production (labor and raw materials)**	*Change in population within user-defined proximity to access-controlled four-lane highway facilities, air cargo service, scheduled air service, intercity bus service, intercity rail service, etc., due to project*	Change in access to jobs and labor (how many jobs and how much labor can be accessed within various periods of time for an entire region or smaller areas) due to project	Change in regional and shortline trackage with 286,000-lb rating due to project		
6.9	**Develop projects that reduce freight transportation costs**	Change in cost of shipment per ton/mile, by mode, due to project	Existence of a process for considering the freight-specific benefits and costs in the programming phase due to project			

Goal 6: Prosperity—Ensure That the Transportation System's Development and Operation Support Economic Development and Prosperity						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 4: Construction						
	N/A	NA				
Focus Area 5: Maintenance						
	N/A	NA				

Goal 6: Prosperity—Ensure That the Transportation System's Development and Operation Support Economic Development and Prosperity						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 6: System Operations						
6.10	**Support growth in jobs and income by improving travel efficiency/reducing congestion**	Change in average truck speed on major freight corridors	Change in travel delay (e.g., travel time index) at major freight bottlenecks by mode	*Change in corridor/city/commuter-shed-specific travel delay or other congestion-related measure*	Change in cost of goods movement in key national modal corridors	
6.11	**Support growth in jobs and income by improving access to markets and factors of production (labor and raw materials)**	Change in population within user-defined proximity to access-controlled four-lane highway facilities, air cargo service, scheduled air service, intercity bus service, intercity rail service, etc.	Change in access to jobs and labor (how many jobs and how much labor can be accessed within various periods of time for an entire region or smaller areas)	Change in regional and shortline trackage with 286,000-lb rating		

Goal 7: Economic Viability—Ensure the Economic Feasibility of Transportation Investments Over Time						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 1: Planning						
7.1	**Ensure that the expected value of social and economic benefits created by proposed transportation projects exceeds their costs**	Project-level cost/benefit ratio for proposed alternatives/policies, including freight				
7.2	**Ensure the selection of the lowest cost project alternative**	Proportion of projects subjected to life cycle cost analysis (LCCA)				
7.3	**Ensure that revenue sources used to pay for transportation infrastructure are sufficient to meet expected needs**	Percent of annual transportation funding needs that can be met with annual revenues				
7.4	**Ensure that the financial burden borne by transportation system users is shared equitably**	*Cost per user/vehicle/household of taxes and fees dedicated to transportation*				

Goal 7: Economic Viability—Ensure the Economic Feasibility of Transportation Investments Over Time						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 2: Programming						
7.5	**Ensure that the expected value of social and economic benefits created by proposed transportation programs exceeds their costs**	*Project-level cost/benefit ratio for proposed programs, including freight*				
Focus Area 3: Project Development						
7.6	**Ensure that the expected value of social and economic benefits created by major transportation projects exceeds their costs**	*Project-level cost/benefit ratio for proposed projects and/or programs, including freight*				
7.7	**Ensure the selection of the lowest cost project alternative**	Proportion of projects for which LCCA is verified/updated through post-project review				

Goal 7: Economic Viability—Ensure the Economic Feasibility of Transportation Investments Over Time						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 4: Construction						
7.8	**Ensure that construction costs are within planned budget**	*Proportion of projects with construction costs within planned budget*				
Focus Area 5: Maintenance						
7.9	**Ensure that maintenance costs are within planned budget**	*Proportion of projects with maintenance costs within planned budget*				
Focus Area 6: System Operations						
7.10	**Ensure that operations costs are within planned budget**	*Proportion of projects with operations costs within planned budget*				

Goal 8: Ecosystems—Protect and Enhance Environmental and Ecological Systems While Developing and Operating Transportation Systems						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 1: Planning						
8.1	**Ensure that environmental and ecological systems function properly**	Change in the number of formalized working partnerships (e.g., memorandums of understanding) with public and private environmental stakeholders	Change in the number of programmatic environmental permits and approvals for streamlining stakeholder regulatory review and support	Preparation of an annual sustainability report on ecological trends and ecological performance against agency sustainability policies and goals	Change in percentage of transportation system covered by consistent and accessible regional ecosystem framework(s) or spatially related ecological database(s)	
8.2	**Ensure that environmental and ecological systems are free of contaminants and pollutants**	*Existence of an agency-wide environmental management system [i.e., plan documenting environmental policy, environmental objectives and targets, identified regulatory requirements and compliance with requirements, defined roles and responsibilities, employee training plan, listing of documented processes, preventive actions, corrective actions, and emergency procedures (i.e., ISO 14001)]*				

Goal 8: Ecosystems—Protect and Enhance Environmental and Ecological Systems While Developing and Operating Transportation Systems						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 2: Programming						
8.3	**Program projects that maximize ecological opportunities and ecosystem benefits**	*Change in the percentage of projects programmed on the basis of achieving priority ecological outcomes*				
8.4	**Maintain ecosystem functions and processes**	Change in the number of projects programmed consistent with regional ecosystem framework(s)	Change in percentage of projects evaluated for ecological impacts through an informed decision-making process (comprehensive environmental review)			
8.5	**Maintain enterprise-wide habitat connectivity**	Change in road miles/square miles of watershed due to program	Change in number of fish passage barriers/hydrological obstructions in right-of-way due to program	Change in the number of retrofitted/maintained drainage and crossing structures due to program		
8.6	**Program projects that maintain and improve quantity and quality of water and aquatic ecosystems**	Change in number (percentage) of projects programmed to maintain or improve water quantity or quality				
8.7	**Program projects that allow normal physical processes within the stream/floodplain corridor**	Change in the number of new and retrofitted water crossings other than overflow crossings that (1) promote natural sediment transport patterns for the reach, (2) provide unaltered fluvial debris movement, and (3) allow for longitudinal continuity and connectivity of the stream/floodplain system due to program	Change in the number of new and retrofitted water crossings that allow lateral connectivity between the stream and floodplain due to program			
8.8	**Program projects that are free of contaminants and pollutants**	Change in the percentage of projects covered by a documented environmental management system due to program	Change in the number of projects developed for remediation of contaminated sites due to program			

Goal 8: Ecosystems—Protect and Enhance Environmental and Ecological Systems While Developing and Operating Transportation Systems						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 3: Project Development						
8.9	**Develop projects that maximize ecological opportunities and ecosystem benefits**	Change in the percentage of project alternatives selected on the basis of achieving priority ecological outcomes				
8.10	**Maintain ecosystem functions and processes**	Change in the number of projects designed consistent with regional ecosystem framework(s)				
8.11	**Conserve natural resources/capital during project implementation**	Change in ratio of resource replacement mitigation (e.g., wetland restoration, creation, enhancement, and preservation) to resource impact (area or function) by habitat type due to project	Change in net area of undeveloped land converted to transportation uses (acres) due to project	Change in percentage of projects evaluated for ecological impacts through an informed decision-making process (comprehensive environmental review) due to project		
8.12	**Maintain enterprise-wide habitat connectivity**	Change in road miles/square miles of watershed due to project	Change in number of fish passage barriers/hydrological obstructions in right-of-way due to project	Change in the number of retrofitted/maintained drainage and crossing structures due to project		
8.13	**Develop projects that maintain and improve quantity and quality of water and aquatic ecosystems**	*Change in number (percentage) of projects designed to maintain or improve water quantity or quality*				
8.14	**Maintain and improve surface water quantity and quality during project implementation**	Change in the amount of net impervious surface area (acres) due to project	Change in the amount of aquatic habitat affected [i.e., wetlands (acres), stream channel (feet, square feet)] due to project			

Goal 8: Ecosystems—Protect and Enhance Environmental and Ecological Systems While Developing and Operating Transportation Systems						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 3: Project Development (Continued)						
8.15	**Design projects that allow normal physical processes within the stream/floodplain corridor**	Change in the number of new and retrofitted water crossings other than overflow crossings that (1) promote natural sediment transport patterns for the reach, (2) provide unaltered fluvial debris movement, and (3) allow for longitudinal continuity and connectivity of the stream/floodplain system due to project	Change in the number of new and retrofitted water crossings that allow lateral connectivity between the stream and floodplain due to project			
8.16	**Develop projects to be free of contaminants and pollutants**	Change in the percentage of projects covered by a documented environmental management system	Change in the number of projects developed for remediation of contaminated sites			

Goal 8: Ecosystems—Protect and Enhance Environmental and Ecological Systems While Developing and Operating Transportation Systems						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 4: Construction						
8.17	**Promote biodiversity during project implementation**	Number of biological communities, species, populations, and genetic assemblages eliminated from effect zones due to construction				
8.18	**Control dispersal and establishment of invasive species during project implementation**	Number of projects implementing integrated pest management or weed control plans during construction				
8.19	**Apply context-sensitive corridor habitat restoration and landscaping during project implementation**	*Ratio of restored and maintained area to disturbed area (acres) within project*				
8.20	**Reduce noise and light effects on fish and wildlife during project implementation**	Amount and duration of priority habitat exposure to high levels of noise/light during construction				
8.21	**Reduce herbicide use during project implementation**	Area (in acres) sprayed with herbicides during construction				
8.22	**Reduce exposure to pollutants and contaminants during project implementation**	Amount of hazardous materials accidentally spilled (e.g., number of spills, gallons spilled, spills per million gallons shipped) during construction				

Goal 8: Ecosystems—Protect and Enhance Environmental and Ecological Systems While Developing and Operating Transportation Systems						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 5: Maintenance						
8.23	**Promote biodiversity during project maintenance**	Number of biological communities, species, populations, and genetic assemblages eliminated from effect zones due to maintenance				
8.24	**Control dispersal and establishment of invasive species during project maintenance**	Number of projects implementing integrated pest management or weed control plans during maintenance				
8.25	**Apply context-sensitive corridor habitat restoration and landscaping during project maintenance**	Ratio of restored and maintained area to disturbed area (acres) due to maintenance				
8.26	**Reduce noise and light effects on fish and wildlife during project maintenance**	Amount and duration of priority habitat exposure to high levels of noise/light during maintenance				
8.27	**Reduce herbicide use during project maintenance**	*Area (in acres) sprayed with herbicides during maintenance*				
8.28	**Reduce exposure to pollutants and contaminants during project maintenance**	Amount of hazardous materials accidentally spilled (e.g., number of spills, gallons spilled, spills per million gallons shipped) during maintenance				

Goal 8: Ecosystems—Protect and Enhance Environmental and Ecological Systems While Developing and Operating Transportation Systems						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 6: System Operations						
8.29	**Operate facilities to promote ecological opportunities, ecosystem benefits, and the building of natural capital**	Change in number of projects using spatially related (i.e., GIS-based) ecological condition inventories for managing healthy ecological systems				
8.30	**Conserve natural resources/capital during operations**	Change in amount of managed natural resource area by habitat type (acres)	Change in the area of previously established resource replacement mitigation disturbed by operations (acres)			
8.31	**Reduce vehicle–animal collisions during operations**	*Change in the number of animal kills*				
8.32	**Control dispersal and establishment of invasive species during operations**	Change in number of noxious species in right-of-way				
8.33	**Apply context sensitive corridor habitat restoration and landscaping during operations**	Change in amount (percentage) of operational budget allocated for landscape maintenance				

Goal 8: Ecosystems—Protect and Enhance Environmental and Ecological Systems While Developing and Operating Transportation Systems						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 6: System Operations (Continued)						
8.34	**Manage facilities to be pervious to the movements of biological organisms**	Change in the amount (percentage) of operational budget allocated for habitat connectivity	Change in the amount (percentage) of operational budget allocated for maintenance of hydrology			
8.35	**Reduce noise and light effects on fish and wildlife during operations**	Change in the amount of priority habitat areas exposed to high levels of transportation noise/light (due to operational improvements)				
8.36	**Maintain surface water quantity during operations**	Change in the number of water detention facilities in operation				
8.37	**Allow normal physical processes within the stream/floodplain corridor during operations**	Change in the percentage of channel crossings with properly functioning fluvial processes	Change in the percentage of floodplain crossings with properly functioning fluvial processes			
8.38	**Reduce herbicide use during operations**	Change in area (in acres) sprayed with herbicides during construction and maintenance				
8.39	**Reduce exposure to pollutants and contaminants during operations**	Change in the number of extant contaminated sites in right-of-way				

Goal 9: Waste Generation—Reduce Waste Generated by Transportation-Related Activities						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 1: Planning						
9.1	**Reduce total waste created**	Change in the amount of waste generated by type, weight, and/or volume				
9.2	**Increase the percentage of waste diverted**	Change in the amount of waste diverted (from landfill) by type, weight, and/or volume				
9.3	**Reduce hazardous waste**	Change in the amount of hazardous waste generated by type, weight, and/or volume				
9.4	**Clean up existing hazardous waste**	Change in the quantity of hazardous waste cleaned up compared to waste generated (e.g., acres of brownfield, gallons of waste, amount of treated groundwater)				
9.5	**Ensure that transportation infrastructure (e.g., pavements, bridges) is designed for long life**	Change in the average structural life of infrastructure network (e.g., pavement, bridge, tunnels)				
9.6	**Ensure that assets are managed to reduce life-cycle cost and increase useful life**	*An asset management system exists*				

Goal 9: Waste Generation—Reduce Waste Generated by Transportation-Related Activities						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 2: Programming						
9.7	**Reduce total waste created by transportation projects**	Change in the amount of waste generated by type, weight, and/or volume due to program	Change in the percentage of projects with a waste management plan in compliance due to program			
9.8	**Increase the percentage of waste diverted from transportation projects**	Change in the amount of project waste diverted (from landfill) by type, weight, and/or volume due to program	Change in the percentage of projects with a recycling plan or waste diversion goal due to program			
9.9	**Reduce hazardous waste generated by transportation projects**	Change in the amount of hazardous waste generated due to program				
9.10	**Clean up existing hazardous waste**	Change in the quantity of hazardous waste cleaned up compared to waste generated (e.g., acres of brownfield, gallons of waste, amount of treated groundwater) due to program				
9.11	**Program infrastructure projects designed for long life**	*Change in average design life of infrastructure (by major component) due to program*				

Goal 9: Waste Generation—Reduce Waste Generated by Transportation-Related Activities						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 3: Project Development						
9.12	**Reduce total waste created by transportation projects**	Change in the amount of waste generated by type, weight, and/or volume due to project	Change in the percentage of projects with a waste management plan in compliance			
9.13	**Increase the percentage of waste diverted from transportation projects**	Change in the amount of project waste diverted (from landfill) by type, weight, and/or volume	*Change in the percentage of projects with a recycling plan or waste diversion goal*			
9.14	**Reduce hazardous waste generated by transportation projects**	Change in the amount of hazardous waste generated due to project				
9.15	**Clean up existing hazardous waste**	Change in the quantity of hazardous waste cleaned up compared to waste generated (e.g., acres of brownfield, gallons of waste, amount of treated groundwater) due to project				
9.16	**Develop infrastructure projects designed for long life**	Change in average design life of project infrastructure (by major component)				

Goal 9: Waste Generation—Reduce Waste Generated by Transportation-Related Activities						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 4: Construction						
9.17	**Reduce total waste created during construction**	Change in the amount of waste generated by type, weight, and/or volume during construction	Change in the percentage of projects with a waste management plan in compliance			
9.18	**Increase the percentage of waste diverted during construction**	*Change in the amount of construction waste diverted (from landfill) by type, weight, and/or volume*	Change in the percentage of construction projects with a recycling plan or waste diversion goal			
9.19	**Reduce hazardous waste generated during construction**	Change in the amount of hazardous waste generated by project construction				

Goal 9: Waste Generation—Reduce Waste Generated by Transportation-Related Activities						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 5: Maintenance						
9.20	**Reduce total waste created during maintenance**	Change in the amount of waste generated by type, weight, and/or volume during maintenance				
9.21	**Increase the percentage of waste diverted during maintenance**	Change in the amount of maintenance waste diverted (from landfill) by type, weight, and/or volume	*Change in the percentage of maintenance projects with a recycling plan or waste diversion goal*			
9.22	**Reduce hazardous waste generated during maintenance**	Change in the amount of hazardous waste generated during maintenance				

Goal 9: Waste Generation—Reduce Waste Generated by Transportation-Related Activities						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 6: System Operations						
9.23	**Reduce total waste created due to system operations**	Change in the amount of waste generated by type, weight, and/or volume due to system operations	Change in the percentage of projects with a waste management plan in compliance			
9.24	**Increase the percentage of waste due to system operations that is diverted**	Change in the amount of operations waste diverted (from landfill) by type, weight, and/or volume	Change in the percentage of operational activities with a recycling plan or waste diversion goal			
9.25	**Reduce hazardous waste generated due to operations**	Change in the amount of hazardous waste generated by operational activities				
9.26	**Reduce litter**	*Change in the quantity of total litter collected annually (weight, volume, etc.)*				
9.27	**Increase composting, reuse of existing vegetation, and clearing/grubbing waste**	Change in total weight/volume composted annually				
9.28	**Reduce use of toxic cleaners, pesticides, and other chemicals**	Change in the total quantity used annually (weight, volume, etc.)				
9.29	**Ensure that transportation infrastructure is operated for long life**	Change in the average actual life of infrastructure (by major component)				
9.30	**Ensure that assets are managed to reduce life-cycle cost and increase useful life**	An asset management system is actively operated				

Goal 10: Resource Consumption—Reduce the Use of Nonrenewable Resources and Promote the Use of Renewable Replacements						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 1: Planning						
10.1	**Maintain a sustainable fleet**	Change in the percentage of zero/low emissions vehicles in DOT fleet	Change in the percentage of total diesel fuel substituted with alternative fuels, ultralow sulfur diesel (ULSD), electric motors			
10.2	**Purchase sustainable materials as a priority**	*Existence of a purchasing plan that establishes priority for sustainable materials*	Change in percentage of sustainable materials (by weight, volume, or dollar value)			
10.3	**Use renewable energy to provide project power**	Change in percentage of renewable energy, in kWh, created in relation to energy requirements				
10.4	**Reduce the demand for single occupancy vehicle travel**	Change in the number (or cost) of multimodal options for state employees				
10.5	**Purchase green energy**	Change in the amount and percentage of green energy purchased				
10.6	**Reduce energy usage**	Change in total energy consumed by DOT facilities (should relate to quantity of facilities)	Change in the number (or value) of investments in operational technologies to reduce fuel consumption (IdleAire, auxiliary power units supported by DOT through the Congestion Mitigation and Air Quality Improvement Program)	Percentage of trucks with Smartway-type technologies		
10.7	**Provide electric vehicle infrastructure**	Change in the number of plug-in stations and amount of energy distributed from those stations	Change in percentage of truck stops with electrification (IdleAire, etc.)			

Goal 10: Resource Consumption—Reduce the Use of Nonrenewable Resources and Promote the Use of Renewable Replacements						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 2: Programming						
10.8	**Encourage the sensible use of recycled materials in project programming**	Existence of a policy or specification prioritizing the use of sustainable materials in program	Change in percentage of sustainable materials (by weight, volume, or dollar value) due to program			
10.9	**Encourage the use of renewable energy in project programming**	*Change in percentage of renewable energy, in kWh, created in relation to project energy requirements due to program*				
10.10	**Program projects that use less energy**	Change in the number and percentage of projects in program that have lighting meeting Energy Star requirements				

Goal 10: Resource Consumption—Reduce the Use of Nonrenewable Resources and Promote the Use of Renewable Replacements						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 3: Project Development						
10.11	**Develop projects that encourage the sensible use of recycled materials**	Change in percentage of sustainable materials (by weight, volume, or dollar value) due to project				
10.12	**Use renewable energy to provide project power**	*Change in percentage of renewable energy, in kWh, created in relation to project energy requirements in project*				
10.13	**Develop projects that use less energy**	Change in the number and percentage of projects that have lighting meeting Energy Star requirements				

Goal 10: Resource Consumption—Reduce the Use of Nonrenewable Resources and Promote the Use of Renewable Replacements						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 4: Construction						
10.14	**Use biofuel for non-road construction equipment**	*Percentage of machine-hours or gallons of biofuel used during construction*				
10.15	**Purchase regionally produced construction materials**	Total weight/volume/cost purchased within a certain radius (e.g., 500 miles) from the project				
10.16	**Reduce energy usage due to construction**	Total machine-hours of energy-efficient non-road equipment as a percentage of all construction-related machine-hours				

Goal 10: Resource Consumption—Reduce the Use of Nonrenewable Resources and Promote the Use of Renewable Replacements						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 5: Maintenance						
10.17	**Use biofuel for non-road maintenance equipment**	*Percentage of machine-hours or gallons of biofuel used during maintenance*				
10.18	**Purchase regionally produced maintenance materials**	Total weight/volume/cost purchased within a certain radius (e.g., 500 miles) from the project				
10.19	**Reduce energy usage due to maintenance**	Total machine-hours of energy-efficient non-road equipment as a percentage of all maintenance-related machine-hours				

Goal 10: Resource Consumption—Reduce the Use of Nonrenewable Resources and Promote the Use of Renewable Replacements						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 6: System Operations						
10.20	**Maintain a sustainable fleet**	Change in the percentage of zero/low emissions vehicles in DOT fleet	Change in the percentage of total diesel fuel substituted with alternative fuels, ULSD, electric motors			
10.21	**Purchase sustainable materials as a priority**	Sustainable purchasing plan that defines and establishes priority for sustainable materials (e.g., recycled, reused, local)				
10.22	**Purchase green energy**	*Change in the amount and percentage of green energy purchased*				
10.23	**Reduce energy usage due to operations**	Change in the number of energy-efficient fixtures, total kWh saved, etc.	Change in percentage of renewable energy, in kWh, created in relation to operations energy requirements			

Goal 11: Emissions and Air Quality—Reduce Transportation-Related Emissions of Air Pollutants and Greenhouse Gases						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 1: Planning						
11.1	**Reduce activity that generates pollutant emissions (travel, trip length, mode split, emissions)**	Change in trips, vehicle trips, vehicle miles traveled (VMT), percent non-driver, tons of emissions per day	Change in percentage of commercial vehicles by EPA tier compliance			
11.2	**Reduce polluting exhaust emissions (criteria pollutants and GHGs)**	Change in emissions by criteria pollutant, total, and by mode/ton mile	Lane miles of new access improvements to intermodal and port facilities	Number of new separated rail crossings replacing grade crossings		
11.3	**Increase land use compactness, density, and balance of interacting uses (compactness, density, balance)**	Change in jobs/housing balance	Change in zoned residential density levels around essential service hubs			
11.4	**Increase the use of nonmotorized modes**	Change in planned miles of transit routes, pedestrian facilities, designated bike facilities, population within 1 mile of transit, connectivity index (pedestrian facilities, bike facilities, transit routes)				
11.5	**Increase street connectivity**	*Change in street connectivity index*				
11.6	**Reduce congestion, promote low emissions travel speeds**	Change percent VMT at low emission speed ranges	Change in percentage of toll lanes with EZPass			

Goal 11: Emissions and Air Quality—Reduce Transportation-Related Emissions of Air Pollutants and Greenhouse Gases						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 1: Planning (continued)						
11.7	**Reduce proximity of air-pollution-sensitive land uses to major pollution sources (high-volume highways)**	Change in sensitive receptors within close proximity, residential population within critical distance, percentage of ethnic/racial population groups within critical distance				
11.8	**Reduce concentration of critical pollutants in populated areas (model forecast) (criteria pollutants, GHGs)**	Change in population within areas above EPA standard (non-attainment areas), percent of ethnic/racial population groups within areas above EPA standard, percent of school population within areas above EPA standard				
11.9	**Provide measures that can reduce air pollutant concentrations (e.g., landscaping)**	Change in $CO_2 \rightarrow O_2$ conversion capacity of planned ROW plant materials				

Goal 11: Emissions and Air Quality—Reduce Transportation-Related Emissions of Air Pollutants and Greenhouse Gases						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 2: Programming						
11.10	**Program projects that reduce pollutant emissions (travel, trip length, mode split, emissions)**	Change in trips, vehicle trips, VMT, percent non-driver, tons of emissions per day due to program	*Change in percentage of commercial vehicles by EPA tier compliance due to program*	Change in emissions by criteria pollutant, total, and by mode/ton mile due to program	Lane miles of new access improvements to intermodal and port facilities due to program	Number of new separated rail crossings replacing grade crossings due to program
11.11	**Increase use of nonmotorized modes**	Change in route or service miles of transit routes, pedestrian facilities, designated bike facilities, population within 1 mile of transit, person-miles walk distance to transit stops, person-miles distance from building entrances to public pedestrian facilities (sidewalks, pedestrianways), connectivity index (pedestrian facilities, bike facilities, transit) due to program				
11.12	**Increase street connectivity**	Change in street connectivity index due to program				
11.13	**Reduce congestion, promote low emissions travel speeds**	Change in percent VMT at low emission speed range, total vehicle delay, percent stops (of intersection approach volumes), multimodal level of service (by mode), percent VMT at each level of service due to program				

Goal 11: Emissions and Air Quality—Reduce Transportation-Related Emissions of Air Pollutants and Greenhouse Gases						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 2: Programming (Continued)						
11.14	**Reduce populations within critical distance of major highway emissions sources (criteria pollutants, GHGs)**	Change in population within critical distance of high-volume highways [specify threshold average daily traffic (ADT)] (schools, hospitals, residences, ethnic/racial group equity) due to program				
11.15	**Reduce traffic volumes on major highways within critical distance of sensitive receptors (schools, hospitals, residences, ethnic/racial equity)**	Change in ADT (total, diesel), emissions due to program				
11.16	**Provide measures that can reduce air pollutant concentrations (e.g., landscaping)**	Change in $CO_2 \rightarrow O_2$ conversion capacity of project plant materials due to program				
11.17	**Reduce travel speeds to those within the lowest emissions ranges (criteria pollutants, GHGs)**	Change in population percentage within a critical distance of traffic operating at speeds outside the lowest emissions range due to program				

Goal 11: Emissions and Air Quality—Reduce Transportation-Related Emissions of Air Pollutants and Greenhouse Gases						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 3: Project Development						
11.18	**Develop projects that reduce pollutant emissions (travel, trip length, mode split, emissions)**	Change in trips, vehicle trips, VMT, percent non-driver, tons of emissions per day due to project	*Change in percentage of commercial vehicles by EPA tier compliance due to project*	Change in emissions by criteria pollutant, total, and by mode/ton mile due to project	Lane miles of new access improvements to intermodal and port facilities due to project	Number of new separated rail crossings replacing grade crossings due to project
11.19	**Increase use of nonmotorized modes**	Change in route or service miles of transit routes, pedestrian facilities, designated bike facilities, population within 1 mile of transit, person-miles walk distance to transit stops, person-miles distance from building entrances to public pedestrian facilities (sidewalks, pedestrianways), connectivity index (pedestrian facilities, bike facilities, transit) due to project				
11.20	**Increase street connectivity**	Change in street connectivity index due to project				
11.21	**Reduce congestion, promote low emissions travel speeds due to project**	Change in percent VMT at low emission speed range, total vehicle delay, percent stops (of intersection approach volumes), multimodal level of service (by mode), percent VMT at each level of service due to project				

Goal 11: Emissions and Air Quality—Reduce Transportation-Related Emissions of Air Pollutants and Greenhouse Gases						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 3: Project Development (Continued)						
11.22	**Reduce populations within critical distance of major highway emissions sources (criteria pollutants, GHGs)**	Change in population within critical distance of high-volume highways (specify threshold ADT) (schools, hospitals, residences, ethnic/racial group equity) due to project				
11.23	**Reduce traffic volumes on major highways within critical distance of sensitive receptors (schools, hospitals, residences, ethnic/racial equity)**	Change in ADT (total, diesel), emissions due to project				
11.24	**Provide measures that can reduce air pollutant concentrations (e.g., landscaping)**	Change in $CO_2 \rightarrow O_2$ conversion capacity of project plant materials due to project				
11.25	**Reduce travel speeds to those within the lowest emissions ranges (criteria pollutants, GHGs)**	Change in population percentage within a critical distance of traffic operating at speeds outside the lowest emissions range due to project				

Goal 11: Emissions and Air Quality—Reduce Transportation-Related Emissions of Air Pollutants and Greenhouse Gases						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 4: Construction						
11.26	**Reduce construction activity that generates pollutant emissions (engine operation, engine emission rates, idling time, emissions)**	Engine hours of operation, emission rates, idling hours per day, tons of emissions per day due to construction				
11.27	**Reduce adverse impact on traffic operations (lane reductions, traffic interruptions, detours, night operations)**	Change in peak hour/period capacity (e.g., lane miles), vehicle hours of delay, extra VMT, percent of passing VMT affected by construction				
11.28	**Reduce equipment emissions (equipment conforming to latest EPA emissions standards)**	*Percent of construction equipment at each tier of emissions standards (weighted or unweighted), percent of construction equipment retrofitted to meet latest EPA emissions standards*				
11.29	**Reduce on-site construction equipment activity**	Percent change in hours of diesel equipment operation compared to conventional techniques, percent of construction completed off-site (e.g., precast)				
11.30	**Reduce construction equipment emissions within a critical distance of sensitive populations (schools, hospitals, residences, ethnic/racial group equity)**	Daily emissions within critical distance (criteria pollutants, GHGs) due to construction				
11.31	**Reschedule urban construction activity with high emission rates to periods of low pollutant concentrations**	Percentage of diesel construction equipment operating hours during low pollutant concentration hours				

Goal 11: Emissions and Air Quality—Reduce Transportation-Related Emissions of Air Pollutants and Greenhouse Gases						
#	Objectives	Measure A	Measure B	Measure C	Measure D	Measure E
Focus Area 5: Maintenance						
11.32	**Reduce maintenance activity that generates pollutant emissions (engine operation, engine emission rates, idling time, emissions)**	Engine hours of operation, emission rates, idling hours per day, tons of emissions per day due to maintenance				
11.33	**Reduce adverse impact on traffic operations (lane reductions, traffic interruptions, detours, night operations)**	*Change in peak hour/period capacity (e.g., lane miles), vehicle hours of delay, extra VMT, percent of passing VMT affected by maintenance*				
11.34	**Reduce equipment emissions (equipment conforming to latest EPA emissions standards)**	Percent of maintenance equipment at each tier of emissions standards (weighted or unweighted), percent of maintenance equipment retrofitted to meet latest EPA emissions standards				
11.35	**Reduce maintenance equipment emissions within a critical distance of sensitive populations (schools, hospitals, residences, ethnic/racial group equity)**	Daily emissions within critical distance (criteria pollutants, GHGs) due to maintenance				
11.36	**Reschedule urban maintenance activity with high emission rates to periods of low pollutant concentrations**	Percentage of diesel maintenance equipment operating hours during low pollutant concentration hours				

Goal 11: Emissions and Air Quality—Reduce Transportation-Related Emissions of Air Pollutants and Greenhouse Gases						
#	**Objectives**	**Measure A**	**Measure B**	**Measure C**	**Measure D**	**Measure E**
Focus Area 6: System Operations						
11.37	**Reduce congestion-related emissions**	Change in the percent of VMT at low emission speed ranges, total vehicle delay, percent of approaching traffic that is stopped, multimodal level of service (by mode)	Change in emissions by criteria pollutant, total, and by mode/ton mile due to operational improvements			
11.38	**Reduce engine idling (on-road, non-road)**	Change in vehicle hours of idling				
11.39	**Promote nonmotorized modes**	Change in multimodal level of service, percent telework jobs (person-days/week), percent jobs within __ minutes of population (average) by nonmotorized modes, percent population within 1/4 mile of transit service, percent jobs within 1/4 mile of transit service, percent jobs within 1/2 mile of designated bike route, percent population within 1/2 mile of designated bike routes, average auto/transit travel time ratio (selected corridors)				
11.40	**Maintain efficient traffic operations**	Percent of area traffic signals retimed during past three years, percent of area traffic signals within coordinated signal systems re-coordinated during past three years	*Change in percentage of toll payers using EZPass*			
11.41	**Promote driving shifts to nonschool hours**	Change in percent (volume) of traffic passing school zones during times when schools are not in session				
11.42	**Promote nonmotorized modes**	Change in the percentage of person miles traveled by nonmotorized modes, emissions				

Appendix C

Electronic Compendium User Instructions

SUSTAINABILITY PERFORMANCE MEASURES COMPENDIUM USER INSTRUCTIONS

Welcome to the Excel-based version of the performance measures compendium, developed for NCHRP Project 8-74, "Sustainability Performance Measures for State DOTs and Other Transportation Agencies." These instructions provide you with the ability to generate and export a custom list of sustainability performance measures using a series of filters. This format will also allow you to customize existing measures (by adding measurement units, for example). You will find the Excel file on the CD-ROM that accompanies this guidebook.

THE BASICS

1. **Opening the document** – There are two versions of the documents provided. The "MAIN" version is for use with Microsoft Excel 2007 or later. The "97-2003" version can be used with earlier versions, but some original formatting types may not be supported. To ensure that the integrity of the original file remains intact, please immediately "Save As" and re-title the workbook. The workbook will typically run faster from your local drive than on a network, CD, or external drive.

2. **Enable macros** – Enable macros by clicking on the Security Warning "Options" box above the formula bar and selecting "Enable this content" (Figure C-1). If upon opening the worksheet, the Options box is not displayed, you may need to modify your macros security protocols, found in the Trust Center Settings (Office Button > Word Options > Trust Center > Trust Center Settings > Disable all macros with notification). Please confer with your IT administrator before making changes.

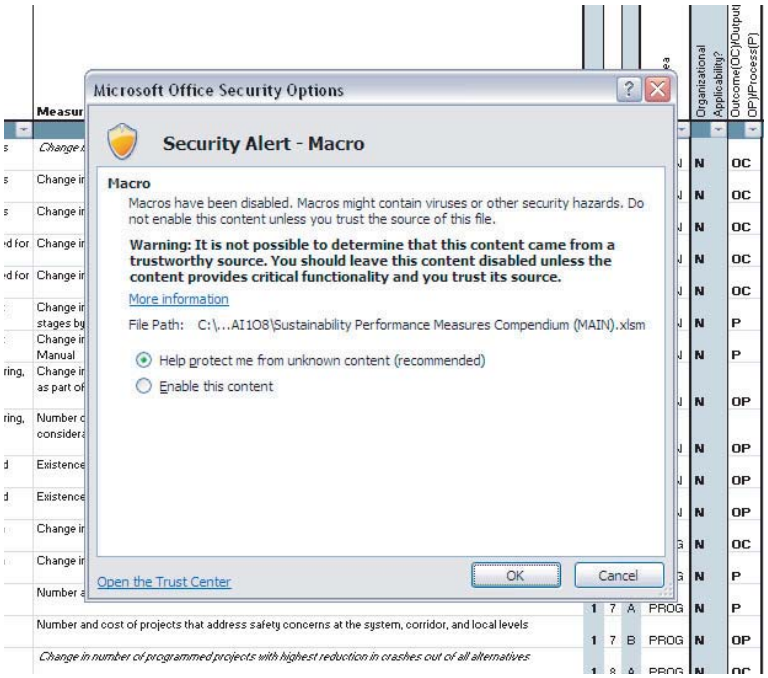

Figure C-1. Macro security alert dialog box.

3. **Worksheet protection** – To prevent users from accidentally deleting data or modifying functionality, each worksheet (the tabs displayed at the bottom of the workbook) is protected, with basic permissions granted based on anticipated user needs. Each worksheet can be unprotected by right clicking on the applicable tab and selecting "unprotect worksheet." Depending on user needs, unprotected worksheets may require manual re-protection. (Right click on the tab and select "Protect Worksheet." No password is required for unprotecting and re-protecting sheets. Respond to the dialog box for re-protecting sheets by clicking "OK"). **Note:** Please **do not** apply workbook protection via the "Review" tab. Doing so will disable the Export macro and yield a run-time error message.

USING THE COMPENDIUM

1. **Workbook components** – The compendium is composed of one worksheet (Figure C-2) for each of the 11 goals and one "All Measures" worksheet, in which all goals, objectives, and measures are assembled and cross-categorized to enable more precise filtering operations. Further information on the compendium, including the development of the goals, focus areas, objectives, and measures, may be found in Appendix B of the guidebook.

	A	B	C	D	E	
1	**Goal 1. Safety—Provide a safe transportation system for users and the general public.**					
2	#	Objectives	Measure A	Measure B	Measure C	Measu
3	*Focus Area 1: Planning*					
4	1.1	Reduce the number and severity of crashes	*Change in the number and severity of crashes*	Change in the number of crashes by crash type and contributing factor	Change in the number and severity of truck crashes	
5	1.2	Ensure safety considerations are addressed for all modes	Change in the number and severity of crashes by user type (e.g., pedestrian, bicycle, transit user, freight)	Change in the number of grade crossing collisions/incidents		
6	1.3	Ensure safety is considered early in project planning	Change in percentage of projects where safety of a project was reviewed in each of the project development stages by a multidisciplinary review team	Change in the percentage of projects implementing predictive methods of the AASHTO Highway Safety Manual		
7	1.4	Ensure projects consider the 4Es (engineering, education, enforcement, EMS) of safety	Change in the percentage of projects where non-infrastructure based safety countermeasures were selected as part of the project	Number of projects incorporating the use of innovative TSM and ITS solutions that address human factors considerations		
8	1.5	Plan road networks that are predictable and recognizable	Existence of a functional class system of highways	Existence of a system that adjust speeds based on the presence of alternative modes and context		

Figure C-2. Screenshot of a compendium worksheet.

2. **Filtering** – Filtering, which allows for the generation of a customized list of goals, objectives, and measures, is enabled through the "All Measures" worksheet. A filtering operation is initiated by clicking on the box (with embedded downward arrow—see arrow in Figure C-3) provided in row three (3), directly beneath the title of the filter (e.g., "Safety."). A drop-down box menu will appear, with a scroll menu at the bottom (beneath "Text Filters"). The filter is applied by selecting *only* checkboxes with relevant categories and clicking "OK." For example, to filter out all goals except 1 and 2, check boxes 1 and 2, ensuring that all others remain blank. Apply as many filters as necessary in order to ensure that the list is sufficiently precise and manageable**. Note:** Using the "Sort" function is not recommended. Although sorting is disabled by the default worksheet protections, selecting "Sort" will harm the "Reset" macro.

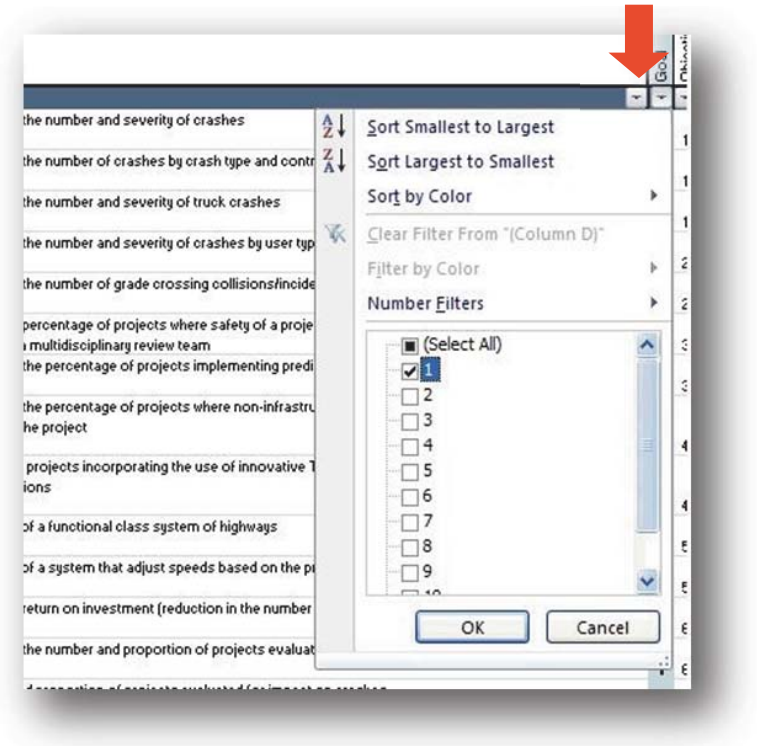

Figure C-3. Filter in the compendium using the checkboxes.

The filters include

1) Goals, Objectives, Measures (columns A–C): As text-based lists offering a multitude of choices (from 11 under Goal to over 400 under Measures), these filters are not recommended for initial filter operations but may be useful for final refinements. The use of italics in the "Measures" column indicates that a given measure is a designated "example of use" measure, described in Appendix D. These columns are linked directly from the Goal tabs and should never be modified on the "All Measures" tab. See Figure C-4.

2) ID: Goal, Objective, Measure (columns D–F): The columns combine to provide a discrete ID number for each measure and may be used to easily trace each measure back to its source goal worksheet. The "Goal" filter (column D) is useful for eliminating unwanted

goals and is well suited for initial filtering operations. "Object" and "Measure" are provided primarily to provide complete IDs but may also be used for final filtering.

3) Focus Areas (column G): This filter allows the user to select from among the six focus areas to provide appropriate emphasis. The abbreviations are defined in the "Key" tab.

4) Type (columns H and I):

    a. Organizational Applicability (column H): Allows the user to view measures only applicable to internal aspects of the agency (pertaining to the agency's own vehicle fleet, for example), or conversely, only focused on external activities.

    b. Outcome (OC)/Output (OP)/Process (P) (column I): Allows the user to filter measures that reflect outcomes (results of activities), outputs (activities themselves), or agency processes (reflects the existence of a process or procedures). Full definitions are included in the "Key" tab.

5) Program Relevance (columns J–N): Allows the user to filter measures by broad program areas or interests, including

    a. Freight,
    b. Transit,
    c. Bike/pedestrian,
    d. Safety, and
    e. Land use.

6) Principles (columns O–R): Allows the user to filter by principle, including the three Es (environment, equity, economy) and fostering community health and vitality.

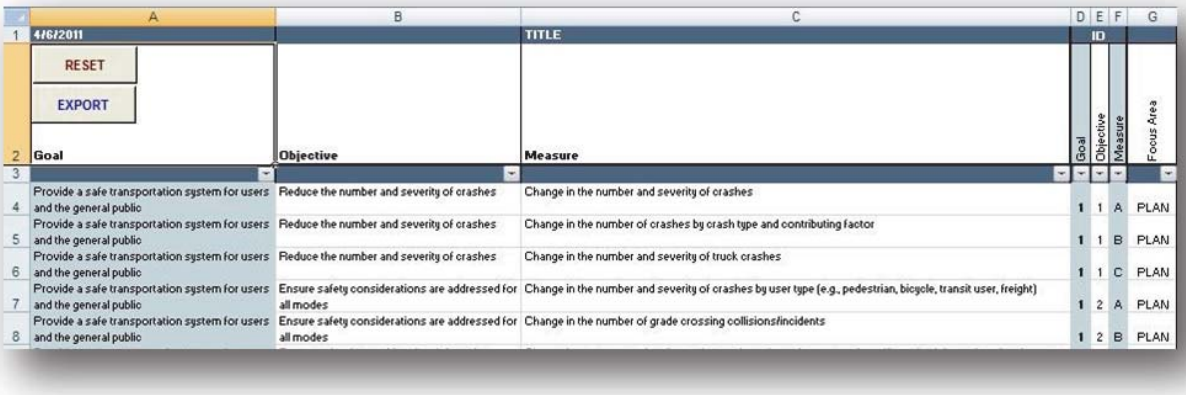

Figure C-4. Screenshot of columns that can be filtered.

3. **Duplicate measures** – Some measures may appear under multiple goals and/or objectives. Measures within different goal categories that are effectively duplicates are cross-listed in the "Duplicate" columns by ID number (Goal-Objective-Measure).

4. **Exporting** – Once you have applied all relevant filters to produce a customized list of goals, objectives, and measures, it may be exported. The exporting operation is accomplished by clicking the "EXPORT" radio button at top left (in cell A-2). If you export the entire, unfiltered worksheet, a pop-up message will occur asking "No filters selected, do you want to export the entire sheet?" Clicking "Yes" will initiate the export operation (Figure C-5). Clicking "No" will ask you to "Please select filters and then export."

Figure C-5. Export dialog box.

If you export a filtered worksheet, the "Export" macro may take several seconds, depending on the processing speed of your computer. The macro begins by copying all visible (filtered) cells into a new worksheet, entitled "Sheet 1" (or 2, 3, etc., if multiple exports are performed). The macro then returns the user to the "All Measures" workbook, where subsequent filtering can occur. (The "All Measures" sheet is automatically reset). This operation can be performed manually but is moderately complicated and time consuming.

Returning to the exported sheet, you will find the date of export stamped in cell A-1. (The "All Measures" sheet has a dynamic date.) By default, the cursor will be located in cell C-1 ("Title"), reminding you of the option to title your customized list. (You may also re-title the tab itself by double clicking on it.) **Note:** To limit the file size of the compendium and prevent noticeable slowdowns, it is recommended that users either delete exported sheets after use or move them to a new workbook (right click on tab > move or copy > to book: (new book) > save).

Figure C-6. Pop-up box alert.

5. **Reset** – The user can simultaneously remove all filters on the "All Measures" sheet by clicking the "RESET" radio button, located in cell A-2. If you have not applied any filters, a pop-up box will alert you by stating "No filters selected" (Figure C-6). The reset

operation is also easily performed manually by clicking "Clear" filter, under the Data menu. Individual filters may be removed by clicking the arrow-embedded filter box and selecting "Clear filter from column ___" or modified by changing the selected check boxes.

6. **Goals** – The 11 goal worksheets feed content directly to the "All Measures" tab but are not intended for direct filtering (a default protection). They are organized by focus areas (which contain relevant objectives and measures), with each row displaying "Goal-Objective" IDs in column A, an objective in column B, and measures applicable to that objective lettered from A to E (providing the measure ID). The sheets may be modified by the user, either to customize existing measures or to add new measures. To create new measures, it is recommended that the user supplant an existing measure, which will be automatically reflected in the "All Measures" tab (although changes in filter criteria need to be updated manually). The creation of new measures in blank cells is not recommended since the "All Measures" sheet would require manual modification.

Each "Goal" tab is set up for easy landscape-format printing, with page breaks coincident with focus areas.

Appendix D

Sustainability Performance Measure Examples

This appendix provides a set of examples in practice for a selected set of performance measures from the compendium. For each goal, one measure per focus area has been illustrated by an example of a similar measure in use by a transportation agency. Many of the measures are not exact duplicates but retain the same value or intention. In some cases the agency examples are more specific than those in the compendium. In a handful of cases the focus areas are combined and one measure is used due to the similarities in the compendium.

In addition to the actual measure that is included, the documents these measures come from (website links are provided) are valuable resources for agencies building a sustainability performance measures program. The range of documents listed as references also provides an indication of the types of departments, programs, and policies that incorporate measures that can be used for sustainability measurement.

Goal 1: Provide a Safe Transportation System for Users and the General Public

Focus area: Planning

Objective: Reduce the severity of crashes

Measure: Change in the number and severity of crashes

Agency: Minnesota DOT (MnDOT)

Document/website: Minnesota Statewide Transportation Policy Plan

http://www.dot.state.mn.us/planning/stateplan/Final%20Plan%20Documents/Policy%20Plan/PDF/AppendixD.pdf

Agency example measure: Annual number of severe or incapacitating injuries on all Minnesota roads

Methodology: A severe or incapacitating injury, classified as a Type A injury in crash reports, is defined as an injury (other than fatal) that prevents the injured person from walking, driving, or normally continuing the activities he or she was capable of performing before the injury occurred. Hospitalization is usually required. This measure tracks the annual total number of severe incapacitating injuries on all state and local roads.

Data source: Department of Public Safety Office of Traffic Safety's crash data

Analysis scale: Roadway, local, regional, statewide

Background: The Minnesota Statewide Transportation Policy Plan identifies 10 major policy areas. This measure supports the first policy area, traveler safety. This policy's goal is to "reduce the number of fatalities and serious injuries for all travel modes." MnDOT has a Toward Zero Deaths initiative as an overall target for their safety goal. While that is the focus, severe injury crashes are also of great concern.

Focus area: Programming

Objective: Prioritized projects with explicit safety considerations

Measure: Change in number of programmed projects with highest reduction in crashes out of all alternatives

Agency: Arizona DOT (ADOT)

Document/website: Arizona Strategic Highway Safety Plan

http://www.azdot.gov/highways/traffic/TSS/SHSP/AZ_Strategic_Highway_Safety_Plan.pdf

Agency example measure: Number of signalized intersections converted to roundabouts

Methodology: This measure is based on data showing the reduction in crashes for intersections converted from signals to roundabouts. The measure is a calculation of the number of projects included in the funded program.

Data source: Arizona DOT

Analysis scale: Roadway, local, regional, statewide

Background: The Arizona Strategic Highway Safety Plan underlies the state's safety vision: "Zero fatalities on Arizona roads; your life depends on it," or the Every One Counts vision. The state's safety goal is to reduce the number of fatalities by 12%. To achieve this goal, the state selected six emphasis areas:

1. Restraint usage,
2. Speeding,
3. Young drivers,
4. Impaired driving,
5. Roadway/roadside (lane departure and intersections), and
6. Data improvement.

Focus area: Project development

Objective: Develop project with explicit safety considerations

Measure: Selected project design has highest reduction out of all alternatives

Agency: ADOT

Document/website: Comprehensive Approach to Wildlife Protection on State Route 260

http://environment.fhwa.dot.gov/ecosystems/eei/az.asp

Agency example measure: Use of engineering measures (wildlife-proof fencing, escape ramps, and one-way gates) to keep elk (and other animals) off the highway

Methodology: ADOT worked in partnership with the Arizona Game and Fish Department (AGFD) to build bridges and other barriers that will enable elk and other animals to safely cross under the highway (or contain them) to reach critical watering sites and other habitat vital to their survival. In a pilot study, AGFD fitted 36 elk with GPS collars to track their movement along the highways and determine seasonal movements. The research has shown that the animals are using the underpasses.

Data sources: Arizona DOT and AGFD

Analysis scale: Roadway, local

Background: This project started as part of a road-widening project from a two-lane route to a four-lane divided highway.

Focus areas: Construction and maintenance

Objective: Reduce crash risk in work zones

Measure: Change in number of crashes per time unit within a particular work zone

Agency: Kentucky Transportation Center

Document/website: Improve Safety of Workers During Highway Construction and Maintenance

http://www.ktc.uky.edu/Reports/KTC_07_16_SPR_323_05_1F.pdf

Agency example measure: Use of a range of engineering and operations measures to reduce the number of accidents in work zones

Methodology: This study collected survey data from construction and maintenance field workers, managers, and engineers. The data highlighted the four most significant safety improvements needed in the state.

Data source: Kentucky Transportation Center

Analysis scale: Statewide

Background: The objective of this study was to identify best safety practices for workers on highway construction and maintenance projects. Although the study does not specifically develop performance measures, it does recommend a series of actions that state DOTs can take to improve safety, which could easily be translated into performance measures.

Focus area: System operations

Objective: Reduce the crash risk of the traveling public using transit

Measure: Number of fatal and disabling injuries sustained by transit users as a portion of 100 million passenger miles traveled or of 100,000 riders

Agency: King County Metro Transit, Washington

Document/website: *2009 Annual Management Report*

http://metro.kingcounty.gov/am/reports/2009/2009-QMRyearend.pdf

Agency example measure: Accidents per million miles

Methodology: King County Metro Transit records the number of vehicle and passenger accidents each year. They classify accidents as preventable and unpreventable.

Data source: King County Metro Transit

Analysis scale: Service area

Background: The annual report provides information and the transit agency's operating and financial statistics.

Goal 2: Provide a Transportation System That Offers Accessibility That Allows People to Fulfill at Least Their Basic Needs

Focus area: Planning

Objective: Ensure accessibility to jobs

Measure: Change in the number of jobs within reasonable travel time (by mode) for region's population

Agency: Metropolitan Transportation Commission, California

Document/website: *Transportation 2030 Equity Analysis Report*

http://www.mtc.ca.gov/planning/2030_plan/downloads/EJ/T2030EquityAnalysisReport.pdf

Agency example measure: Number of jobs accessible by auto and transit within 15, 30, and 45 minutes

Methodology: This evaluation factor measures the number of jobs accessible by auto and transit for each of the alternatives for communities of concern and the remainder of the Bay

Area. The analysis measures jobs accessible by both modes within 15, 30, and 45 minutes. The forecasts include regional population projections for 2030 as well as job growth projected for 2030. For this measure, job accessibility is considered representative of other key destinations such as hospitals, retail, government centers, and so forth.

Data source: Metropolitan Transportation Commission

Analysis scale: Regional

Background: This measure is included in the Metropolitan Transportation Commission's *2030 Equity Analysis Report*. The report measures the benefits and burdens associated with the proposed transportation projects in the Transportation 2030 plan to ensure that minority and low-income communities receive equitable benefits without shouldering a disproportionate share of the burdens.

Focus area: Programming

Objective: Program projects that increase access to essential destinations

Measure: Change in travel time (by mode) to schools, health services, grocery stores, civic and public spaces, and recreation due to project

Agency: Michigan Department of Transportation (MDOT)

Document/website: *Driven by Excellence: A Report on Transportation Performance Management at MDOT*

http://www.michigan.gov/documents/mdot/MDOT_DrivenExcellenceReport_323894_7.pdf

Agency example measure: Number of Michigan counties that provide some form of local bus service

Methodology: MDOT tracks the number of counties (out of 83) that offer some level of bus transit service to residents.

Data source: MDOT

Analysis scale: County, state

Background: MDOT produced this report to provide its customers with an overview of how the transportation system in the state is functioning. The measures included in the report are linked to the four goal areas of the Michigan Transportation Plan: stewardship, safety and security, system improvement, and efficient and effective operation.

MDOT views transit service as an important lower-cost transportation service and a critical service to maintain for its residents. Currently there is transit service in all 83 counties, but service is very limited in some counties. MDOT's goal is protect the existing system, although it also recognizes the gaps that exist and could be improved.

Focus area: Project development

Objective: Develop projects that increase access to essential destinations

Measure: Change in travel time (by mode) to schools, health services, grocery stores, civic and public spaces, and recreation due to selected project alternative

Agency: Puget Sound Regional Council (PSRC)

Document/website: Vision 2040

http://www.psrc.org/assets/366/FullReport.pdf

Agency example measure: Travel mode splits, travel times, and delay by county and major corridor, and by regional geography (including designated centers)

Methodology: PSRC uses a range of data to calculate mode splits, travel times, and delay in key travel areas.

Data sources: U.S. Census, PSRC Household Travel Survey, Washington State Department of Transportation

Analysis scale: County, corridor, regional geography, designated centers

Background: Vision 2040 was developed to create a shared strategy for moving the central Puget Sound region toward a sustainable future. Central to the document and policies is the concept of "People, Places, Prosperity."

Focus area: Construction and maintenance

Objective: Reduce delay to commuters due to construction or maintenance activities

Measure: Change in travel time delay for commuters due to construction or maintenance activities

Agency: The National Work Zone Safety Information Clearinghouse

Document/website: *Work Zone Safety Performance Measures Guidance Booklet*

http://www.workzonesafety.org/fhwa_wz_grant/atssa/atssa_wz_performance_measures

Agency example measure: Travel time/delay during construction or maintenance

Methodology: Relies on good baseline information; data are collected on commute days (Monday through Friday, not including holidays). Delay value can be scaled based on project/traffic characteristics.

Data source: The National Work Zone Safety Information Clearinghouse

Analysis scale: Project, local, county, corridor

Background: The National Work Zone Safety Information Clearinghouse is dedicated to providing the transportation construction industry and the general public with comprehensive information to improve motorist, worker, and pedestrian safety in work zones.

Focus Area: System operations

Objective: Improve travel time reliability to jobs and other essential destinations through operational improvements

Measure: Change in the reliability of travel time per mode per destination type

Agency: Washington State Department of Transportation (WSDOT)

Document/website: *2010 Congestion Report*

http://www.wsdot.wa.gov/Accountability/Congestion/2010.htm

Agency example measure: Range of percentiles reliability analysis

Methodology: WSDOT uses the reliable travel time measure using multiple percentile thresholds as part of their travel time analysis for 38 high-demand Puget Sound commute routes. Reliability percentile analysis looks at travel times at the 50th percentile (median), 80th percentile, 90th percentile, and 95th percentile values. The 95th percentile reliability score is the duration that gets drivers to their destination on time 95% of the time.

Data source: WSDOT collects real-time data for 52 commute routes in the Puget Sound region, two commute routes in Spokane, and for other highways throughout the State.

Analysis scale: Corridor, local, regional, statewide

Background: WSDOT produces an annual analysis of travel statewide with an emphasis on major commute routes in the more densely populated areas of the state. The *2010 Congestion Report* provides WSDOT with an evaluation of the success of their congestion relief projects and strategies.

Goal 3: Provide Options That Allow Affordable and Equitable Transportation Options for All Sections of Society

Focus area: Planning

Objective: Ensure accessibility to jobs and essential destinations for all communities

Measure: Relative change in the level of access for disadvantaged populations to jobs, schools, health services, grocery stores, civic and public spaces, and recreation

Agency: Metropolitan Transportation Commission, California

Document/website: *Transportation 2030 Equity Analysis Report*

http://www.mtc.ca.gov/planning/2030_plan/downloads/EJ/T2030EquityAnalysisReport.pdf

Agency example measure: Access and travel time to essential destinations by auto and transit

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Methodology: This evaluation factor measures the travel time to essential destinations by auto and transit for communities of concern and the remainder of the Bay Area. Essential destinations include schools, food stores, health services, and local services (e.g., banks and post offices). The Transportation 2030 investment alternatives are compared against this measure.

Data source: Metropolitan Transportation Commission

Analysis scale: Regional

Background: This measure is included in the Metropolitan Transportation Commission's *2030 Equity Analysis Report*. The report measures the benefits and burdens associated with the proposed transportation projects in the Transportation 2030 plan to ensure that minority and low-income communities receive equitable benefits without shouldering a disproportionate share of the burdens.

Focus area: Programming

Objective: Program transportation projects that improve transportation infrastructure equitably

Measure: Change in ratio of transportation disadvantaged to non-disadvantaged population benefitting from program

Agency: Southern California Association of Governments (SCAG)

Document/website: 2008 Regional Transportation Plan – *Environmental Justice Report*

http://www.scag.ca.gov/rtp2008/pdfs/finalrtp/reports/fEnvironmentalJustice.pdf

Agency example measure: Distribution of plan expenditures

Methodology: SCAG reports expenditure distribution by estimating the share of total regional transportation plan expenditures allocated to each category of household income by totaling expenditures on each mode and allocating them to each group's level of use.

Data sources: U.S. Census, American Housing Survey, National Household Travel Survey

Analysis scale: Regional

Background: This measure is included in SCAG's *Environmental Justice Report*. The purpose of the analysis is to ensure that the important principles of environmental justice are considered and integrated into the transportation planning process.

Focus area: Project development

Objective: Develop transportation projects that improve transportation infrastructure equitably

Measure: Ratio of disadvantaged to non-disadvantaged population experiencing negative impacts of transportation program (e.g., noise, air quality, neighborhood fragmentation)

Agency: Mid-Ohio Regional Planning Commission

Document/website: Environmental Justice Technical Analysis

http://www.morpc.org/pdf/CapitalWays%20EJ%20Appendix%20May%202008.pdf

Agency example measure: Displacement from projects

Methodology: During the preparation of the transportation plan, all projects are qualitatively assessed as to the number of displacements resulting from the project. MORPC developed four categories—none, low, moderate, and high—to classify each project.

Data source: MORPC

Analysis scale: Regional

Background: This measure is included in MORPC's Environmental Justice Technical Analysis. The purpose of the analysis is to ensure that the important principles of environmental justice are considered and integrated into the transportation planning process.

Focus area: Construction and maintenance

Objective: Reduce delay due to construction or maintenance activities equitably

Measure: Ratio of disadvantaged to non-disadvantaged system users experiencing delay due to construction or maintenance activities

Agency: The National Work Zone Safety Information Clearinghouse

Document/website: *Work Zone Safety Performance Measures Guidance Booklet*

http://www.workzonesafety.org/fhwa_wz_grant/atssa/atssa_wz_performance_measures

Agency example measure: Travel time/delay during construction or maintenance

Methodology: Relies on good baseline information; data are collected on commute days (Monday through Friday, not including holidays). Delay value can be scaled based on project/traffic characteristics. This measure can be calculated for disadvantaged and non-disadvantaged groups to understand the implications for sections of society.

Data source: The National Work Zone Safety Information Clearinghouse

Analysis scale: Project, local, county, corridor

Background: The National Work Zone Safety Information Clearinghouse is dedicated to providing the transportation construction industry and the general public with comprehensive information to improve motorist, worker, and pedestrian safety in work zones.

Focus area: System operations

Objective: Ensure that transportation costs do not disproportionately affect low-income users

Measure: Change in incidence of travel costs by income group due to operational improvements

Agency: SCAG

Document/website: 2008 Regional Transportation Plan – *Environmental Justice Report*

http://www.scag.ca.gov/rtp2008/pdfs/finalrtp/reports/fEnvironmentalJustice.pdf

Agency example measure: Taxes paid

Methodology: SCAG reports the amount of taxes (sales, gasoline, and income) to determine whether lower income groups are paying an amount proportional to the transportation services they are using.

Data source: SCAG

Analysis scale: Regional

Background: This measure is included in SCAG's *Environmental Justice Report*. This measure is compared to the share of transit system usage and transit travel time savings by income groups to determine the benefits they are receiving compared to their tax burden. As transit operations are improved, this relationship changes. The purpose of the analysis is to ensure that the important principles of environmental justice are considered and integrated into the transportation planning process.

Goal 4: Ensure That the Transportation System's Functionality and Efficiency Are Maintained and Enhanced

Focus area: Planning

Objective: Ensure that transportation options are efficient for all users

Measure: Change in travel time index by mode

Agency: Texas Transportation Institute

Document/website: Annual *Urban Mobility Report*

http://mobility.tamu.edu/

Agency example measure: Travel time index calculated as the ratio of travel time in the peak period to travel time in free flow

Methodology: A measure of congestion that focuses on each trip and each mile of travel. It is calculated as the ratio of travel time in the peak period to travel in free flow. A value of 1.30 indicates that a 20-minute free-flow trip takes 25 minutes in the peak.

Data source(s): The Texas Transportation Institute produces this annual report of congestion on freeways and major streets in 101 cities in the United States.

Analysis scale: Local, regional

Background: This report is an excellent resource for the agencies included in the analysis areas.

Focus area: Programming

Objective: Program projects designed to maintain or achieve a state of good repair for the existing transportation system

Measure: Change in existing lane/track/sidewalk miles in a state of good repair due to program

Agency: MDOT

Document/website: *Driven by Excellence: A Report on Transportation Performance Management at MDOT*

http://www.michigan.gov/documents/mdot/MDOT_DrivenExcellenceReport_323894_7.pdf

Agency example measure: 90% of trunk-line pavement rated in fair or better condition

Methodology: MDOT uses a measure called remaining service life (RSL), which estimates the remaining years until a pavement's most cost-effective treatment is either reconstruction or major rehabilitation. Pavements with an RSL of two years or less are considered to be in poor condition.

Data source: MDOT asset management

Analysis scale: Local, regional, state

Background: MDOT produced this report to provide its customers with an overview of how the transportation system in the state is functioning. The measures included in the report are linked to the four goal areas of the Michigan Transportation Plan: stewardship, safety and security, system improvement, and efficient and effective operation.

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Focus area: Project development

Objective: Develop projects that maintain or improve the functionality of the transportation system for all users

Measure: Change in volume/capacity ratio [congestion reduction per unit (lane mile)] due to project

Agency: Oregon Department of Transportation (ODOT)

Document/website: *ODOT Operations Performance Measures Final Report*

http://mobility.tamu.edu/resources/odot_op_perf_measures_final.pdf

Agency example measure: Volume-to-capacity ratio (V/C)

Methodology: The Highway Economic Requirements System, State Version (HERS-ST) is used to estimate peak-period V/C as a function of the K-factor, annual average daily traffic (AADT), and internally computed capacity.

Data source: ODOT

Analysis scale: Local, regional, state

Background: ODOT funded this report to identify and test a small number of operations performance measures. Based on the testing, the report makes recommendations for further improvements to data gathering, geographic precision, and sensitivity to operations programs.

Focus area: Construction and maintenance

Objective: Minimize the impact of construction activities on system efficiency

Measure: Change in travel time delay for commuters due to construction or maintenance activities

Agency: The National Work Zone Safety Information Clearinghouse

Document/website: *Work Zone Safety Performance Measures Guidance Booklet*

Agency example measure: Travel time/delay during construction or maintenance.

Methodology: Relies on good baseline information; data are collected on commute days (Monday through Friday, not including holidays). Delay value can be scaled based on project/traffic characteristics.

Data source: The National Work Zone Safety Information Clearinghouse

Analysis scale: Project, local, county, corridor

Background: The National Work Zone Safety Information Clearinghouse is dedicated to providing the transportation construction industry and the general public with comprehensive information to improve motorist, worker, and pedestrian safety in work zones.

Focus area: System operations

Objective: Implement operational improvements that enhance or maintain the reliability of transportation options

Measure: Change in person hours of nonrecurring delay due to operational improvements

Agency: Florida Department of Transportation (FDOT)

Document/website: *Quarterly Incident Duration – Performance Measures Report* (Palm Beach)

http://www.smartsunguide.com/Reports/Quarterly_Palm_Beach_010111-033111_040511-114316.pdf

Agency example measure: Incident clearance duration

Methodology: FDOT has an incident management system that allows for web-enabled automatic reports based on incident management activity logged into the system. The reporting includes reporting of detection, verification, response, and roadway clearance.

Data source: FDOT incident management system

Analysis scale: Local, regional, state

Background: FDOT tracks incident management duration as part of an incident management system to alleviate nonrecurring delay and other impacts.

Goal 5: Ensure That the Transportation System Is Secure from, Ready for, and Resilient to Threats from All Hazards

Focus area: Planning

Objective: Protect transportation users, agency personnel, and critical infrastructure

Measure: Change in share of agency staff that have received appropriate emergency training

Agency: U.S. Department of Homeland Security

Document/website: *Annual Performance Report, Fiscal Years 2010–2012*

http://www.dhs.gov/xlibrary/assets/cfo_apr_fy2010_appendix.pdf

Agency example measure: Percent of mass transit and passenger rail agencies that have effectively implemented industry agreed-upon security and emergency management actions to improve security.

Methodology: Transportation security inspectors conduct the baseline assessment for security enhancement jointly with transit agencies using a standardized checklist of 235 equally weighted questions.

Data source: U.S. Department of Homeland Security

Analysis scale: National

Background: This measure is calculated for the 100 largest mass transit, light and passenger rail, bus, and other commuter transportation agencies that have taken recommended steps to improve security.

Focus area: Programming

Objective: Program projects that prevent incidents within a transportation agency's control and responsibility

Measure: Change in level of redundancy for critical passenger and freight infrastructure

Agency: U.S. Department of Transportation – Research and Innovative Technology Administration

Document/website: Ensure Redundancy of Critical Components in Transportation Support Systems to Be Used in Case of an Emergency: Experience Nationwide with Responding to Catastrophic Events

http://www.benefitcost.its.dot.gov/its/benecost.nsf/SummID/LL2010-00520?OpenDocument&%5ELOTM

Agency example measure: Prioritize system redundancy plans according to the agency's strategic functions

Methodology: Possible strategies include having a source of backup power and having redundant supplies of equipment on call.

Data source: U.S. Department of Transportation – Research and Innovative Technology Administration

Analysis scale: Local, regional system

Background: This measure is included in a study that looked at six case studies examining the effects of catastrophic events on transportation system management and operations.

Focus area: Project development

Objective: Program projects that prevent incidents within a transportation agency's control and responsibility

Measure: Change in level of redundancy for critical passenger and freight infrastructure

Agency: U.S. Department of Transportation – Research and Innovative Technology Administration

Document/website: Ensure Redundancy of Critical Components in Transportation Support Systems to Be Used in Case of an Emergency (Experience nationwide with responding to catastrophic events)

http://www.itslessons.its.dot.gov/its/benecost.nsf/ID/2267EC3DCC57FBB2852576C70059F1E3?OpenDocument&Query=Home (or search for document at http://www.itslessons.its.dot.gov)

Agency example measure: Prioritize system redundancy plans according to the agency's strategic functions

Methodology: Possible strategies include having a source of backup power and having redundant supplies of equipment on call.

Data source: U.S. Department of Transportation – Research and Innovative Technology Administration

Analysis scale: Local, regional system

Background: This measure is included in a study that looked at six case studies examining the effects of catastrophic events on transportation system management and operations.

Focus area: System operations

Objective: Implement operational improvements that enhance the security of freight transportation assets

Measure: Relative change in operational funding allocated to disaster/incident response and management

Agency: FDOT

Document/website: *Performance Briefs: Safety and Security* (October 2010)

http://www.dot.state.fl.us/planning/performance/Safety-Security.pdf

Agency example measure: Conduct research into innovative highway safety devices, including those which prohibit motorists from driving around rail–highway crossing protection systems, and work with appropriate agencies to incorporate research results into program development

Methodology: FDOT monitors this activity.

Data source: FDOT

Analysis scale: Statewide

Background: This measure is included in a performance brief reporting on one of the five goals of the 2025 Florida Transportation Plan.

Goal 6: Ensure That the Transportation System's Development and Operation Support Economic Development and Prosperity

Focus area: Planning

Objective: Support growth in jobs and income by improving travel efficiency/reducing congestion

Measure: Change in travel delay (e.g., travel time index) at major freight bottlenecks by mode

Agency: FHWA

Document/website: Freight Performance Measurement: Travel Time in Freight-Significant Corridors

http://ops.fhwa.dot.gov/freight/freight_analysis/perform_meas/fpmtraveltime/traveltimebrochure.pdf

Agency example measure: Travel time on freight-significant corridors. Travel time index calculated as the ratio of travel time in the peak period to travel time in free flow.

Methodology: Five freight-significant corridors (which account for almost 25% of commodity-carrying truck vehicle-miles traveled) were chosen. Speed data were collected from automatic vehicle location equipment and then averaged for each selected road segment. A buffer index was used to determine how much more time needs to be budgeted to make a trip on time at a given level of certainty. The buffer index was calculated using a 95% on-time arrival rate, which is typically what shippers and receivers tolerate.

Data Sources: FHWA and American Transportation Research Institute

Analysis scale: Freight corridor, national

Background: FHWA produced this report to examine national-level issues with travel time on freight-significant corridors. It provides important background analysis for FHWA when working with regional, state, and local transportation agencies.

Focus area: Programming

Objective: Support growth in jobs and income by improving access to markets and factors of production (labor and raw materials) through programming

Measure: Change in access to jobs and labor (how many jobs and how much labor can be accessed within various periods of time for an entire region or smaller areas) due to program

Agency: WSDOT

Document/website: *The Gray Notebook*

http://www.wsdot.wa.gov/NR/rdonlyres/86DF8F42-BD2A-438A-A216-6AA2C1A42133/0/GrayNotebookDec10.pdf

Agency example measure: Economic vitality – to promote and develop transportation systems that stimulate, support, and enhance the movement of people and goods to ensure a prosperous

economy. (Note: performance measures and WSDOT strategic directions for the economic vitality policy goal are under development.)

Methodology: Measure under development

Data source(s): TBD

Analysis scale: TBD

Background: In 2010, the Governor and Legislature of Washington State added economic vitality as a goal for transportation. Performance measures are still under development.

Focus area: Project development

Objective: Develop projects that support growth in jobs and income by improving access to markets and factors of production (labor and raw materials)

Measure: Change in population within user-defined proximity to access controlled four-lane highway facilities, air cargo service, scheduled air service, intercity bus service, intercity rail service, and so forth

Agency: MnDOT

Document/website: *Annual Minnesota Transportation Performance Report*

http://www.dot.state.mn.us/measures/

Agency example measure: Number of national and international air destinations served by nonstop flights from Minnesota

Methodology: MnDOT tracks this number as a key component of a healthy economic future for the state's people and freight.

Data sources: Minnesota commercial service airports

Analysis scale: Regional, statewide

Background: MnDOT produces this annual report to describe the condition and service levels of the state's transportation system. It includes 18 performance measures that track progress on 10 policy goals.

Focus area: System operations

Objective: Support growth in jobs and income by improving travel efficiency/reducing congestion

Measure: Change in corridor/city/commuter-shed-specific travel delay or other congestion related measure

Agency: FDOT

Document/website: *2025 Florida Transportation Plan Performance Report*

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http://www.dot.state.fl.us/planning/performance/PerformanceReport2010.pdf

Agency example measure: Preserve new capacity on the strategic intermodal system for projected growth in trips between regions, states, and nations, especially for trips associated with economic competitiveness. FDOT measures this from a few perspectives (e.g., utilization – indicates whether or not a transportation system is properly sized and has the ability to accommodate growth). The measures are percent of system heavily congested, percent of travel heavily congested, vehicles per lane mile, and duration of congestion.

Methodology: Percent of system heavily congested, percent of travel heavily congested, vehicles per lane mile, and duration of congestion.

Data source: FDOT

Analysis scale: Local, regional, statewide

Background: FDOT released this document in 2010 to report on the goals of the 2025 Florida Transportation Plan (FTP). The *2011 Performance Report* will be revised to align with the goals of the 2060 FTP.

Goal 7: Ensure the Economic Feasibility of Transportation Investments over Time

Focus area: Planning

Objective: Ensure that the financial burden borne by transportation system users is shared equitably

Measure: Cost per user/vehicle/household of taxes and fees dedicated to transportation

Agency: SCAG

Document/website: 2008 Regional Transportation Plan – *Environmental Justice Report*

http://www.scag.ca.gov/rtp2008/pdfs/finalrtp/reports/fEnvironmentalJustice.pdf

Agency example measure: Taxes paid

Methodology: SCAG reports the amount of taxes (sales, gasoline, and income) to determine whether the lower income groups are paying an amount proportional to the transportation services they are using.

Data source: SCAG

Analysis scale: Regional

Background: This measure is included in SCAG's *Environmental Justice Report*. The purpose of the analysis is to ensure that the important principles of environmental justice are considered and integrated into the transportation planning process.

Focus area: Programming and project development

Objective: Ensure that the expected value of social and economic benefits created by proposed transportation programs/projects exceeds their cost

Measure: Project-level cost/benefit ratio for proposed programs, including freight

Agency: Iowa Department of Transportation

Document/website: Use of a Benefit-Cost Ratio to Prioritize Projects for Funding

http://www.iowadot.gov/iowarail/assistance/130/130SelectionProcess_final.pdf

Agency example measure: Use of a benefit–cost ratio for project selection

Methodology: Iowa DOT's benefit–cost calculation includes calculations of exposure, predicted accidents, severity, societal cost, benefits, and cost. The benefit is then divided by the cost for the final ratio.

Data source: Iowa DOT

Analysis scale: Project

Background: The benefit–cost ratio calculation moves beyond a measure of the predicted accidents at a crossing to a calculation that allows Iowa DOT to maximize the public benefit in relationship to the public investment. Iowa DOT's use of the benefit–cost ratio to prioritize projects for selection is projected to result in five fewer fatalities and an increased safety benefit that totals nearly $10 million over a 10-year period.

Focus areas: Construction, maintenance, and operations

Objective: Ensure construction, maintenance, and operation costs are within planned budget

Measure: Proportion of projects with construction, maintenance, and operation costs within planned budget

Agency: Idaho Transportation Department (ITD)

Document/website: Transportation System Dashboard

http://itd.idaho.gov/dashboard/budget.htm

Agency example measure: Construction costs at award as a percent of construction budget

Methodology: The construction costs of projects obligated in the fiscal year are totaled and compared to the total construction budget programmed at the beginning of the year for the same projects.

Data source: ITD

Analysis scale: Project level, statewide

Background: ITD maintains its dashboard as part of its commitment to efficiency, transparency, and accountability.

Goal 8: Protect and Enhance Environmental and Ecological Systems While Developing and Operating Transportation Systems

Focus area: Planning

Objective: Ensure that environmental and ecological systems are free of contaminants and pollutants

Measure: Existence of an agency-wide environmental management system (EMS)

Agency: City of Gaithersburg, Maryland, Public Works

Document/website: Gaithersburg, Maryland, Environmental Management System

http://www.gaithersburgmd.gov/poi/default.asp?POI_ID=389&TOC=107;81;388;387;389

Agency example measure: Gaithersburg's EMS covers the Department of Public Works, Parks Maintenance, and Engineering.

Methodology: Gaithersburg's EMS seeks to integrate environmental considerations into their day-to-day operations, improve their overall environmental performance and compliance, and demonstrate this performance to outsiders, including regulatory agencies. An EMS consists of a series of standard procedures and practices that organizations put into place to manage their environmental obligations. They do not impose new technical requirements, nor are they a substitute for existing regulatory standards. However, an EMS provides a framework for an organization to more effectively manage its environmental obligations and improve its environmental performance. By effectively managing these obligations, organizations can also operate more efficiently and reduce costs.

Data source: Performance is measured on compliance with applicable environmental requirements and is reported in their *State of the Environment Report*.

Analysis scale: Roadway, project, local, citywide

Background: In the process of developing the EMS, a number of objectives and targets were identified. These included a reduction in the amount of grit, oil, and other materials entering the storm water system; environmental awareness training for employees; reduction in the amount of salt applied to city streets; and an assessment of soil conditions and the fertilizer needs of city property. The fundamental component of Gaithersburg's EMS is continued pollution prevention and responsible compliance with all environmental statutes and regulations.

Focus area: Programming

Objective: Program projects that maximize ecological opportunities and ecosystem benefits

Measure: Change in the percentage of projects programmed on the basis of achieving priority ecological outcomes

Agency: Indiana Department of Transportation (INDOT)

Document/website: Indiana Bat Habitat Conservation Plan

http://www.in.gov/indot/3424.htm?cof=FORID%3A10&ie=UTF-8&num=10&q=indiana+bat+habitat&cx=005966028202432817588%3Alwngueu4xie&siteurl=www.in.gov%252Findot%252F#843

Agency example measure: Protecting and planting natural habitats of bats

Methodology: Offset the destruction and deterioration of natural habitat caused by road construction. Restore and protect natural habitat beyond regulatory requirements.

Data source: Monitoring of the plantings for 5 years and the bat population in the project area for 15 years.

Analysis scale: Local

Background: The need for highway improvements near the Indianapolis International Airport brought together several agencies, including the Indiana Department of Transportation and the local office of the FHWA, to develop a plan to protect and conserve local habitat for the Indiana bat, an endangered species. The plan, called the Indiana Bat Habitat Conservation Plan, has the following features: 3,600 acres protected (approximately 10% existing bat habitat), 346 acres of newly planted habitat, a public outreach program, and a 15-year monitoring program. The HCP was completed in conjunction with approximately $1.5 billion in highway improvements in an area forecasted for high urban growth.

Focus area: Project development

Objective: Develop projects that maintain and improve quantity and quality of water and aquatic ecosystems

Measure: Change in number (percentage) of projects designed to maintain or improve water quantity or quality

Agency: City of Bellingham, WA

Document/website: Northshore Drive Roadway and Drainage Improvement Project

www.cob.org/documents/pw/curconst/ES-0367.pdf

Agency example measure: Mimic predevelopment hydrological conditions in the right-of-way

Methodology: Implementing storm water best management practices (BMPs) for storm water flow control, including low-impact development. Use BMPs to manage onsite runoff from the project as the first priority. This measure computes the flow rates and runoff volumes from post-construction compared to computed predevelopment values.

Data source: City of Bellingham storm water runoff calculations

Analysis scale: Roadway, local

Background: The project includes all of Northshore Drive from the Dakin Street intersection to the Britton Road intersection, including sidewalk facilities and storm water system improvements. Northshore Drive received an asphalt overlay after surface grinding the existing roadway and making minor alignment modifications. Lane widths were reduced to 11 ft to accommodate new porous pavement bike lanes and sidewalks. A new storm water drainage system was also installed to meet requirements for both enhanced and phosphorus treatment of storm water runoff.

Focus area: Construction

Objective: Apply context-sensitive corridor habitat restoration and landscaping during project implementation

Measure: Ratio of restored and maintained area to disturbed area (acres) within project

Agency: WSDOT

Document/website: I-405 - Springbrook Creek Wetland & Habitat Mitigation Bank

http://www.wsdot.wa.gov/Projects/i405/Springbrook/

Agency example measure: Acres of wetland enhanced and restored by construction

Methodology: Springbrook Creek Wetland & Habitat Mitigation Bank is an early environmental investment project. The bank provides mitigation for highway construction and city development projects prior to impacts on wetlands and other aquatic resources. The Springbrook Wetland & Habitat Mitigation Bank benefits the environment and transportation projects by

- Increasing habitat diversity and developing habitat conditions,
- Potentially improving water quality and enhancing hydrologic function,
- Removing wetland fills,
- Improving riparian (strip of land adjacent to a body of water) functions in a highly urbanized area,
- Setting up the site in advance of project development and wetland impacts, and
- Consolidating mitigation for multiple small wetland impacts into one large site with greater ecological value—the value of the site increases as the site matures.

Data sources: Washington State Department of Transportation and the City of Renton

Analysis scale: Roadway, local

Background: The Springbrook Creek Wetland & Habitat Mitigation Bank project enhances 110 acres of wetlands and buffers, restores, and creates another connected 20 acres of wetland, totaling approximately 130 acres of wetlands. Thousands of native plants were planted over the entire project site, including black cottonwood, Pacific willow, Sitka spruce, western red cedar, snowberry, Douglas-fir, and big-leaf maple. These trees, shrubs, and plants will attract and create habitat for many different species of wildlife. WSDOT crews have completed building an interpretive boardwalk trail through a portion of the site that will provide opportunities to educate the public on the benefits of wetlands and the habitat they support. The start of the

boardwalk trail is located on SW 27th Street between Oakesdale Avenue SW and Lind Avenue SW.

Focus area: Maintenance

Objective: Reduce herbicide use during project maintenance

Measure: Area (in acres) sprayed with herbicides during maintenance

Agency: Santa Cruz County Department of Public Works

Document/website: Bonny Doon Road Herbicide Reduction Project

http://www.dpw.co.santa-cruz.ca.us/Operations/HerbicideReductionProject/Bonny_Doon_Rd_Results_Report_3_10_PostITR.pdf

Agency example measure: Reduce or eliminate herbicide use in vegetation management

Methodology: Particular native plant species encroach on the roadway right-of-way, which causes visibility concerns as well as safety issues. Typically these plants require semiannual maintenance to keep their height at a minimum. This measure evaluates the amount of maintenance required when new vegetation management techniques are implemented while also significantly reducing herbicide use.

Data source: Santa Cruz County Department of Public Works

Analysis scale: Roadway, local

Background: The Bonny Doon Road Herbicide Reduction Project was a pilot project as part of the Santa Cruz County Integrated Vegetation Management Program. Boony Doon Road is approximately 1.1 miles of a winding two-lane road that follows the contours of a canyon and nearby creek. Roadside vegetation including fennel and poison hemlock, if left to grow naturally, will block horizontal sight distance, which becomes a safety concern for motorists. The project proved that methods including mowing, mulch, and maintenance were effective in controlling growth of the roadside vegetation, which resulted in a reduction of 154 gallons of diluted herbicide.

Focus area: System operations

Objective: Reduce vehicle–animal collisions during operations

Measure: Change in the number of animal kills

Agency: Banff National Park of Canada

Document/website: Banff National Park in Canada, Highway Fencing and Wildlife Crossings

http://www.pc.gc.ca/pn-np/ab/banff/docs/routes/sec3.aspx

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Agency example measure: Provide or improve wildlife access and mobility across roadway facility boundaries and reduce vehicle–wildlife collisions and related accidents

Methodology: Dedicated wildlife crossings are structural features of the roadway that are not used by motorized vehicles. Installing new dedicated wildlife crossing structures and protective fencing (if needed) as recommended by the wildlife assessment greatly reduces the number of vehicle–wildlife collisions and related animal deaths.

Data source: Banff National Park Maintenance and Operations

Analysis scale: Roadway, local

Background: Banff National Park's Highway Fencing and Wildlife Crossings is an example of one of the first and most successful projects to accommodate terrestrial habitat connectivity. In response to high and rising traffic volumes, sections of the Trans-Canada Highway have been upgraded from a two-lane to a four-lane divided highway in Banff National Park. To reduce the negative impacts of a larger highway on wildlife populations in Banff National Park: 1) Fencing has been installed on both sides of the twinned highway sections to prevent large animals from getting onto the highway, and 2) Wildlife underpasses and overpasses have been installed to connect vital habitats and help sustain biodiversity. Vehicle–wildlife collisions have been significantly reduced.

Goal 9: Reduce Waste Generated by Transportation-Related Activities

Focus area: Planning

Objective: Ensure that assets are managed to reduce life-cycle cost and increase useful life

Measure: An asset management system exists

Agency: WSDOT

Document/website: WSDOT Pavement Management System

http://www.wsdot.wa.gov/Research/Reports/300/315.2.htm

Agency example measure: Tracking pavement performances to make them last longer by preserving and maintaining them

Methodology: A pavement management system is a systematic process of preserving and rehabilitating a particular section of pavement or network of pavements. It measures the pavement condition, includes decision criteria for rehabilitation actions, and records when the pavement rehabilitation occurs.

Data sources: Washington State Department of Transportation Materials lab in conjunction with the WSDOT Pavement Management System (WSPMS)

Analysis scale: Roadway, local, regional, and statewide

Background: The WSPMS is one of the oldest internally built systems in the United States. It began collecting data in 1963 and developed a management system in 1982. WSPMS tracks

pavement condition, predicts future pavement condition based on current and past conditions, and chooses when and by what means the pavement should be preserved and/or rehabilitated. WSDOT makes the case that since tracking began in 1971, the WSPMS has contributed to a shift toward good pavement conditions.

Focus area: Programming

Objective: Develop infrastructure projects designed for long life

Measure: Change in average design life of infrastructure (by major component) due to program

Agency: Asphalt Pavement Alliance (APA)

Document/website: Perpetual Asphalt Pavements: A Synthesis

http://asphaltroads.org/PerpetualPavement

Agency example measure: Minimize life-cycle costs by promoting design of long-lasting design pavement structures.

Methodology: As defined in the synthesis document (APA, 2002), "long-life pavement is a well-designed and constructed pavement that could last indefinitely without deterioration in the structural elements provided it is not overlooked and the appropriate maintenance is carried out." To reduce the life-cycle costs of pavement, the pavement must be designed accordingly. This includes the proper pavement section and material types. In addition, design life is also a function of the construction practices as well as maintenance procedures/activities.

Data source(s): National Center for Asphalt Technology (NCAT)

Analysis scale: Roadway, nationwide

Background: The APA defines a perpetual pavement as "…an asphalt pavement designed and built to last longer than 50 years without requiring major structural rehabilitation or reconstruction, and needing only periodic surface renewal in response to distresses confined to the top of the pavement" (APA, 2002). The synthesis provides guidance for design and construction of asphalt pavements that yield a longer life cycle.

Focus area: Project development

Objective: Increase the percentage of waste diverted (from landfill) from transportation projects

Measure: Change in the percentage of projects with a recycling plan or waste diversion goal

Agency: City of Vancouver, British Columbia

Document/website: British Columbia Recycling Initiative

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http://www.tac-atc.ca/english/resourcecentre/readingroom/conference/conf2006/docs/s007/bremner.pdf

Agency example measure: Utilize an accounting and management plan for road construction waste materials, and minimize the amount of construction-related waste destined for landfill

Methodology: Establishing a formal process for removing and recycling infrastructure waste will reduce the amount of materials being sent to the landfill. Reducing waste will not only reduce needed landfill space but will be better for the environment, reduce dump truck trips (and exhaust), and will have an overall cost savings for the project.

Data source(s): The information in this case study comes from the report produced by Bremner and the City of Vancouver (2006).

Analysis scale: Roadway, local

Background: In 2005, the City of Vancouver created a new engineering branch in their governmental agency strictly for management of infrastructure waste, such as waste generated from roadway, water, and sewer development. The estimated amount of this infrastructure waste exceeded 400,000 metric tons (about 441,000 tons) annually. This waste had previously been disposed of in the Vancouver landfill. After this initiative, 100% of annual hot-mix asphalt milling waste is now recycled; 100% of annual concrete curb, sidewalk, and roadway slab material is now recycled; stockpiles of soil, asphalt, and concrete are now available for more projects after reprocessing, and extraction of new aggregate is often avoided.

Focus area: Construction

Objective: Increase the percentage of waste diverted (from landfill) during construction

Measure: Change in the amount of construction waste diverted by type, weight and/or volume

Agency: Texas Department of Transportation (TxDOT)

Document/website: TxDOT Waste Tracking System

http://www.fhwa.dot.gov/publications/publicroads/00julaug/recyctx.cfm

Agency example measure: Utilize an accounting and management plan for road construction waste materials, and minimize the amount of construction-related waste destined for landfill

Methodology: Establish, implement, and maintain a formal construction and demolition waste management plan (CWMP) during roadway construction. Construction and demolition waste constitutes any material that must be hauled off-site for disposal or reprocessing, or if disposed (stockpiled) within the ROW is not intended for use as a structural element.

Data source(s): TxDOT and Construction Materials Recycling Association

Analysis scale: Roadway, local, regional, and statewide

Background: TxDOT's Waste Tracking System tracks the volume of materials used on a project, their associated costs, and environmental benefits. In addition, the system considers life-cycle costs of materials as well as cost incentives for contractors to implement a waste management plan. In the previous two years the program saved over 1.8 million tons of virgin aggregate by incorporating a variety of pavement recycling options into the general agency practice.

Focus area: Maintenance

Objective: Increase the percentage of waste diverted (from landfill) during maintenance

Measure: Change in the percentage of maintenance projects with a recycling plan or waste diversion goal

Agency: NYSDOT

Document/website: GreenLITES

https://www.nysdot.gov/programs/greenlites/operations-cert

Agency example measure: Change the amount of waste that is created during operations of roadway facilities

Methodology: Increase sustainability measures in transportation maintenance statewide in all aspects of their work. This includes maintenance work on roadways that need construction maintenance as well as in-office recycling.

Data source(s): GreenLITES

Analysis scale: Roadway, statewide

Background: In 2009, GreenLITES' Operations Division was launched to increase sustainability in all aspects of maintenance operations for transportation. The Operations Division has devised and incorporated more than 100 tasks into its planning process. These tasks are then chosen based on sustainability trade-offs and tracked for progress. Many of these GreenLITES tasks include recycling or waste diversion—for example, office waste recycling and reuse, garage waste minimization and recycling, implementing a zero waste strategy, pavement in-place recycling, recycled asphalt paving, concrete recycling, fluorescent lightbulb recycling, and recycled materials for erosion/sediment control.

Focus area: System operations

Objective: Reduce litter

Measure: Change in the quantity of total litter collected annually (weight, volume, etc.)

Agency: New Mexico Department of Transportation (NMDOT)

Document/website: NMDOT Litter Control Plan

http://nmshtd.state.nm.us/upload/images/GTG/Q3_07/DOT_Litter_Control_Program.pdf

Agency example measure: Prevent pollution and maintain aesthetic quality of road and bridge networks through cleaning and litter removal

Methodology: To measure their efforts, NMDOT collects the following data and reports them on a quarterly and annual basis:

- Number of special litter events,
- Number of volunteers,
- Tons of trash removed,
- Number of highway miles cleaned, and
- Number of dollars allocated to litter removal.

Data source(s): NMDOT data collection

Analysis scale: Roadway, local, regional, and statewide

Background: In recognition of a worsening litter presence on New Mexico highways as well as a realization of the aesthetic benefits of a clean and safe roadway, NMDOT began a litter control program. NMDOT tracks performance of the litter control program, including number of cleaning events, tonnage of collected litter, involved volunteers, and money spent. Sources of cleanup include NMDOT maintenance crews, volunteer efforts (through the Adopt-A-Highway program), and inmate labor. NMDOT also works with other agencies (e.g., Keep New Mexico Beautiful) to meet department goals and promote a litter-free environment.

Goal 10: Reduce the Use of Nonrenewable Resources and Promote the Use of Renewable Replacements

Focus area: Planning

Objective: Purchase sustainable materials as a priority

Measure: Existence of a purchasing plan that establishes priority for sustainable materials

Agency: Seattle DOT

Document/website: Seattle's Sustainability Purchasing Plan

http://www.cityofseattle.net/environment/purchasing.htm

Agency example measure: Promoting the use of environmentally preferable products in the city's acquisition of goods and services

Methodology: Sustainable purchasing demonstrates the commitment to buying goods, materials, services, and capital improvements in a manner that reflects fiscal responsibility, social equity, community, and environmental stewardship values. This measure tracks the amount of goods and services purchased that are environmentally preferable.

Data source(s): The Department of Executive Administration and Office of Sustainability and Environment produce an annual summary of the city's environmentally responsible/sustainable purchasing actions.

Analysis scale: All city departments and offices that make purchases of goods and services or that contract with others to make purchases

Background: The goal is to bring together policies, communication tools, process improvements, standards, and reporting mechanisms to help align purchasing practices with the city's values and incorporate these into a sustainable purchasing program. The three values that the city identified are environmental factors including life-cycle assessments, social equity factors, and fiscal factors. The city will purchase and use materials, products, and services that are fiscally responsible, reduce resource consumption and waste, promote opportunities to lesser-advantaged segments of the community, perform adequately, and promote human health and well-being.

Focus area: Programming

Objective: Use renewable energy to provide project power

Measure: Change in percentage of renewable energy, in kWh, created in relation to project energy requirements due to a program

Agency: Oregon Department of Energy

Document/website: A Renewable Portfolio Standard (RPS) for Oregon

http://www.oregon.gov/ENERGY/RENEW/RPS_home.shtml

Agency example measure: Reduce the consumption of fossil fuels during operation and maintenance of facilities

Methodology: Have a documented plan that outlines how renewable energy will be procured for operations and maintenance of roadway facilities. This includes maintaining an electricity monitoring system for operations and maintenance that tracks electricity usage for highway facilities.

Data source(s): The Western Renewable Energy Generation Information System certifies the Renewable Energy Certificates (http://www.wregis.org/).

Analysis scale: Roadway, local, regional, and statewide

Background: Oregon's current RPS requires the largest utilities in Oregon to provide 25% of their sales of electricity from renewable sources of energy by 2025. Smaller utilities have similar obligations but at a smaller percentage of sales.

Focus area: Project development

Objective: Use renewable energy to provide project power

Measure: Change in percentage of renewable energy, in kWh, created in relation to project energy requirements in a project

Agency: ODOT

Document/website: Oregon Solar Highway

http://www.oregonsolarhighway.com

Agency example measure: Reduce the consumption of fossil fuels during operation of highway illumination

Methodology: Compute the energy requirements for all electrified components on the project. Provide operational energy for the project's electrified components using autonomous, on-site, renewable energy sources.

Data source(s): Portland General Electric

Analysis scale: Roadway, local, regional, and statewide

Background: In December 2008, ODOT partnered with Portland General Electric to form and implement the Oregon Solar Highway Initiative and build the first solar project in a public ROW in the United States. A 104-kW ground-mounted solar array was installed at the Corridor of the Future interchange of I-5 and I-205. The solar panels supply approximately one-third of the energy needed to illuminate the project. Over the lifetime of the project, it is expected to save 2,900 tons of CO_2 emissions.

Focus area: Construction

Objective: Use biofuel for non-road maintenance equipment

Measure: Percentage of machine hours or gallons of biofuel used during construction

Companies: Microsoft and Turner Construction

Document/website: Constructing a Cleaner Work Environment, *Biodiesel Magazine*

http://biodieselmagazine.com/articles/1798/constructing-a-cleaner-work-environment

Agency example measure: Reduce the overall consumption of fossil fuels by non-road construction equipment.

Methodology: Reduce the fossil fuel requirements of non-road construction equipment by using biofuel or biofuel blends as a replacement for fossil fuel.

Data source(s): Turner Construction and the Washington State Department of Labor and Industries both collected air quality data.

Analysis scale: Project specific

Background: B99, a 99% proportion of biodiesel to conventional fuel, was used during the construction of the Microsoft Windows Live Columbia One Data Center in Quincy, Washington, to fuel equipment operated by subcontractors hired by Turner Construction Company. Discussions with the safety manager assigned to the project reveal that the reason behind the switch to biodiesel for the on-site construction equipment was to provide a remedy for the noxious diesel fumes that were emitted by the construction equipment. Air quality readings were reduced to 2–4 ppm CO at the exhaust of the concrete pump trucks, which is significantly less than the air quality regulation of 40–45 ppm.

Focus area: Maintenance

Objective: Use biofuel for non-road maintenance equipment

Measure: Percentage of machine hours or gallons of biofuel used during maintenance

Agency: Tennessee Department of Transportation (TDOT)

Document/website: www.tennessee.gov/tdot

Agency example measure: Reduce the overall consumption of fossil fuels by maintenance vehicles

Methodology: Reduce the fossil fuel requirements of fleet and maintenance vehicles by using biofuel or biofuel blends as a replacement for fossil fuel. Biodiesel is made from renewable sources such as soybean oil, burns cleaner than traditional diesel, and requires little or no engine modifications. In addition, it also supports the farmers who grow the materials used.

Data source(s): www.tennessee.gov/tdot

Analysis scale: TDOT Maintenance Operations

Background: TDOT has begun using B20 (20% biodiesel and 80% diesel fuel) to fuel TDOT maintenance and fleet vehicles, including heavy-duty dump trucks and large pieces of equipment such as bulldozers and backhoes. TDOT has also installed B20 pumps at each of the regional offices for use in these vehicles.

Focus area: System operations

Objective: Purchase green energy

Measure: Change in the amount and percentage of green energy purchased

Agency: Hawaii Department of Transportation (HDOT)

Document/website: http://www.marketwire.com/press-release/Hawaii-State-Department-Transportation-Purchase-Clean-Solar-Energy-From-Hoku-Solar-NASDAQ-HOKU-906483.htm

Agency example measure: Purchasing renewable solar energy for operations and maintenance of roadway facilities

Methodology: Procuring renewable energy for the operations and/or maintenance of transportation facilities. Renewable energy will reduce the DOT's carbon footprint and emissions. The goal of this measure is to reduce the amount of fossil fuels that would alternatively be imported.

Data source(s): HDOT

Analysis scale: Statewide DOT facilities

Background: Hawaii's Clean Energy Initiative has the goal that by year 2030, 70% of Hawaii's energy is to come from clean sources. To reduce the state's dependency on imported fossil fuels, HDOT is currently purchasing solar electricity generated by Hoku Solar. This solar electricity comes from the photovoltaic (PV) power that is generated at several of HDOT's facilities located across the state, including airports and administration buildings. It is expected that the PV systems will generate 1.2 million kWh of clean, solar energy and will offset 12,000 tons of carbon dioxide emissions.

Goal 11: Reduce Transportation-Related Emissions of Air Pollutants and Greenhouse Gases

Focus area: Planning

Objective: Increase street connectivity

Measure: Change in street connectivity index

Agency: Virginia Department of Transportation (VDOT)

Document/website: Secondary Street Acceptance Requirements (SSAR)

http://www.virginiadot.org/projects/ssar/

Agency example measure: Increasing roadway connectivity will reduce the amount of pollutant emissions created from vehicles.

Methodology: Roadway connectivity involves a system of streets and routes and how the area is connected within the street system. Better connected streets make it easier to get from place to place within a community and provide several routes to do so. Increasing connectivity will reduce the amount of travel miles for vehicles, which will in turn reduce the related emissions of air pollutants and greenhouse gases. This measure will increase the amount of connectivity for new developments.

Data source(s): VDOT

Analysis scale: Statewide

Background: VDOT's SSAR was approved in 2009 and revises the policy for the design and function a street must meet in order to be created. One part of this regulation is connectivity. Streets must be created to support better street connectivity within the area. Fewer culs-de-sac and dead end streets will be allowed to enter the state system. A better connected street system will enable a more efficient use of the roadways as well as reduce the amount of vehicle miles driven. More direct routes will be created for residents, delivery vehicles, and emergency vehicles when there is a better grid of streets.

Focus area: Programming

Objective: Program projects that reduce pollutant emissions (travel, trip length, mode split, emissions)

Measure: Change in percentage of commercial vehicles by EPA tier compliance due to program

Agency: TxDOT

Document/website: Texas Emission Reduction Plan (TERP)

http://www.tceq.texas.gov/airquality/terp

Agency example measure: Reduce air emissions from vehicles and construction equipment by encouraging the use of alternative fuel vehicles

Methodology: Activities such as driving vehicles and operating construction equipment contribute to creating pollutants that cause adverse health conditions. This measure will assure that air quality is safe to breathe and meets minimum air quality standards in Texas by reducing the amount of emissions of pollutants.

Data source(s): TERP Summary Reports

Analysis scale: Statewide

Background: Realizing that air pollution is a problem, TxDOT has created the TERP program, which is designed to increase the use of alternative fuel vehicles. TERP offers financial incentives and grants to individuals or companies to purchase vehicles or construction equipment that reduce emissions more than EPA's Tier II standards.

Focus area: Project development

Objective: Develop projects that reduce pollutant emissions (travel, trip length, mode split, emissions)

Measure: Change in percentage of commercial vehicles by EPA tier compliance due to project

Agency: Washington State Department of Ecology

Document/website: Diesel Particulate Emission Reduction Strategy for Washington State

http://www.ecy.wa.gov/biblio/0602022.html

Agency example measure: Reduce air emissions from non-road construction equipment by encouraging early achievement of the EPA Tier 4 emission standard

Methodology: Diesel engines release pollutants that include over 40 cancer-causing substances. The goal is to reduce the amount of diesel exhaust that produces air pollution, which will in turn reduce the negative health effects of diesel pollution for the public. One of the most significant sources of diesel emissions is non-road construction equipment.

Data source(s): Washington State Department of Ecology

Analysis scale: Statewide

Background: Washington State's Department of Ecology's Diesel Particulate Emission Reduction Strategy has the following four goals: (1) install emission reduction exhaust retrofits on 50% of the public legacy diesel fleet in four years; (2) install emission reduction exhaust retrofits and add-on fuel efficiency technologies on 50% of the private legacy diesel fleet in eight years; (3) evaluate, develop, and implement an idle-reduction program that addresses and remedies unnecessary idling through onboard retrofits, on-the-ground infrastructure, and anti-idling regulations; and (4) replace 25% of older (pre-1996 for non-road) legacy vehicles in the private fleet in eight years.

Focus area: Construction

Objective: Reduce equipment emissions (equipment conforming to latest EPA emissions standards)

Measure: Percent of construction equipment at each tier of emissions standards (weighted or unweighted), percent of construction equipment retrofitted to meet latest EPA emissions standards

Agency: Cook County Department of Environmental Control, Illinois

Document/website: Cook County Green Construction Ordinance

http://www.cookcountyclerk.com/countyboard/DocumentLibrary/2009ordinances.pdf

Agency example measure: Reduce air emissions from non-road construction equipment by achievement of the EPA tier emission standards

Methodology: Diesel engines release pollutants that include over 40 cancer-causing substances. The goal is to reduce the amount of diesel exhaust that produces air pollution, which will in turn reduce the negative health effects of diesel pollution for the public. One of the most significant sources of diesel emissions is construction equipment.

Data source(s): Cook County Department of Environmental Control

Analysis scale: Roadway, countywide

Background: The Cook County Green Construction Ordinance requires all public construction contracts greater than $2 million (budgeted) to use ultralow sulfur diesel fuel for all non-road

vehicles and equipment. It also requires the use of diesel retrofitting on all vehicles and equipment. In mid-2011, vehicles will need to be equipped to meet Level 2 PM (particulate matter) retrofits (on non-road equipment), and beginning in 2014 will need to be equipped to meet Level 3 retrofits (on non-road and road vehicles/equipment) for any publicly funded projects.

Focus area: Maintenance

Objective: Reduce adverse impact on traffic operations (lane reductions, traffic interruptions, detours, night operations)

Measure: Change in peak hour/period capacity (e.g., lane miles), vehicle hours of delay, extra VMT, percent of passing VMT affected by maintenance

Agency: INDOT

Document/website: Interstate 70 Rehabilitation Project

http://www.fhwa.dot.gov/publications/publicroads/98novdec/customer.cfm

Agency example measure: Reducing the impact and delays on traffic operations by doing roadway maintenance during off-peak hours at night

Methodology: Performing roadway maintenance during regular traffic hours (in particular peak hours) typically means closing a lane of traffic. This can cause long delays for commuters and increase the emissions of air pollutants. This measure encourages off-peak maintenance scheduling to minimize congestion (and air pollution).

Data source(s): INDOT

Analysis scale: Roadway, statewide

Background: As part of the Interstate 70 Rehabilitation Project, INDOT included the cost of traffic delays caused by roadwork as part of the proposals. As a result, the contractor finished with fewer lane closures and ahead of schedule. This reduced the amount of traffic delay hours and roadway emissions.

Focus area: System operations

Objective: Maintain efficient traffic operations

Measure: Change in percentage of toll payers using E-ZPass

Agency: New York State Thruway Authority

Document/website: E-ZPass New York

http://www.thruway.ny.gov/about/performance-quarterly.html

Agency example measure: Increase efficiency in traffic operations through the use of E-ZPass electronic tolling

Methodology: E-ZPass is an electronic tolling device that eliminates the need to stop at toll booths. Tolls are prepaid, and a toll tag is placed inside vehicles. The E-ZPass system maintains the account balance and usage.

Data source(s): New York State Thruway Authority

Analysis scale: Roadway, statewide

Background: The New York State Thruway Authority has a goal to increase efficiency and effectiveness of operations. Quarterly, the authority assesses this goal based on performance measures. One of these performance measures is the percentage of E-ZPass transactions. E-ZPass transactions increased by 2.08% in the third quarter of 2010 as compared to the same quarter of 2009.

Appendix E

Data Sources

The list that follows provides some resources for data that may be used to support many of the performance measures included in the compendium. Much of the data will have to come directly from state or regional agencies, but these represent data sources that may be relevant for a large number of agencies.

Environmental Data Sources

- **National Air Toxics Assessments** – Ongoing comprehensive evaluation of air toxics in the United States maintained by EPA. http://www.epa.gov/nata/
- **National Water Quality Standards Database** – A compilation of designated uses, used by each state to describe the functions each water body is intended to support. http://water.epa.gov/scitech/swguidance/standards/wqshome_index.cfm
- **National Wetlands Inventory** – A series of topical maps to show wetlands and deepwater habitats. http://www.fws.gov/wetlands/
- **Nature Conservancy's Spatial Data Resources** – Publicly available conservation data for GIS and non-GIS users. http://maps.tnc.org/
- **State Wildlife Action Plans** – A summary of these plans as well as links to contacts and more information. http://www.teaming.com/pdf/StateWildlifeActionPlansReportwithStateSummaries.pdf
- **The USGS National Hydrology Dataset** – A comprehensive digital spatial dataset that contains information about surface-water features such as lakes, ponds, streams, rivers, springs, and wells. http://nhd.usgs.gov/index.html
- **Watershed Data** – Available on EPA's national watershed webpage at http://water.epa.gov/type/watersheds/links.cfm.

Transportation Data Sources

- **Census Transportation Planning Package** – A subset from the decennial census demographic surveys designed for transportation planners. http://www.fhwa.dot.gov/ctpp/
- **FHWA Freight Management and Operations** – A resource of major sources of national freight transportation data. http://ops.fhwa.dot.gov/freight/freight_analysis/data_sources/index.htm

- **National Highway Traffic Administration Fatality Analysis Reporting System** – Data on all vehicle crashes in the United States that occur on a public roadway and involve a fatality. http://www-fars.nhtsa.dot.gov/Main/index.aspx

- **Texas Transportation Institute Urban Mobility Report** – Annual report of congestion on freeways and major streets in 101 cities in the United States. http://mobility.tamu.edu/

Other Data Sources

- **U.S. Census Data** – Decennial demographic data, American Household Survey, and National Household Travel Survey. http://www.census.gov/

- **U.S. Department of Homeland Security Annual Performance Report** – Provides information about the effectiveness of the DHS's mission performance and stewardship of resources. http://www.dhs.gov/xabout/budget/editorial_0430.shtm

Appendix F

Case Studies and Rating System Summaries

CASE STUDIES

Each of the case studies included in this document provides the following information, organized into sections:

- Details about the interview contacts and any background documents reviewed for compilation of the case studies,
- The agency's adopted definition of sustainability or a discussion of the lack of definition,
- Specific agency programs and practices that incorporate sustainability principles,
- The impetus or history behind the agency's incorporation of sustainability principles,
- Actual sustainability performance measures in use and discussion of the development of those measures,
- A description of how the performance measures are tracked,
- How the measures have been applied to decision making,
- Lessons learned by the agency as a result of development and/or adoption of sustainability performance measures, and
- The future outlook of sustainability performance measures at the agency.

California Department of Transportation

A set of recent state bills have required California's agencies to consider topics correlated with sustainability. Much of Caltrans' sustainability work responds to this legislation, which includes Assembly Bill 32: Global Warming Solutions Act (the primary goal of which is to reach 1990 greenhouse gas emissions levels by 2020 and 80% of 1990 levels by 2050); State Bill 375, which furthers the greenhouse gas related activities proposed in AB 32; and State Bill 391, which requires Caltrans to prepare a state plan to address how the state will meet its GHG reduction targets.

In 1998 (updated 2004), Caltrans published the *Transportation System Performance Measures Report*, which outlined how to develop performance measures and identified mode-neutral candidates for measures. The measures used throughout Caltrans' programs are guided by this report. Caltrans has a number of programs and efforts that incorporate sustainability principles and measures, including

- **California Transportation Plan (CTP).** CTP updates have, since 2006, included the "3Es" (equity, environment, and economy), which inform the goals and policies that direct all programs and projects. Although none of the related performance measures were specifically identified to address sustainability, many of them are related. The next CTP update will focus on GHGs and climate change and will have a context-sensitive solutions orientation. The Smart Mobility Framework, a recent effort to add action and implementation to the policies in the CTP, recommends 17 performance measures for use in project evaluations.
- **Regional Blueprints.** The Caltrans Regional Blueprints are voluntary planning processes that engage residents of a region in creating a vision of the region's future. Applicants are required to provide information on how they plan to measure success in the short-term and how they will measure the long-term impacts of the process toward meeting blueprint goals. There are no specific guidelines for this measurement, and it is up to the agencies to determine what they will measure and how.
- **California Progress Report.** In 2007, information gathered from the Regional Blueprints was used to compile the *California Progress Report*, a snapshot of regional conditions and progress across the state. A set of indicators was selected by an advisory team, which reviewed the blueprints to determine what was being measured at the regional level. The *2010 Progress Report* update will feature 15 indicators, distributed among up to 10 potential issue areas: greenhouse gas emissions, air quality, energy use, water use and quality, health, transportation, economy, natural resources/productive farmland/open space, housing, and land use. The indicators will be selected to provide a good cross section of data and answer the question: "Are our regions becoming more sustainable?" The intent is that this will also serve as the overarching sustainability framework for the Strategic Growth Council and help to align state programs to better achieve progress.

Caltrans has two units set up to track performance. The Office of Strategic Planning and Performance Measures is responsible for measures that Caltrans can control through programs and policies. The Transportation System Information group sources data from other divisions and then categorizes the data into a set of system indicators.

Colorado Department of Transportation

CDOT does not currently have an official definition of sustainability, although the agency's overall approach to sustainability is along the lines of the United Nations Brundtland Commission definition. CDOT has also adopted an "environmental ethic," defined as a responsibility to "support and enhance efforts to protect the environment and quality of life for all of Colorado's citizens in the pursuit of providing the best transportation systems and services possible" (CDOT, 2011).

CDOT addresses sustainability through four primary structures or processes:

- **Environmental Stewardship Guide.** This guide documents how social, economic, environmental, and engineering considerations are to be integrated into transportation decision making. The current (2005) version has expanded beyond NEPA processes to discuss community impacts and livability.
- **Transportation Environmental Resource Council sustainability subcommittee.** TERC is composed of representatives of transportation agencies and resource agencies from throughout the state. The sustainability subcommittee encourages sharing between agencies working on sustainability, with a focus on sharing best practices, creating a sustainability template, creating a potential coordinated certification system, creating a sustainability policy that can be adopted by all members, and developing performance measures, including a potential statewide baseline.
- **CDOT Greening Council – greening government initiative.** A 2007 executive order by Colorado's governor directed state agencies to reach a set of goals (including reduced energy use and petroleum consumption) by June 2012. Transportation was one of the focus areas, and CDOT is implementing this initiative through the CDOT Greening Council. The aim of the council is to share expertise at a statewide level, among CDOT's regions.
- **I-70 Corridor – sustainability applications.** The I-70 Corridor Context Sensitive Solutions process included identifying a means for evaluating the sustainability of construction activities and a pilot application of NYSDOT's GreenLITES effort. However, the primary acknowledgement of the I-70 sustainability effort is that the larger issues of sustainability are outside the control of the state DOT and need to be led and addressed by the local governments.

Currently, performance measures are not being used for sustainability, although there are existing economic and functional performance measures, which could be expanded to encompass sustainability. Future applications envisioned for a program of sustainability performance measures include funding, resource allocation, and the development of standards and specifications.

Florida Department of Transportation

Florida has a long history with sustainability and environmental protection. Most recently, in 2007, then-Governor Crist issued Executive Orders establishing a climate action team, setting state emissions reduction targets, and prompting additional state actions on issues of energy climate change. The Florida Governmental Carbon Scorecard was established to track and report the reduction of GHGs, with each jurisdiction required to report its contribution to emissions.

FDOT has responded to state initiatives by reiterating the role of transportation in enhancing the environment, communities, and economy, largely through the following initiatives:

- **Florida Transportation Plan.** FDOT is currently updating the FTP for the year 2060, which will result in goals, objectives, and strategies to address the long-term needs of the state transportation system. Sustainability is expected to be a focus area, with specific attention to issues of climate change and energy. The prior FTP (2025) focused on sustainable investments and also addressed sustainability with a specific objective related to conservation of the natural environment, nonrenewable resources and energy, and reduction in greenhouse gases and air pollutants.
- **Strategic Intermodal System (SIS).** The SIS Strategic Plan calls for the department to strengthen the linkage between transportation and land-use planning by working closely with statewide partners to develop and implement a complementary land use management strategy to preserve capacity and communities.
- **Metropolitan planning.** Florida MPOs are legislatively required to minimize GHG emissions as part of the planning process. MPOs also must consider strategies for integrating transportation and land use to provide for sustainable development and to reduce GHG emissions. In addition, energy considerations must be included in all state, regional, and local planning efforts.
- **Regional visioning.** FDOT has supported the development of long-term regional visioning processes throughout the state, including several visions that are well established and moving into implementation phases. Several regions are assessing impacts through the use of key measures of sustainability, including acres of land urbanized, water consumption, greenhouse gases and air pollutants, and vehicle miles travelled.
- **Efficient Transportation Decision Making (ETDM).** The ETDM process and screening tool creates linkages between land use, transportation, and environmental resource planning initiatives through early, interactive agency involvement and availability of data.

FDOT has an established performance measurement framework. FDOT reports on performance within three categories: “how we report on what we are accomplishing,” “how we are being measured by others,” and “how we measure ourselves on an ongoing basis.” Specific environmental performance metrics are reported regularly by the Office of Policy Planning in a publication series entitled *Trends and Conditions: Environment*, which includes general, statewide metrics as well as measures addressing the actual impact of DOT decisions or activities. Specific measures include acres of wetland directly affected by federal-aid roadway construction projects, number of parcels of right-of-way acquired annually, and estimated amount of recycled asphalt pavement used in construction annually.

Minnesota Department of Transportation

In 2006, Minnesota Executive Order 06-03 mandated the increased use of renewable fuels by state agencies, and in 2007 the Next Generation Energy Act required an 80% reduction in greenhouse gas emissions by 2050. Although MnDOT does not currently define sustainability, the agency's vision statement refers to a "safe, efficient, and sustainable transportation system," and the agency is moving in that direction. MnDOT has seen a noticeable shift in public opinion, with growing public support for transit and alternative modes.

MnDOT considers sustainability as a factor in several key agency initiatives:

- The most recent state transportation plan is more focused on sustainability than earlier versions, though sustainability is not fully defined. The energy and environment policy areas look to improve the efficiency and sustainability of Minnesota's transportation system. The next iteration of the long-range plan is expected to be more explicit in discussing sustainability issues.
- MnDOT conducted an internal strategic planning effort that identified sustainability as a flagship focus area.
- MnDOT's annual performance report has measures and indicators for the 10 policy areas—with individual measures/indicators for pavement quality, mobility, transportation fuel consumption, and more. MnDOT defines *performance measures* as those that the agency has control over and that can be actively improved through agency decisions. *Performance indicators*, however, are considered reflective of how the transportation system is functioning, without regard to MnDOT's role in managing the variables. Generally, performance measures/indicators are based on policies in statewide plans.

Performance measures pertaining to sustainability include those under the energy and environment policy area—including air pollution, clean fuels, and wetland preservation. CO_2 emissions are listed as a developmental performance measure, meaning the measure has yet to be operationalized with specific data. Measures from other policy areas such as mobility, accessibility, and so forth also touch upon sustainability issues. Other MnDOT programs also use transportation and land use measures that are relevant to sustainability. Each of the measures has a specific office/division with a reporting responsibility assigned. In the future, performance measures may facilitate the comparison of transit and highway projects in terms of their sustainability impacts.

New York State Department of Transportation

While many of NYSDOT's programs and practices have long incorporated some aspects of sustainability, the agency initiated the GreenLITES program to recognize and expand upon existing sustainability practices. The GreenLITES certification program was developed as a project-evaluation tool. The GreenLITES program was put in place in 2008 and has since been expanded to include an operations program and a voluntary local project certification program for federally funded projects. In recognition that issues such as GHG emissions and habitat connectivity need to be tackled at a higher level, a proposed expansion of GreenLITES to include planning metrics is currently being considered.

As a part of the GreenLITES effort, NYSDOT defined transportation sustainability as a philosophy based on a set of six principles: protect and enhance the environment; conserve energy and natural resources; preserve or enhance the historic, scenic, and aesthetic project setting characteristics; encourage public involvement in the transportation planning process; integrate smart growth and other sound land-use practices; and encourage new and innovative approaches to sustainable design and how facilities are operated and maintained. Currently, however, efforts are under way to redefine sustainability to emphasize the ways in which transportation serves a sustainable society, rather than just considering sustainability in the context of transportation operations.

As a rating system, GreenLITES is highly focused on metrics. Both the project design and operations programs have extensive metrics built into spreadsheet-based scorecards. The identification of measures was accomplished through a discussion-based process, in which measures were brainstormed and then refined by NYSDOT staff and stakeholders. A similar process was followed for assigning a weight to each metric. The proposed GreenLITES planning and program management scoring tool would contain metrics reflecting the eight federally required planning factors, along with other goals such as GHG reduction, smart growth, environmental stewardship, social equity, quality of life, and innovation.

Tracking the GreenLITES project design metrics is mandatory for NYSDOT projects and voluntary for non-NYSDOT projects. Currently, however, the GreenLITES program only provides ratings and does not directly tie into funding allocations or decision making. Future GreenLITES applications might include project prioritization or the provision of comparative project results.

Oregon Department of Transportation

A few key state initiatives set the groundwork for sustainability at ODOT. In 2000, the Oregon Progress Board convened a comprehensive assessment of Oregon's ecological health to help non-scientists understand the need for better environmental stewardship. This report forms the basis of Oregon's and the Oregon Department of Transportation's current sustainability efforts. Subsequently, the Oregon Sustainability Act of 2001 was passed, and Executive Orders 03-03 and 06-02 established a plan for sustainability leadership in each of 20 state agencies and an overall sustainability leadership team composed of high-level state leaders.

To comply with Executive Order 03-03, ODOT issued its first formal sustainability plan in 2004. This plan integrated the state's sustainability goals with ODOT strategic goals, which are: (1) improve safety, (2) move people and goods efficiently, and (3) improve Oregon's livability and economic prosperity. Based on the mandates and strategies set out in the sustainability plan, the Oregon Transportation Commission adopted a new Oregon Transportation Plan (OTP) in 2006 that emphasized sustainability.

ODOT's sustainability strategies are initiated and coordinated by the Sustainability Program, which also acts as a resource to staff members as they adopt new sustainability activities in their own work. The program is responsible for developing the sustainability plan and identifying strategies to implement it. In 2008, ODOT updated the sustainability plan, which remains the prevailing document. The plan addresses the vision, goals, and strategies included in the 2006 OTP. This plan establishes seven focus areas for ODOT efforts: energy/fuel use and climate change, material resource flows, environmental stewardship, land use and infrastructure, economic health, social responsibility/workforce well-being and development, and health and safety.

Volume 2: Internal Operations, issued in 2010, addresses how ODOT staff and contractors will pursue sustainability within the agency's internal operations. It establishes specific performance measures for each of the sub-focus areas, although much of the data required are not currently collected.

In the future, a supplemental installment of the ODOT sustainability plan will be prepared to address project-level sustainability plans. To develop these project-level plans, a team of ODOT managers has been tasked with investigating potential strategies for integrating sustainability into the agency's transportation projects. This committee is seeking a tool that can be used to provide project-level performance measures and is actively investigating the use of Greenroads for roadway design and construction.

Washington State Department of Transportation

Impetus for many recent sustainability initiatives at WSDOT came from a series of executive orders, including Executive Orders 02-03: Sustainable Practices by State Agencies, 04-01: Persistent Toxic Chemicals, 05-01: Establishing Sustainability and Efficiency Goals for State Operations, and 09-05: Washington's Leadership on Climate Change. WSDOT is currently in the process of determining their definition of sustainability, which will bear close relation to the relevant executive orders and revised code of Washington, while at the same time maintaining the core mission of WSDOT.

WSDOT has translated these executive orders and relevant legislation into 18 tasks, the most significant of which include adaptation issues, GHG strategies, VMT measurement, and VMT effectiveness—all of which have a designated technical advisory group. The agency considers itself to be well structured to carry out these tasks and to address sustainability. The executive level staffs of the Environmental Services, Public Transportation, and Strategic Planning groups jointly lead the effort, with support from the WSDOT Steering Committee.

WSDOT prepared its first sustainability plan in 2007, which was updated in 2008. This plan identifies existing WSDOT objectives that support sustainability and creates four long-range goals based on Executive Order 02-03. The plan contains some quantifiable metrics pertaining to internal operations (e.g., ferry fuel use, number of low-emission/hybrid vehicles, biodiesel use, paper purchases, paper recycling, and energy use).

WSDOT has long tracked agency-wide performance measures in their Grey Notebook, including some basic metrics related to sustainability. The agency is currently considering the future implementation of more significant sustainability metrics.

Chicago Metropolitan Agency for Planning

CMAP embarked on its long-range comprehensive planning process, GO TO 2040, in 2007. During the first phase of gathering public input and developing a vision, stakeholders expressed significant interest in sustainability principles. Therefore, the agency realized it needed to understand and define sustainability. In response, CMAP created a definition of sustainability composed of four principles: protect the environment and improve natural resources for future generations; improve economic performance and quality of life for individuals; preserve the value of human and man-made capital for future generations; and ensure a fair distribution of life-quality.

A central element of the GO TO 2040 effort is the Regional Indicators Project, which involved the development of a set of 250 performance measures for the region grouped by 10 overarching themes, including environment and natural resources, with over 50 subcategories. The first indicators developed during the GO TO 2040 process were primarily for evaluating the impacts of potential regional scenarios, and therefore were more physically oriented and focused on transportation, land consumption, environmental, and economic measures. As the Regional Indicators Project evolved, CMAP made sure that all facets of the agency had a role in developing sustainability performance measures. CMAP also convened outside groups to define indicators in areas beyond those traditionally addressed by CMAP, including workforce development, arts and culture, health, public safety/crime, emergency preparedness, food systems, and hunger.

CMAP anticipates continuously collecting data and tracking performance measures while publicly reporting progress every two years. Ongoing performance-measure tracking on a biannual basis will be enabled via a website under development by CMAP. The website will display a dashboard of key measures comparing the Northeast Illinois region with the five other most populous U.S. regions, Illinois, and the United States. Throughout this process, CMAP has identified a need for improved data sharing among government agencies, and CMAP hopes that other agencies using the web tool will take a more active role in data collection and sharing.

As it considers major transportation projects for inclusion in the GO TO 2040 plan, CMAP is using a subset of 23 indicators to evaluate each project's sustainability. The agency is currently performing the analysis for 50 major capital projects that have been proposed for inclusion in the GO TO 2040 plan. Results of each project evaluation are presented to the sponsors and will be used to prioritize the list of projects for inclusion in the GO TO 2040 plan. Use of the sustainability performance measures is not possible for Transportation Improvement Program (TIP) projects because the regional travel model is the main tool for calculating the measures, and TIP projects are too small in size for such calculations to be meaningful.

Mid-Ohio Regional Planning Commission

Land use was a driving factor in MORPC's history of sustainability promotion. In the 1990s, the Greenways program was developed to coordinate among several stakeholders such as parks, grassroots citizen groups, and municipal governments on waterways planning. The effort strove to develop a cohesive organization and get approval for common goals and directions for county waterways. In 2006, the Greenways program became the Center of Energy & Environment (CEE), which is focused on improving sustainability in the region through watershed planning, local foods, sustainable development, air quality, and weatherization of homes and businesses. The Green Pact program, run by CEE, is a voluntary commitment program through which local municipalities and other agencies pledge to follow several guidelines focused on sustainability, such as investing in greener public fleets, purchasing green products, and supporting mass transit.

MORPC releases an annual public policy agenda that states their policy goals and informs political stakeholders of their priorities. Smart growth and patterns of sustainable development and multimodal transportation have been features of this document for many years. Among several other sustainability-oriented elements, the *2009 Public Policy Agenda* calls for the region to "establish 'Regional Prosperity Indicators' that enable annual measurement and analysis of regional performance versus our peer regions and ourselves on an ongoing basis."

In recent years, MORPC has promoted 40 sustainability performance indicators through its annual State of the Region reports, divided into the focus areas of people, place, and prosperity. The State of the Region reports contain indicators that are intended to be included in the long-range plan (*Shaping Our Region*), currently being developed for release in the spring of 2012. In the long-range plan, MORPC intends to draw from the performance indicators of the State of the Region reports and define targets for the year 2035, growing the current indicators into true long-range sustainability performance measures. The State of the Region reports and long-range plan will also serve as mechanisms for tracking and monitoring progress. MORPC anticipates continued emphasis on sustainability performance measures through their long-range planning effort, the continued work of the CEE, and additional multimodal transportation planning efforts such as the Complete Streets program.

Metropolitan Washington Council of Governments

The primary impetus for addressing sustainability was the growing interest across the Washington, D.C., region in solutions for the interconnected challenges that face the region, including population growth, aging infrastructure, threatened environmental quality, and growth in social and economic disparities. The *National Capital Region Climate Change Report (2008)* was also an important precursor to current efforts, focusing attention on the greenhouse gas impacts of the predicted new residents and jobs that will come to the Washington region by 2030. Preparation of the *Climate Change Report* was led by a Climate and Energy Steering Committee that was later reorganized into a Climate, Energy, and Environment Policy Committee.

Most recently, sustainability has emerged as a priority at MWCOG via special policy study designed to provide a long-range vision for the region's development that outlines desirable attributes for the region in 2050. The study is called *Region Forward: a Comprehensive Guide for Regional Planning and Measuring Progress in the 21st Century.* It outlines four principles that participants agree should be used as a framework for guiding regional development in the future: accessibility, sustainability, prosperity, and livability. The *Region Forward* report sets out ambitious goals associated with these principles. To ensure progress on each goal, the report identifies multiple performance targets. Most targets include specific, measureable milestones and can be tracked with available data. Several are annual targets, while others are set for a longer horizon, such as 2025 or 2050. In addition to targets, the report also identifies numerous indicators that track progress toward achieving the goals.

Although tracking protocols have not yet been established, MWCOG is in the process of beginning a plan for regularly monitoring progress toward the goals identified in *Region Forward* through regional progress reports. While the concepts of sustainability embodied by the MWCOG *Region Forward* report have yet to be integrated into MWCOG's Transportation Planning Board's policies and decision making, in the future it is hoped that the goals, targets, and indicators will help inform regional leadership and policy making.

Hampton Roads Transit (HRT)

HRT began to get involved in sustainability practices in 2005 when it was chosen by the Federal Transit Administration to develop a pilot EMS. This initiative was made a priority in 2007, when the HRT added staff support and committed to meeting ISO 14001 certification standards. HRT was also the first American transit agency to sign the APTA's Sustainability Commitment Pilot in January 2009.

All programs that address sustainability at HRT are included under the HRT CARES (Creating Accessible Regional Sustainability) "Go Green" program. These include activities at headquarters to reduce waste and conserve energy, an energy reduction lighting program at the bus maintenance facility, the purchase of cleaner buses, and an agency-wide EMS designed to embed sustainable practices into the agency's daily activities and services. HRT has a set of measures they have identified for the EMS.

When HRT committed to create an EMS that would meet ISO 14001 standards, they created an internal EMS team tasked with the responsibility of setting objectives, targets, and procedures for the EMS. The team chose three impact areas and related measures as a starting point (prevent future releases from HRT's underground storage tanks, reduce HRT's GHG footprint, and reduce HRT's overall energy consumption). The EMS team felt that it made more sense to start measuring a few areas and add more as goals were met.

The data for HRT's sustainability performance measures come primarily from the facility maintenance group or the operations manager. The Director of Energy Management and Sustainability is in charge of collecting the data and tracking the measures. HRT has encountered challenges in measuring some of the required APTA measurements, due in part to resource constraints.

HRT expects to begin compiling an annual report for tracking its sustainability performance measures in the near future. HRT's goal is to see a full sustainability program in place, as a routine and integrated as a part of the culture at the agency, with the EMS functioning as a program to spur continual improvement.

City of Alexandria, Virginia

The City of Alexandria has a strong track record of environmental stewardship by government and engagement by its citizens on environmental issues. Examples include the 1998 Environmental Quality of Life Summit, which led to Alexandria's first strategic environmental plan, and the Alexandria 2015 Strategic Plan published in 2004. The original strategic environmental plan and the later strategic plan vision statement helped build momentum for three interrelated activities over three years that have driven Alexandria's sustainability agenda:

- In 2007, a "Green-ventory" of city environmental policies, plans, and programs;
- In 2008, an Eco-City Charter; and
- In 2009, the Environmental Action Plan 2030, which is based on the Eco-City Charter and frames Alexandria's sustainability policy.

The Environmental Action Plan (EAP) provides the foundation for incorporating sustainability principles into all the city's programs and plans. It does this by (1) making sector-specific recommendations for concrete short-, mid-, and long-term sustainability actions and (2) identifying nine cross-cutting strategies for supporting integration of sustainability principles into plans and programs. The majority of the Environmental Action Plan 2030 is dedicated to sector-focused chapters on transportation, green building, air quality, water resources, health, energy, land use, solid waste, and climate change. Each sector features a single statement on guiding principles and a related set of policy goals that will be achieved through a series of short-, mid-, and long-term actions. In addition, each sector has a handful of performance targets that are designed to demonstrate progress toward the goals. The city plans to continue to expand its efforts to track sustainability-related performance measures and to use this information in decision making.

With the EAP in place, the City of Alexandria is working to incorporate the concepts of sustainability into its master plan and area plans as they are updated.

Swedish Road Administration

Sustainability became a dominant force with the passage of the Swedish government's transport bill of 1997, entitled Transport Policy for a Sustainable Development (translated). Sustainability thus came to the road agency from the top, but has since also developed in a bottom-up way within the agency. Most recently (in 2009) the SRA produced its first specific sustainability report. Sustainability features in the following critical agency activities: strategic management, long-range planning and programming, project development and design, and construction.

Performance measures have been defined for reporting at the sectoral level (addressing national objectives for the transport system) as well as at the agency level (addressing the strategic and performance objectives formulated at the SRA level). The measures have mostly been defined by the government agencies expected to report progress (e.g., the SRA), with reference to both national objectives and strategic plan objectives of the agency. Performance measures are used in strategic reports, long-term transport plans and associated program assessments, annual letters of appropriations, and agency annual reports and annual sectoral reports, as well as internally in SRA's "Goals and Metrics" database, in scorecards, in tertiary and monthly reports to SRA top management, and in several other contexts. Ideally they help craft and adjust transport plans and guide agencies and the government ministry's control of their implementation activities. However, efforts to develop meaningful performance measures have only been partly successful—for several objectives only general measures exist, or performance measures exist that only partly address the objective.

Although data collection and reporting is handled by SRA (using a goal and metrics database), another agency is charged with producing aggregated interpretations and assessments of progress toward the national transport policy objectives, based on all the transport agencies' submitted data. The idea is to have a neutral body charged with making this overall assessment. SRA believes that interagency collaboration may help pave the way toward more integrated, intermodal transport policy development and assessment, but may also increase the need for external oversight of the performance measures.

UK Highways Agency

Sustainable development has been formally incorporated into the management goals of the UK Highways Agency since 2005–06, when the agency began its corporate social responsibility reporting. In 2007–08, the agency established its first Sustainable Development Action Plan (SDAP), which is reported on and refreshed every year. In order to ensure that sustainability was properly incorporated within the agency's thinking and practices, changes were made to management structures and processes to ensure that sustainability had a high priority at board level that would support further changes within the operating practices of the agency.

Sustainability principles cut across the actions of all parts of the organization, including strategic management, long-range planning and programming, project development and design, construction, and operations and maintenance.

The 2007–08 SDAP set about defining what sustainable development meant to the Highways Agency. It was important that the agency's actions were consistent with the five overarching goals of the UK-wide strategy: living within environmental limits; ensuring a strong, healthy and just society; achieving a sustainable economy; promoting good governance; and using sound science responsibly. The 2007–08 SDAP was largely populated with process measures. Subsequent updates have strengthened and expanded on this document.

In addition to the SDAP, a series of management tools were developed to help ensure that sustainability is part of the decision-making processes, including a monthly scorecard for each business unit (internal), a reporting tool to assess the compatibility of proposals with the SDAP goals, a corporate social responsibility report, and a national framework for project appraisal decisions.

SUSTAINABILITY RATING SYSTEMS

FHWA Sustainable Highways

Website: www.sustainablehighways.org

Purpose: The FHWA Sustainable Highways Self-Evaluation Tool identifies characteristics of sustainable highways and provides procedures and techniques to help agencies and organizations apply and integrate sustainability best practices into highway and other roadway projects and programs within system planning, project development, and operations and maintenance. While the words "highway" and "roadway" are both used in this tool, the FHWA Sustainable Highways Self-Evaluation Tool is designed to be applied to all roadway projects, not just highways. The goal of the FHWA Sustainable Highways Self-Evaluation Tool is to encourage increased application of the principles of sustainability by presenting best practices and establishing standard and qualitative measures for sustainability.

Sustainability definition: The definition of sustainability used by Sustainable Highways is simply that sustainability is the *capacity to endure*. Sustainable Highways describes the goal of sustainability as the "triple bottom line" concept, which includes equity (also known as social or people), ecology (also known as environment or planet), and economy. The goal of sustainability is the satisfaction of basic social and economic needs, both present and future, and the responsible use of natural resources, all while maintaining or improving the well-being of the environment and ecology on which life depends.

Weighting or scoring logic: There are 68 credits in the beta version of the Sustainable Highways Self-Evaluation Tool. The credits are grouped into three categories based on what the credits address. Each category serves as an independent self-evaluation tool that can be scored independently of the others. These categories are system planning (SP), project development (PD), and operations and maintenance (OM). Currently, it is not possible to mix credits from the three different categories. SP credits are concerned with agency-wide management and planning of highway networks, and apply to all roadways under the jurisdiction of the owner-agency, not a specific project. PD credits address the development of a specific project once the general need and proposal for a solution to a transportation problem has been programmed. They involve environmental review, project planning, design, and construction decisions related to a specific project. OM credits are credits concerned with agency-wide practices, policies, and procedures required for the overall functionality and efficiency of a highway network and are not specific to one project. Currently PD credits are individually weighted, and the credits within other categories are equally weighted. The overall goal of weighting within the PD credits is to make the point value for each credit commensurate with its potential to promote sustainability. Greater weights are assigned to credits that are likely to have the greatest impact on sustainability from project to project.

Sustainable Transportation Access Rating System

Website: http://www.portlandonline.com/transportation/index.cfm?a=319882&c=34749

Purpose: STARS is an integrated planning framework and rating system for transportation plans, projects, and employer programs that is based on sustainability principles. STARS aims to evaluate the full life cycle of transportation projects and acknowledges that the decision of what to build in the first place is just as important (and sometimes more important) than how it is constructed. This upstream approach to transportation projects distinguishes STARS from other rating systems that are centered on the design and construction phases. STARS is designed as a

third-party certification rating system and was initiated by the North American Sustainable Transportation Council. The current draft of the STARS-Project manual was developed through a partnership between the Santa Cruz Regional Transportation Council; the City of Portland Bureau of Transportation; CH2M HILL; Parsons Brinckerhoff Quade & Douglas, Inc.; ECONorthwest; Brightworks; Confluence Planning, LLC; and numerous volunteer credit peer reviewers.

Sustainability definition: STARS uses the Natural Step as a sustainability framework, which is based on systems thinking and recognizes that what happens in one part of a system affects every other part of the system. STARS focuses on sustainability with respect to access, climate, and economic health.

Weighting or scoring logic: Currently, the draft STARS-Project manual serves as a planning and evaluation tool. Subsequent versions of STARS will include credit weighting, scoring, and certification levels and will also function as a rating system. The current draft version of STARS-Project is organized into 29 credits, five of which are required. To be considered for certification, a project applicant must demonstrate that they have met the minimum credit requirements for the five required credits and several of the non-required credits. The credits are broken down into six categories: integrated process, access, climate and energy, ecological function, cost effectiveness analysis, and innovation. The latter category is provided to allow for flexibility and enable applicants to receive credit for new and innovative strategies that meet sustainability goals.

Greenroads

Website: www.greenroads.us

Purpose: Greenroads is a voluntary sustainability rating system, or performance metric, for roadway design and construction, including project planning. It is applicable to all roadway projects including new, reconstructed, and rehabilitated roadways. It awards points for sustainable choices/practices and can be used to assess roadway project sustainability. Greenroads is a metric that helps quantify the sustainable attributes of a roadway project. This quantification can be used to

- Define what features contribute to sustainability on the project,
- Provide accountability for sustainability on roadway projects,
- Measure and track specific sustainability goals over time,
- Manage and improve roadway sustainability,
- Encourage new and innovative practices,
- Promote competitive advantage and other economic or market incentives for sustainability, and
- Communicate sustainable features to stakeholders in an understandable way, especially to the general public.

Greenroads is a publicly available system that can be used by anyone. However, the Greenroads logo and name are trademarked and remain the property of Greenroads. The University of Washington and CH2M HILL are the Greenroads developers, and the Greenroads Foundation, an independent nonprofit organization, now owns Greenroads.

Agencies and organizations can use Greenroads in a variety of ways, including (1) a performance metric for roadway design and construction sustainability, (2) a means to define basic roadway sustainability attributes, (3) a means of conferring market recognition on more sustainable

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roadway projects, and (4) a voluntary or required baseline standard to which roadways are designed and constructed.

Sustainability definition: Greenroads defines sustainability as a system characteristic that reflects the system's capacity to support natural laws and human values. The definition of sustainability used in Greenroads centers on seven different components that are demonstrated by a metric in a variety of ways. These seven components are the basis for the phrases "natural laws" and "human values." These components include the three commonly cited principles of sustainability: ecology, equity, and economy. Additionally, there are four other essential components to this systems-based definition that are emphasized within the context of the Greenroads metric: extent, expectations, experience, and exposure. Since sustainability is context sensitive and dependent on the human needs and values of the project management team and stakeholders, the extent and expectations components were identified because they act as the project system boundaries. The experience component includes technical expertise, engineering ingenuity, and knowledge of applicable historical information, which is critical in decision-making processes. The exposure component represents the idea that implementing sustainability in practice requires ongoing educational and awareness programs for the general public, professionals, agencies, and stakeholders.

Weighting or scoring logic: Greenroads applies sustainability best practices to roadways. Best practices are divided into two types: required and voluntary. Required best practices, called "project requirements," are those that must be done as a minimum in order for a roadway to be considered a Greenroad. Voluntary best practices, called "voluntary credits," are those that may optionally be included in a roadway project. Each voluntary credit is assigned a point value (1–5) depending upon its impact on sustainability. Currently, there are 37 voluntary credits that total 108 points. Greenroads also allows a project or organization to create and use its own voluntary credits (called "custom credits"), subject to approval of Greenroads, for a total of 10 more points, which brings the total available points to 118.

Green Leadership in Transportation and Environmental Sustainability

Website: www.nysdot.gov/programs/greenlites

Purpose: The GreenLITES rating system is owned and was developed by NYSDOT for use on state roadway projects. The system was first published in 2008 and serves primarily as an internal management program for NYSDOT to measure performance, recognize good practices, identify needed improvements, and share advances in sustainable practices with the public. GreenLITES is a self-certification program that distinguishes transportation projects and maintenance activities based on the extent to which they incorporate sustainable practices.

Sustainability definition: Sustainability is defined broadly in the GreenLITES rating system to refer to any human use of resources that does not exhaust those resources. The concept is described as balancing what is beneficial to people with what is economically sound and environmentally compatible. Specifically, NYSDOT defines transportation sustainability to mean a design philosophy that:

- Protects and enhances the environment;
- Conserves energy and natural resources;
- Preserves or enhances the historic, scenic, and aesthetic project setting characteristics;

- Encourages public involvement in the transportation planning process;
- Integrates smart growth and other sound land-use practices; and
- Encourages new and innovative approaches to sustainable design.

GreenLITES also acknowledges that increases in project costs may result from some sustainability efforts; however, these cost increases are often warranted when all external environmental and social costs are fully considered.

Weighting or scoring logic: The GreenLITES system is rated in a similar fashion to Greenroads with certified, silver, gold, and evergreen serving as the progressive certification levels for more sustainable practices. Certification is based on the total amount of points received. Points are allocated to different activities and levels of accomplishment based on their perceived sustainability impact (weighting). Projects receive points in the GreenLITES Project Design program for undertaking actions in the following categories: sustainable sites, water quality, materials and resources, energy and atmosphere, and innovation/unlisted. The latter category is provided to allow flexibility in the scoring system and allow points to be received for new and innovative sustainability practices. Projects receive points in the GreenLITES Operations program for undertaking actions such as using alternatives to herbicides during roadway vegetation maintenance, improving or retaining bridge aesthetics, optimizing signal timing, or improving ADA access.

Illinois Livable and Sustainable Transportation System and Guide

Website: www.acec-il.org/ and http://www.dot.il.gov/green/projects.html

Purpose: I-LAST is a sustainability performance metric system developed by the Joint Sustainability Group of the Illinois Department of Transportation, the American Council of Engineering Companies–Illinois (ACEC-IL), and the Illinois Road and Transportation Builders Association (IRTBA). The stated purposes of I-LAST are threefold: (1) provide a comprehensive list of practices that have the potential to bring sustainable results to highway projects; (2) establish a simple and efficient method of evaluating transportation projects with respect to livability, sustainability, and their effect on the natural environment; and (3) record and recognize the use of sustainable practices in the transportation industry.

Sustainability definition: I-LAST uses the United Nations Brundtland Commission definition of sustainability. The Brundtland Commission defined sustainability as "Meeting the needs of the present generation without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987). Specifically, I-LAST identifies the following goals for providing sustainable features in the design and construction of highway projects:

- Minimize impacts to environmental resources;
- Minimize the consumption of material resources;
- Minimize energy consumption;
- Preserve and/or enhance the historic, scenic, and aesthetic context;
- Integrate highway projects into the community in a way that helps preserve and enhance community life;
- Encourage community involvement in the transportation planning process;

- Encourage integration of nonmotorized means of transportation into highway projects;
- Find a balance between what is important to the transportation function of the facility, to the community, to the natural environment, and to what is economically sound; and
- Encourage the use of new and innovative approaches in achieving these goals.

Weighting or scoring logic: The I-LAST Guidebook and Construction Practices Addendum consist of a total of eight credit categories and 20 unique credits. The credit categories are planning, design, environmental, water quality, transportation, lighting, materials, and innovation. The innovation credit is included to foster creativity and reward the use of experimental and innovative features to improve the sustainability of the transportation industry. Each credit identifies criteria to meet the intent of the credit. Point values are assigned to each criterion, depending on the level of sustainability benefit.

To evaluate a project's sustainability performance, the I-LAST guidebook recommends that the number of points earned be taken as a percentage of the total number of points possible. However, due to the varying nature of highway projects and the range of items in I-LAST, not all credit topics are relevant for every project. It is therefore recommended that the number of points possible be determined at the outset by deciding which credit topics are applicable to a specific project. Using this method, I-LAST users are encouraged to compare their final percentage-based score to the scores of other projects to estimate their level of sustainability achievement.

Green Guide for Roads

Website: http://www.tac-atc.ca/english/projects/greenguide.cfm

Purpose: The stated purpose of Canada's national Green Guide for Roads is to promote sustainable growth and alternative multimodal transportation solutions within corridors, along with safe, long-lasting roadway infrastructure and green construction principles. The intent of the guide is to respect traditional design objectives for safety, efficiency, capacity, and maintenance, while integrating objectives relating to compatibility, livability, universal accessibility, modal equity, conservation of resources, affordability, and environmental protection. The Green Guide for Roads is currently designed as a self-evaluation tool and was initiated by the Transportation Association of Canada in 2010.

Sustainability definition: No explicit definition of sustainability is offered throughout the documents produced to date for the Green Guide for Roads. However, the Benefits of Green Roads section of the document offers the following information on the role of transportation in creating a sustainable society:

> A fundamental component of sustainable development is having a transportation system that is affordable, safe, efficient, and environmentally friendly. While a transportation system brings people and goods together and contributes to the growth and prosperity of Canada, it does have environmental, economic, and social costs that affect our quality of life. As such, decisions and choices made with respect to the development, operation, and use of the transportation system shape the communities we live in and have an impact on the future sustainability of our communities. (http://www.tac-atc.ca/english/projects/pdf/greenguide-benefits.pdf)

Weighting or scoring logic: Currently the working template is a compilation of sustainability requirements and best practices to meet the 13 identified sustainability principle application areas. The 13 sustainability principle application areas in the working template are community interface,

valued environmental components and land consumption, mobility choices, intersections and driveways, hard surfaces, landscaping, amenities, drainage, safety, energy consumption, construction, operations and maintenance, and services and utilities.

A suggested ordinal ranking system is provided to help the users of the template score their projects based on their level of accomplishment in meeting the requirements of each application area. The ordinal ranking system is based on a three-point low, medium, and high scale, which is weighted equally between the requirements. Currently there are no point thresholds or certification levels established since these will be included in the next phase of the rating system development. Additionally, the ability to earn points for new and innovative strategies that are not already included in the working template is limited; currently only a few of the 13 sustainability principle application areas allow points to be earned for innovation.

Building Environmentally and Economically Sustainable Transportation-Infrastructure-Highways (BE^{2}ST-in-Highways)

Website: www.rmrc.unh.edu/Outreach/docs/Lee,Edil,Benson,Tinjum.pdf

Purpose: BE^{2}ST-in-Highways was developed by the University of Wisconsin to provide a quantitative methodology for rating the benefits of sustainable highway construction. The methodology is grounded in quantitative metrics so that a transparent linkage exists between the project rating and the sustainable practices employed in design and construction. This rating system can be used by the highway industry to help incorporate sustainable elements into projects more easily at the forefront but also in any phase of a project.

Sustainability definition: BE^{2}ST-in-Highways defines sustainable development as the ability to "meet the needs of the present without compromising the ability of future generations to meet their own needs," which is the definition from the United Nations Brundtland Commission's 1987 report entitled *Our Common Future*.

Weighting or scoring logic: With the criteria and their target values established, weights are assigned to each criterion along with credit levels. An equally weighted system consisting of 2 points for each criterion, resulting in 18 total points, is the default in the BE^{2}ST-in-Highways system. In application, stakeholders can select the weights and credits. Weights are based on the importance ascribed to each criterion and can be assigned using the analytical hierarchy process, which is a separate software package designed to compute the weighting value.

GreenPave

Website: http://www.mto.gov.on.ca/english/transtek/roadtalk/rt16-1/#a6

Purpose: GreenPave is a Canadian system developed by the Ministry of Transportation of Ontario (MTO). The system primarily focuses on roadway pavements. GreenPave is a green rating system for pavements that provides a way of recognizing sustainability in pavement projects. The points-based system is designed to assess the sustainability of flexible and riding pavement designs and their construction. GreenPave is modeled after Greenroads and GreenLITES, but is customized for Ontario.

Sustainability definition: The definition of sustainability that serves as an organizing concept for GreenPave is the same definition used to guide MTO. MTO is committed to enhancing the sustainability of Ontario's transportation infrastructure, including safe, efficient, economical, environmentally friendly technologies and materials that meet the needs of present-day users without compromising those of future generations.

Weighting or scoring logic: GreenPave assesses pavements within four categories: pavement design technologies, materials and resources, energy and atmosphere, and innovation and design process. Each category has a maximum number of points that can be awarded, for a total of 36 possible points. Each category is further broken down to address specific objectives, with corresponding points assigned to each subcategory. Achievement levels of bronze, silver, gold, and trillium can be awarded.

Appendix G

Project Overview and Interactive Workshop Material

The research team presented two interactive practitioner workshops in April 2011. The aim of these workshops was to evaluate the practical application of the framework as presented in the guidebook, to test the application in practice, and to incorporate feedback received, as appropriate, to further enhance the guidebook.

The presentation materials used for these workshops, including supplementary material and handouts, have been modified and included on the CD-ROM accompanying this guidebook. They are also available for download at the NCHRP project website. These materials may be used/adapted by your agency to present the SPM framework and guidebook or train a working group in the hands-on application of the approach to developing sustainability performance measures described in this guidebook.

A suggested agenda for the workshop follows. The workshop is developed as a day-long session with a break for lunch. The first part of the workshop should be conducted in an instructional format, with a facilitator describing the basic concepts of sustainability and performance measurement, the framework developed as part of this research, and the overall research approach by means of a PowerPoint presentation. The research products, including the guidebook and electronic compendium, should also be introduced.

The handouts provided to participants should include key material from the guidebook. The instruction provided should also include a demonstration on the use of the electronic compendium to identify objectives and performance measures.

After the introductory lessons, the participants are divided into groups for an interactive exercise. The exercise is structured to allow the participants to walk through the major steps of applying the framework to understand sustainability; identify goals, objectives, and measures; and discuss practical applications of the measures. Participants may be divided into groups representing divisions within an agency. A group representing the agency as a whole may also be included. A rough participant brief can include

- Developing a position statement that defines how their division understands sustainability in the broader context of their agency;
- Identifying five goals, 10 objectives, and up to 15 performance measures using the recommended goals and the electronic compendium of objectives and measures as a starting point; and
- Discussing applications of the performance measures and data sources for their quantification.

On completion of the interactive exercise, groups are asked to report back on their findings. The workshop can then conclude with a group discussion of the process and future research needs, followed by a final review and recap by the facilitator.

Suggested Workshop Agenda

09:00–09:15 Welcome and Introductions
09:15–09:30 Purpose and Overview
09:30–10:15 Background
- What does sustainability mean?
- Performance measures for sustainability
- Application of performance measures

10:15–10:30 Break
10:30–11:00 Introduction to Guidebook
- Guidebook Modules
- Spreadsheet-based compendium

11:00–12:00 Interactive Exercise
- Briefing
- Participant exercise

12:00–13:00 Lunch
13:00–14:00 Interactive Exercise
- Participant exercise (continues)

14:00–14:45 Group Presentations and Discussion
14:45–15:00 Final Review and Conclusion

Appendix H

Glossary

Biogeophysical Sustainability – Biogeophysical sustainability is the maintenance and/or improvement of the integrity of the life-support systems on Earth.

Earth's Life Support Systems – Natural systems that support life on Earth; the atmosphere, the waters, the soils; ecosystems that provide essential services, such as food, energy, waste decomposition, and pollination of plants.

Eco-Efficiency – World Business Council for Sustainable Development describes eco-efficiency as a management strategy of doing more with less (Schmidheiny and the Business Council for Sustainable Development, 1992). In practice, eco-efficiency is achieved through the pursuit of three core objectives: increasing product or service value, optimizing the use of resources, and reducing environmental impact. Eco-efficiency is only a relative measure, seen by some as a necessary but not sufficient condition for achieving sustainability, since in some cases absolute reductions in some environmental pressures are needed.

Ecological Economics – Ecological economics is a transdisciplinary field of study that combines economics and technology with ecology. It studies the relationships between ecosystems and economic systems, encompassing both biological and cultural change.

Ecological Modernization – Ecological modernization refers to the transformation or adaption of industrial systems to reduce their environmental impacts. The concept focuses on material and energy productivity gains through actions such as product and process innovations, supply chain management improvements, and the replacement of hazardous chemicals with nontoxic substitutes.

Equity/Equitable Distribution Among Population Groups – Equity concerns the distribution of access to facilities (e.g., jobs and leisure), benefits from investment decisions, and exposure to the negative externalities generated by transport. Equitable policies are those that both promote social progress and lead to a narrowing of the gap between groups that have the best and worst of current conditions. Progressive policies close the gap between the true marginal social cost of journeys and the prices paid by travelers.

Human Needs (Basic) – Basic human needs can be grouped into four general areas that can be used to consider the motivation, functioning, and well-being of humans. These areas are (1) safety, security, and sustenance; (2) competence, efficacy, and self-esteem; (3) autonomy and authenticity; and (4) connectedness. The satisfiers to these needs are defined by economic, social, and political systems. Thus, they differ across cultures and change over time.

Impact (Cost/Benefit) – The effect or consequence of something. Impact is the effects (desirable or undesirable) of some activity or influence on entities of human concern. Impact is often seen as the terminal point of a causal chain, following intermediate steps such as pressure on and change in the state of a system or entity. For example, a disturbance (pressure) on a traffic flow may change the average speed (state), leading to time losses (impact). Impacts are therefore the ultimate concern for policy or project assessment. Impacts can be positive or negative. Impacts are sometimes aggregated into categories depending on the domain in which they occur (e.g., environmental impacts, economics impacts) or on their value to human society (costs or benefits).

Indicators – Indicators are measurable entities or variables that can be used to evaluate progress toward achievement of a goal or objective. While often used interchangeably with "performance measures," indicators typically provide an idea of general direction of performance, without the introduction of specific units or benchmarks.

Industrial Ecology – Industrial ecology is the study of material and energy uses and flows in products, processes, and industrial systems. It focuses on ways to reduce negative environmental impacts from industrial activity using techniques such as life-cycle analysis.

Livability – Livability captures the degree to which integrated transport and land-use planning initiatives contribute to communities with high environmental quality, which promote walking, cycling, and public transport use and easy access to local amenities.

Management of Resources – Management of resources refers to the prudent use of nonrenewable resources that are currently used as inputs to the transport system (e.g., construction materials and fuels). The general direction of change is to use fewer nonrenewable resources and to use them at rates no greater than that at which they can be replaced.

Natural Capital – Natural capital is the stock of all environmental and natural resource assets. It consists of three main categories: (1) nonrenewable resources, (2) renewable resources, and (3) the capacity of natural systems to absorb emissions and pollutants from human activity.

Performance Measures – Performance measures are quantifiable indicators of performance that can be used to evaluate progress toward achievement of a goal or objective. While often used interchangeably with "indicator," performance measures generally denote the presence of specific quantification mechanisms, units, and implied targets/benchmarks.

Quality of Life – Quality of life at the community level or individual level encompasses aspects that go beyond basic human needs for survival—for example, health, comfort and convenience, safety, security, and quality of community and social interactions. Indicators for quality of life are highly context specific and are typically defined by a significant community engagement exercise.

Steady-State Economy – A steady-state economy is one where the throughputs of all raw materials and wastes are kept to levels within the regenerative and assimilative capacity of the ecosystem. Within the steady-state economy, technology, knowledge, the distribution of income, and the allocation of resources are fluid. Since a fixed amount of resources will yield a constant flow of goods and services (all else being equal), technological progress is one way in which more (or more highly valued) goods and services can be produced.

Strong Sustainability – Strong sustainability means assuming that environmental resources and systems, or the "natural capital," cannot be replaced by artificial systems and resources, or "man-made capital," without detriment to sustainability. To ensure sustainable development, it is necessary to preserve the natural capital and therefore to measure it in natural rather than economic units.

Sustainability – Sustainability emphasizes the need to balance human needs with consideration of the natural environment and equity issues, in both a present (intragenerational) and future (intergenerational) context. Sustainability is generally discussed in terms of three dimensions: economic, environmental, and social (equity). The distinction between sustainability and

sustainable development is usually made by considering sustainability to be an idealized end state and sustainable development as the process of moving toward it.

Sustainable Development – Sustainable development can be viewed as a process of working toward achievement of sustainability, with a particular focus on human needs. Traditionally, it is defined as *development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*

Weak Sustainability – Weak sustainability means assuming that man-made capital (machines, technology, etc.) in principle can replace natural capital when the latter is consumed or depleted, provided the former is able to produce an equivalent economic value to society over time. According to this assumption, it is not the natural resources or systems per se that matter for sustainable development, but the welfare they are able to produce for society.

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Abbreviations and acronyms used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	Air Transport Association
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation