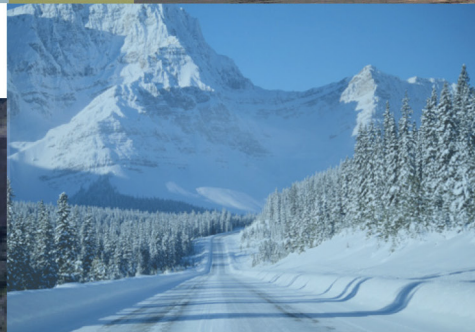


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F H W A

Advancing a Sustainable Highway System: Highlights of FHWA Sustainability Activities



U.S. Department
of Transportation
**Federal Highway
Administration**

Prepared for:
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The Federal Highway Administration (FHWA) is committed to improving social, economic, and environmental outcomes—the sustainability triple bottom line—of FHWA activities. FHWA has spearheaded numerous efforts to address and advance sustainability ranging from projects to mitigate climate change impacts, to initiatives that promote sustainable pavements and improve safety, to developing tools to better assess the benefits and costs of transportation investments. This report illustrates how sustainability has been incorporated into a wide variety of FHWA programs, projects, policies, processes, and partnerships. A diverse audience of transportation agency professionals at the Federal, State, and local levels, as well as the general public, can use this report.

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Abbreviations and Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
ADOT	Arizona Department of Transportation
BCA	Benefit-cost analysis
BLCCA	Bridge life-cycle cost analysis
BMPs	Best Management Practices
CAMPO	Capital Area Metropolitan Planning Organization
CIPR	Cold In Place Recycling
CMAQ	Congestion Mitigation and Air Quality Improvement
CO	Carbon monoxide
CSS	Context Sensitive Solutions
DOT	Department of Transportation
DSNY	New York City Department of Sanitation
EAR	Exploratory Advanced Research
EERPAT	Energy and Emissions Reduction Policy Analysis Tool
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
FITSEVAL	Florida Intelligent Transportation Systems Evaluation Tool
FRATIS	Advanced Freight Traveler Information System
FSUTMS	Florida Standard Urban Transportation Model Structure
FTA	Federal Transit Administration
GHG	Greenhouse gas
GSTP	Georgia Statewide Transportation Plan
HEC-25	Hydraulics Engineering Circular 25
HMA	Hot-mix asphalt
HSIP	Highway Safety Improvement Program

HSM	Highway Safety Manual
INVEST	Infrastructure Voluntary Evaluation Sustainability Tool
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation Systems
KEEC	Kinetic-to-electric conversion
kWh	kilowatt-hours
LCCA	Life cycle cost analysis
LRTP	Long-range transportation plan
MAP-21	Moving Ahead for Progress in the 21st Century
MnDOT	Minnesota DOT
MPO	Metropolitan Planning Organization
MSAT	Mobile Source Air Toxics
NAAQS	National Ambient Air Quality Standards
NBIAS	National Bridge Investment Analysis Software
NCHRP	National Cooperative Highway Research Program
NEPA	National Environmental Policy Act
NHI	National Highway Institute
NHS	National Highway System
NPDES	National Pollutant Discharge Elimination System
ODOT	Oregon Department of Transportation
PA	Programmatic approaches
PBPP	Performance-Based Planning and Programming
PSC	Partnership for Sustainable Communities
PGE	Portland General Electric
PM	Particulate matter
R&D	Research and Development
RAP	Reclaimed Asphalt Pavement

ROI	Return on investment
ROW	Right-of-way
RWMP	Road Weather Management Program
SBIR	Small Business Innovation Research
SCDOT	South Carolina Department of Transportation
SHRP2	Second Strategic Highway Research Program
SHSP	Strategic Highway Safety Plan
SIS	Strategic Intermodal System
SP TWG	Sustainable Pavements Technical Working Group
SSP	Safety Strategic Plan
STACC	Sustainable Transport and Climate Change
STEAM	Surface Transportation Efficiency Analysis Model
SWG	Sustainability Working Group
Title VI	Title VI of the Civil Rights Act of 1964
TAMP	Transportation Asset Management Plan
TAP	Transportation Alternatives Program
TPCB	Transportation Planning Capacity Building
U.S. DOT	United States Department of Transportation
WFL	Western Federal Lands
WMA	Warm-mix asphalt
WRR	Watershed Resource Registry

Purpose of the Report

FHWA is undertaking a significant amount of work related to sustainability across a number of program areas throughout the Agency. The purpose of this report is to showcase some of the ways in which FHWA is incorporating and embedding sustainability into its programs, projects, policies, processes, and partnerships. This report will highlight several agency initiatives and programs including “Action Areas” developed in consultation and collaboration with the FHWA Sustainability Working Group. The Action Areas are those in which there is currently a focus on sustainability, or are emerging activities that support the “triple bottom line” principles of sustainability. While sustainability is fully supported in other long-standing and well-established programs throughout the agency, the featured Action Areas represent significant opportunities for new growth and advancement in this area and have high potential for achieving sustainability goals and benefits in the near term. This report will serve as a resource to the public, transportation professionals, and those working within FHWA to help them better understand the various sustainability activities and initiatives moving forward within the Agency.

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1 Introduction

In the transportation industry, projects and systems serve many different and sometimes competing roles, in order to achieve varying objectives, including safety, mobility, environmental protection, livability, and asset management. A sustainable approach seeks to meet all of these needs while working to achieve economic targets for cost-effectiveness throughout a highway's life cycle. For the Federal Highway Administration (FHWA), a sustainable approach to highways means decisionmakers are able to make balanced and efficient choices among environmental, economic, and social values—the triple bottom line of sustainability—that will provide the best benefits to the natural and human environment now and in the future. A sustainable approach includes a wide variety of activities and a diversity of concepts that support the triple bottom line principles. These include efficient use of funding, incentives for construction quality, climate change considerations, and civil rights.

Using sustainable approaches in transportation planning, investments, operations, and other phases of transportation project delivery will help decisionmakers continue to enhance quality of life and serve the transportation needs of the present without compromising the ability of future generations to meet their needs.

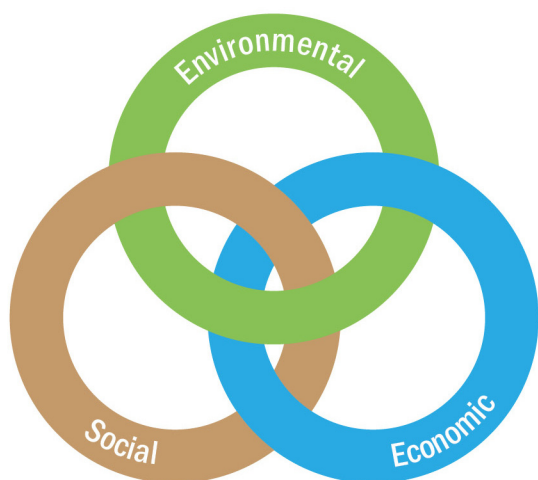


Figure 1: The Sustainability Triple Bottom Line.

Sustainability Goals

Sustainability is often described using the “triple bottom line” concept, which includes giving consideration to principles in three primary categories: Social, Environmental, and Economic (see Figure 1). Sustainability aims to satisfy basic social and economic needs, both present and future, by promoting the responsible use of natural resources, while maintaining or improving the environment on which life depends. For the purposes of this report, rather than define sustainability, FHWA wishes to reflect upon the triple bottom line by examining and highlighting the multitude of sustainable activities that FHWA leads. FHWA values investing in sustainability practices and stewardship activities. FHWA works hand-in-hand with stakeholders nationwide to demonstrate the benefits derived from sustainability and stewardship opportunities including expedited program delivery, accelerated transportation decisionmaking, and improved environmental streamlining.

Background on Sustainable Highways

Sustainable Highways Initiative

For years, FHWA has supported research and development and implementation efforts at the forefront of the sustainability movement. [The Sustainable Highways Initiative](#) supports programs and activities conducted across FHWA to facilitate balanced decisionmaking among environmental, economic, and social values — the “triple bottom line of sustainability”. The [Infrastructure Voluntary Evaluation Sustainability Tool](#) (the callout box on page 4 provides a summary of INVEST), the FHWA [Sustainability Working Group](#) (see box below), and the creation of a Sustainable Pavements Program are a few examples of efforts underway at FHWA to help State and local agencies strengthen the sustainability of the Nation's roadways.

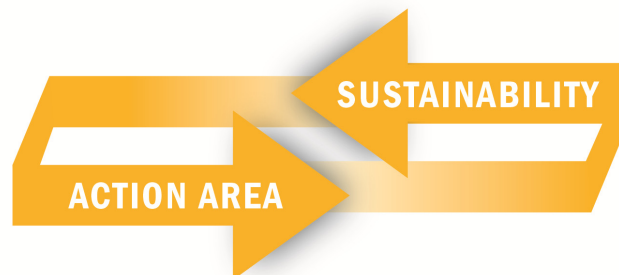
Sustainability Working Group	Membership
In recognition of the importance of building and managing a more sustainable transportation system, a working group was formed within FHWA in the summer of 2010 to focus on sustainability. The FHWA Sustainability Working Group (SWG) leads, coordinates, promotes, and communicates FHWA's sustainability activities in a centralized and integrated manner. The SWG membership represents nearly all of the Agency's major program areas, and includes representatives from Headquarters, Division Offices, Resource Centers, and the Federal Lands Highway Division. The SWG will continue to help define sustainability goals and strategies for FHWA.	<p>The following offices and divisions are represented on the SWG:</p> <ul style="list-style-type: none">• Office of Environment, Planning, and Realty• Office of Infrastructure• Office of Operations• Office of Safety• Office of Civil Rights• Office of Research, Development, and Technology• Office of Policy and Governmental Affairs• Field Services Offices - North, West and South• Division Offices• Resource Centers• Federal Lands Highway

Introduction to Sustainability Practices

FHWA has a wide variety of existing and planned initiatives that address and promote sustainability. The next section of this report showcases a selection of FHWA's sustainability practices as they relate to overarching topics, such as Freight and Goods Movement, Roadway Maintenance and Operations, and Safety. Each of these topics will include details regarding specific FHWA programs, projects, policies, processes, and partnerships and will showcase exemplary State, regional, and local examples (located in separate callout boxes). Some topics will also be highlighted as **Sustainability Action Areas**. This report is not meant to be exhaustive, but rather to provide a snapshot of the wide variety of ways in which FHWA is advancing sustainability.

Sustainability Action Areas

In 2012, SWG members identified and shared sustainability priorities among FHWA offices to better leverage activities across the Agency. In spring 2013, **Sustainability Action Areas** were developed in consultation and collaboration with the SWG. The Action Areas represent significant opportunities for new growth and advancement in sustainability for FHWA, and have high potential for achieving sustainability goals and benefits in the near term. The current Sustainability Action Areas are featured throughout this report and are identified by the following symbol:



These focus areas are expected to change over time, as FHWA's sustainability work evolves. Although not identified as Sustainability Action Areas, other long-standing, pertinent programs and initiatives within the agency were also recognized as important and are captured in this report.

Sustainability Action Areas

Safety
Access and Affordability
Freight and Goods Movement
Linking Asset Management and Planning
Infrastructure Resiliency
Economic and Life Cycle Cost Analyses
Sustainable Pavements
Road Weather Management

Infrastructure Voluntary Evaluation Sustainability Tool (INVEST)



FHWA developed INVEST as a practical, web-based collection of best practices to help transportation agencies integrate sustainability into their programs and projects. Agencies, such as DOTs, Metropolitan Planning Organizations (MPOs), Councils of Government, public works departments, and their consultants and partners, can voluntarily use INVEST to evaluate the sustainability of their programs and projects. The tool is intended to identify and recognize efforts that go above and beyond standard practice toward the goal of sustainability.

INVEST users can evaluate the transportation life cycle using the system's three modules: System Planning, Project Development, and Operations and Maintenance. Each module is based on a specific set of criteria and can be used separately.

FHWA is currently partnering with State DOTs, MPOs, Federal Lands, and local governments to implement INVEST. This process will establish a broader collection of case studies, gather lessons learned, and solicit feedback on ways to further enhance the tool.

Three INVEST Modules:



Sustainable Practices

3



3.1 Safety

Overview

The [FHWA Safety Program](#) is designed to reduce fatalities and injuries on the Nation's roadways, benefiting all of the triple bottom line sustainability principles. Reducing fatal and serious injuries contributes to the social and economic triple bottom line sustainability principles by reducing loss of life and injury and the impacts associated with personal and public property damage. The FHWA Office of Safety works with Federal, State, local partners, and others in the transportation community to develop and promote programs and technologies to improve roadway safety performance.



Sustainability Practices

Safe Roads for a Safer Future: A Joint Safety Strategic Plan – The Office of Safety, Office of Safety Research and Development, and Resource Center Safety and Design Technical Services Team, otherwise known as FHWA's safety units, collaborated to develop a [Safety Strategic Plan](#) (SSP). The strategic planning process brought together these safety units to focus on a common vision, ensuring that each unit makes decisions that put them all on a path toward the same goals. The SSP supports the U.S. DOT and FHWA strategic plans and goals and provides a guide for other safety activities throughout the Agency. The SSP can also provide FHWA's external partners with an understanding of where FHWA will focus safety resources as they make their own resource allocation decisions.

Highway Safety Improvement Program – The [Moving Ahead for Progress in the 21st Century Act](#) (MAP-21) continues the [Highway Safety Improvement Program](#) (HSIP) as a core Federal-aid program. The goal of the HSIP is to significantly reduce traffic fatalities and serious injuries on all public roads, including non-State-owned public roads and roads on Tribal lands. The HSIP requires a data-driven, strategic approach to improving highway safety on all public roads that focuses on performance. To obligate HSIP funds, a State must develop, implement, and update a Strategic Highway Safety Plan (SHSP), produce a program of projects or strategies to reduce identified safety problems, and evaluate the SHSP on a regular basis. The SHSP is a statewide-coordinated safety plan that identifies a State's key safety needs and guides investment decisions toward strategies and countermeasures that have the greatest potential to save lives and prevent injuries.

Roadway Departure – A roadway departure crash is defined as a non-intersection crash that occurs after a vehicle crosses an edge line or a centerline, or otherwise leaves the traveled way. Roadway departure crashes are frequently severe and account for the majority of highway fatalities. FHWA's [Roadway Departure Safety Program](#) provides important information for transportation practitioners, decisionmakers, and others to reduce the risk of roadway departure fatal and serious injury crashes. This is accomplished through the development, evaluation, and deployment of life-saving countermeasures and promoting data-driven application of safety treatments. In March

2013, FHWA produced a [Roadway Departure Strategic Plan](#) to provide a common vision for research, policy, and implementation to address these crashes.

Intersection Safety – Strategies to improve intersection safety are diverse. Many strategies are engineering based, including alternative intersection design and application of traffic control devices. Equally important strategies involve education and enforcement. [Intersection safety](#) is a national, State, and local priority. As a result, organizations such as the FHWA, National Highway Traffic Safety Administration, the Institute of Transportation Engineers (ITE), the American Association of State Highway and Transportation Officials (AASHTO), the American Automobile Association, and other private and public organizations continue to develop and deploy resources designed to help make intersections safer, and are saving lives as a result. In July 2013, FHWA released the second edition of [Signalized Intersections: An Information Guide](#), which serves as an introduction to and guide for evaluating the safety, design, and operations of signalized intersections. It takes a holistic approach to signalized intersections and considers the safety and operational implications of a particular treatment on all system users (e.g., motorists, pedestrians, bicyclists, and transit users). The information in the guide is based on the latest research available and includes examples of novel treatments and best practices used by jurisdictions across the U.S. and other countries. The callout box on page 7 showcases South Carolina's intersection improvement work.

Pedestrian and Bicycle Safety – FHWA's Office of Safety develops projects, programs, and materials for use in reducing pedestrian and bicyclist fatalities and injuries. For more information on the [Pedestrian Safety program](#), see the Multimodal Transportation section on page 17.

Data and Analysis – FHWA provides and supports a wide range of [data and safety analysis tools](#) for State and local practitioners. These tools have been designed to help practitioners better understand safety problems on their roadways, link crashes to their roadway environments, and select and apply appropriate countermeasures. One such tool is the [Highway Safety Manual](#) (HSM). The HSM provides practitioners with information and tools to consider safety when making decisions related to design and operation of roadways. The HSM assists practitioners in selecting countermeasures and prioritizing projects, comparing alternatives, and quantifying and predicting the safety performance of roadway elements considered in planning, design, construction, maintenance, and operation.

Proven Safety Countermeasures – In 2012, FHWA issued a "[Guidance Memorandum on Promoting the Implementation of Proven Safety Countermeasures](#)" that takes into consideration the latest safety research to advance a group of nine countermeasures (such as roundabouts and road diets) shown to be effective in improving safety. The [Proven Safety Countermeasures](#) encourages safety practitioners to consider a set of nine countermeasures that are research-proven, but not widely applied on a national basis.



Looking Forward

FHWA safety units continue to align their existing efforts with the SSP goals. The Office of Safety will continue to administer the HSIP and provide resources and assistance to State, local, and Tribal officials and governments to reduce fatalities and serious injuries on the Nation's roadways. The [Focused Approach to Safety](#) provides additional resources to eligible high priority States to address the Nation's most critical safety challenges. FHWA will assist each State participating in the Focused Approach in reducing highway fatalities using infrastructure-oriented improvements in any one or all of three critical focus areas: roadway departure, intersection safety, and pedestrian safety.

South Carolina Systematic Intersection Improvements Case Study

In 2008, South Carolina Department of Transportation (SCDOT) set out to implement all of the recommended improvements identified in its Intersection Safety Implementation Plan. Over a three-year period, SCDOT carried out more than 2,200 intersection improvements, including installation of signage to warn drivers of upcoming stop signs (Figure 2). Although these improvements encompassed only about 1.3 percent of all South Carolina intersections, they covered locations that accounted for 44 percent of all South Carolina intersection crashes. SCDOT reviewed preliminary crash data for locations with one year of “after” data and observed that an approximate crash reduction of 20 percent occurred where these low-cost improvements were implemented.



Figure 2: Photo of doubled up (left and right) signing to warn drivers of an upcoming stop sign. (Courtesy of SCDOT)

3.2 Freight and Goods Movement

Overview

Planning for freight and goods movement benefits all of the triple bottom line sustainability principles by supporting economic prosperity through improved freight efficiency and reliability, reducing fuel consumption and related emissions, and reducing adverse impacts of freight movement on communities. [The FHWA Office of Freight Management and Operations](#) is dedicated to promoting the efficient movement of freight across all transportation modes and fostering the economic benefits of efficient freight movement. Moreover, this office is committed to lessening the effects of freight movement on nearby localities and regions.



Sustainability Practices

Freight Advanced Traveler Information System (FRATIS) – Advanced traveler information, such as real-time messages on incidents, congestion, and travel time, has the potential to improve the mobility, safety, and environmental sustainability of the Nation’s transportation system. Through FRATIS, FHWA is bringing advanced traveler information to the freight industry. FRATIS enhances truck movements, especially short-haul truck trips in urban areas. It utilizes both private freight shipper and carrier information about the origins and destinations for goods with real-time highway condition information from the public sector. By using these sources of information, trucks can be optimally routed when delivering and picking up shipments, and the number of empty trucks or empty truck miles can be reduced. FRATIS is being tested in three locations – Los Angeles, Dallas, and south Florida (see the callout box on page 9 for more information on the Los Angeles FRATIS Project). These prototype demonstrations are expected to run for approximately six months and evaluation results are expected later this year.

Truck Parking Study – As part of MAP-21, FHWA is required to carry out a survey to examine each State’s capability to provide truck parking and rest facilities, assess the commercial motor vehicle volume, and develop metrics to measure the adequacy of truck parking facilities. Although MAP-21 mandated the on-going study, various truck parking-related efforts involving the Office of Freight Management and Operations were already completed prior to MAP-21’s adoption. Previously, FHWA provided funding for pilot projects to address the shortage of long-term parking for commercial motor vehicles on the National Highway System (NHS). By examining and addressing truck parking needs, commercial motor vehicle sustainability and safety issues can be better addressed.

Performance Measurement – MAP-21 requires reporting on performance metrics and includes freight-specific performance measures. Performance measures help identify and measure the effectiveness of needed transportation improvements. They also serve as indicators of economic health and traffic congestion. The Office of Freight Management and Operations has completed various [performance measurement-related initiatives](#). Many of these efforts have focused on travel time in key truck (mostly interstate highway) corridors and cross-border travel times. Some of FHWA’s initiatives have involved coordination between the Office of Freight Management and Operations and the American Transportation Research Institute, a trucking-focused research organization.

Smart Roadside – [Smart Roadside](#) is a system envisioned for use at strategic points along commercial vehicle routes to improve the safety, mobility, and efficiency of truck movement and operations on the roadway. The objective is to apply advanced technologies to create more efficient and streamlined processes, and share data in real time or near-real time to maximize its utility. Spearheaded by the Federal Motor Carrier Safety Administration and FHWA, the Smart Roadside Initiative enhances the collection of roadside commercial vehicle data, such as truck weight, by gathering data while trucks are traveling at speed. Because the trucks do not need to slow down



Looking Forward

Los Angeles FRATIS Project

The Los Angeles FRATIS project is developing and testing FRATIS applications in the Gateway Cities subregion that encompasses southeastern Los Angeles County, one of the leading freight movement areas in the western hemisphere. The project is designed to address dynamic travel planning around the marine terminals and queues to move cargo out more efficiently. The primary goal is to enable and optimize information sharing between drayage fleets and marine terminals using a fusion of public and private sector data. The project will build support for freight-specific Intelligent Transportation Systems (ITS) applications, strengthen regional efforts for cooperation within the intermodal freight industry, and provide the groundwork for further testing initiatives. For Dray Operators, this means improved planning for container pickups; dynamic routing to avoid congestion and severe queues; and terminal and yard information/alerts. Marine Terminal Operators will benefit from improved labor, equipment, and gate operations and truck-specific yard management information. They will also be able to alert trucks approaching or within the terminal. Anticipated outcomes of the project include reduced fuel costs and shorter idle times with the avoidance of congested gates. The public will receive benefits from congestion reduction and air quality improvements. Figure 3 below depicts the technical architecture for project.

Marine Terminal Interface
ETA Status
Jobs Overview
Weather

External Services Inputs to Optimization
Mapping Service
Historical Traffic
Terminal Wait Times

DISPATCHER MANAGEMENT TOOLS
Optimization
Real Time Traffic
Weather
Vehicle Tracking
Communication

DRIVER INTERFACE
Dynamic Routing
Incidents & Alerts
Order Fulfillment

Figure 3: Los Angeles FRATIS Technical Architecture. (Courtesy of FHWA)

Figure 3: Los Angeles FRATIS Technical Architecture. (Courtesy of FHWA)

3.3 Linking Asset Management and Planning

Overview

Historically, asset management has been a critical, but under-represented element of the transportation planning process. Asset management is a strategic and systematic process of operating, maintaining, and improving physical assets. It focuses on both engineering and economic analysis based upon quality information, to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions. Ultimately these actions should achieve and sustain a desired state of good repair over the life cycle of the assets at minimum practicable cost. Incorporating transportation asset management data and economic analysis methods throughout system planning advances sustainability in multiple ways. Specifically, linking asset management and planning supports the environmental and economic triple bottom line principles of sustainability by improving investment decisions, extending the life of assets, and reducing the demand for raw materials.



The enactment of MAP-21 codified asset management principles into law. The legislation established a performance-based highway program with the goal of improving how Federal transportation funds are allocated. In addition, MAP-21 stipulated that each State Department of Transportation (DOT) develop a risk-based [Transportation Asset Management Plan \(TAMP\)](#) for bridges and pavements on the NHS to improve or preserve the condition of the assets and the performance of the system.

Multiple FHWA offices including the Office of Asset Management, Office of Transportation Performance Management, and the Office of Planning are involved in a number of initiatives that directly support incorporating asset management principles in the planning process. FHWA is particularly focused on MAP-21 implementation, including rulemaking activities and performance-based planning efforts.

Sustainability Practices

Generic Work Plan for Developing a TAMP – Published in March 2013, FHWA's [work plan for developing a TAMP](#) presents a generic outline and sample templates for what a TAMP should look like and what it should include. Since the passage of MAP-21, many State DOTs have begun to prepare for developing a TAMP. In many cases, State DOTs are seeking guidance on what to include in the plan as well as how to begin the process of creating a TAMP. To address these issues, FHWA designed the generic work plan to be flexible for any State DOT's situation and any level of asset management maturity. This flexibility is essential, because the asset management planning process will only be a success if the resulting TAMP influences and directs how the agency allocates funds. Using this document as a starting point, FHWA worked with the DOTs in Louisiana, Minnesota, and New York (as part of the pilot program mentioned below) to develop State-specific work plans to serve as examples upon which other State DOTs can draw.

Pilot Project - Development of TAMPs – The Office of Asset Management is undertaking a [pilot effort](#) to support three State DOTs (Louisiana, Minnesota, and New York) as they develop their first TAMPs. The TAMPs will serve as models for other agencies managing highway infrastructure assets at the State or local level that are looking for direction on how to create a TAMP. This effort will focus on pavements and bridges on the NHS. During the pilot projects, staff from the participating agencies will conduct analyses and work through the asset management planning process, with support from a consultant team who will facilitate the process and assist in writing the TAMPs. The consultant team will then document lessons learned from these efforts, and use the results to develop templates that other States can use for their TAMPs. FHWA anticipates completion of the model

TAMPs by later this year. Additional details regarding Minnesota DOT's TAMP Pilot Project are included in the callout box below.

Performance-Based Planning and Programming (PBPP) Guidebook – MAP-21 placed increased emphasis on performance management within the Federal-aid highway and transit programs, and requires use of [performance-based approaches](#) in metropolitan, statewide and non-metropolitan transportation planning. In September 2013, FHWA produced [a guidebook](#) to describe the PBPP process. This guidebook identifies PBPP elements that are common to all levels of government, while highlighting examples of approaches that apply to different types of agencies involved in metropolitan, statewide, and non-metropolitan transportation planning and programming. The guidebook was designed to help State DOTs, MPOs, Regional Transportation Planning Organizations, transit agencies, and other partner organizations understand the key elements of a PBPP process, the relationship of these elements within existing planning and programming processes, and examples of best practices to help support implementation. The guidebook builds on existing PBPP resources and tools, including a white paper and series of workshop discussions that FHWA and the Federal Transit Administration (FTA) have sponsored to encourage dialogue among the transportation community.

Also in September 2013, FHWA collaborated with FTA to host a two-day workshop to discuss the key elements of the PBPP Guidebook and share existing practices. The workshop addressed key issues associated with implementing a PBPP approach, including data collection, identifying preferred trends and targets, and using performance information to support investment decisions in planning and programming. The workshop also explored opportunities to integrate performance-based processes (e.g., Asset Management Plans and Highway Safety Plans.) into the transportation planning process. Presentations focused on opportunities to advance the implementation of PBPP using the guidebook and lessons learned to demonstrate how to overcome potential obstacles.



Looking Forward

In the short term, FHWA's efforts to link asset management and planning are directly connected to MAP-21 activities. FHWA intends to complete the TAMP Pilot Projects this year and will continue to promote the application of PBPP through the PBPP Guidebook. Moreover, FHWA plans to host several workshops and national webinars on asset management, performance-based planning and programming, and MAP-21 performance provisions.

Minnesota DOT TAMP Pilot Project

To provide guidance to State DOTs in meeting the MAP-21 requirements, FHWA initiated a pilot project to assist three State agencies with developing their own TAMP. The Minnesota DOT (MnDOT) is one of three participating agencies. As part of the project, FHWA will provide technical guidance to MnDOT during the development of its TAMP. In July 2013, MnDOT submitted a Work Plan to FHWA. This document outlines a plan for conducting the work required to develop MnDOT's first formal TAMP. It is based on input from MnDOT's Asset Management Steering Committee and Project Management Team, which includes members from a broad cross section of MnDOT and the FHWA. MnDOT plans to finalize its TAMP later this year.

3.4 Human Environment and Civil Rights

3.4.1 Access and Affordability

Overview

Improved access and affordability of transportation systems benefit the social and economic tenets of sustainability by improving employment opportunities and enhancing opportunities to interact with the community. Additionally, increasing the modal choices available to the public through access improvements supports the environmental tenet of sustainability by offering alternatives to motorized travel. A sustainable transportation system is not only safe, healthy, affordable, and renewable, but it also operates fairly and in a way that provides accessibility to all persons. Within FHWA, the [Office of Civil Rights](#) engages in activities that support sustainability by addressing issues of access and affordability. The Office of Civil Rights primarily focuses on protecting the rights of those employed in, benefitting from, or affected by FHWA or the programs, policies, and activities of its recipients, subrecipients, or contractors.



Sustainability Practices

Americans with Disabilities Act (ADA) Program – The primary purpose of the FHWA’s [ADA program](#) is to ensure that pedestrians with disabilities have opportunities to use the transportation system in an accessible and safe manner. As part of FHWA’s regulatory responsibility under Title II of the ADA, FHWA ensures that recipients of Federal-aid and State and local entities that are responsible for roadways and pedestrian facilities do not discriminate on the basis of disability in any highway transportation program, activity, service, or benefit they provide to the general public. FHWA is also responsible for ensuring that people with disabilities have equitable opportunities to use the public right-of-way (ROW). This program focuses on developing policy and guidance and providing technical assistance and training for FHWA Division Offices and State transportation agencies.

Key sustainability accomplishments are those that have advanced FHWA’s ADA program as a core element of the civil rights discipline. These accomplishments include, but are not limited to, the establishment of an ADA Transition Plan performance metric for U.S. DOT’s Strategic Plan and for FHWA’s 2014 Strategic Implementation Plan. Additional achievements include the development and delivery of national webinars and best practices focusing on ADA transition plans for both FHWA recipients and subrecipients. FHWA is also providing ongoing technical assistance related to Title II of the ADA requirements to provide curb ramps when streets, roads, or highways are altered through resurfacing. The Agency has conducted numerous national training webinars on new technical assistance issued jointly with the U.S. Department of Justice on these subjects for FHWA Division Offices, State DOTs, and other external stakeholders.

See page 14 for more information regarding Florida’s innovative approach to ADA accessibility.

Incorporation of Environmental Justice and Language Access Plan recipient and subrecipient requirements into the Title VI Program – The interconnection between sustainability and civil rights is not limited to the removal of barriers to accessibility in the public ROW as required by the ADA. More generally, it includes a focus on human values that incorporates social equity principles. To that effect, an intersection exists between sustainability and FHWA’s longstanding policy to actively ensure nondiscrimination under Title VI of the 1964 Civil Rights Act in Federally funded activities. Under Title VI and related statutes, each Federal agency is required to ensure that no person is excluded from participation in, denied the benefits of, or subjected to discrimination under any program or activity receiving Federal financial assistance on the basis of race, color, national origin, age, sex, or disability.

There are two Presidential Executive Orders that place further emphasis upon the Title VI protections of race and national origin: Executive Order #12898 (Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations) and Executive Order #13166 (Improving Access to Services for Persons With Limited English Proficiency). Executive Order #12898 directs Federal agencies to develop strategies that address disproportionately high and adverse human health or environmental effects of their programs on minority and low-income populations. Executive Order #13166 directs Federal agencies to evaluate services provided and implement a system that ensures Limited English Proficiency persons are able to meaningfully access the services provided without unduly burdening the fundamental mission of each Federal agency.

FHWA Division Offices are responsible for ensuring that all recipients have an approved Title VI Program Implementation Plan and submit annual update reports. Additionally, FHWA Division Offices are responsible for ensuring State transportation agencies are effectively monitoring their subrecipients' implementation of Title VI and other nondiscrimination requirements. FHWA's National Title VI Program Manager coordinates FHWA's monitoring activities and works closely with other Federal Program Offices and U.S. DOT modal agencies to address opportunities for improved implementation of the [Title VI Program](#).



Looking Forward

The Office of Civil Rights will continue to provide targeted technical assistance and training for the ADA program and Title VI Program areas (incorporating environmental justice and language access planning components) for both FHWA Division Offices and State transportation agencies, and, where such assistance and training focus on the specific “how to” aspects of program implementation. Additionally, FHWA will continue to work with States to ensure the continued and steady increase in the number of States with ADA transition plans that include the public ROW, as well as an increase in the number of States implementing corrective actions with regard to ADA program deficiencies.

FDOT's ADA Approach

The Florida Department of Transportation (FDOT) has long taken a progressive stance on ADA accessibility. Rather than complying with 28 CFR 35.105 and 150(d) in a standalone program or plan, FDOT married accessibility with all aspects of project development and delivery. Each FDOT project is screened for accessibility needs and scoped accordingly, regardless of the nature of the project. While other States grappled with the issue of what constituted an alteration, FDOT improved or installed ADA features as part of every project in its five-year work plan (see Figure 4 for the types of ADA features Florida implemented). After 20 years of this comprehensive approach, FDOT finds its facilities are fully transitioned, requiring maintenance and upgrading to keep up with changing standards and wear and tear. FHWA appreciates this approach for two reasons. First, it integrates what is often a fragmented program into the overall project development and construction process, mainstreaming ADA into the industry's culture. Second, it treats those with disabilities as customers in need of service, rather than a special needs community that requires accommodation. FDOT is also currently in the process of more-closely associating its ADA Program with other non-discrimination programs (Title VI, Environmental Justice, etc.) This is intended to better ensure the Department complies with Federal civil-rights regulations and guidance, and supports the Department's "Consistent, Predictable & Repeatable" policies.

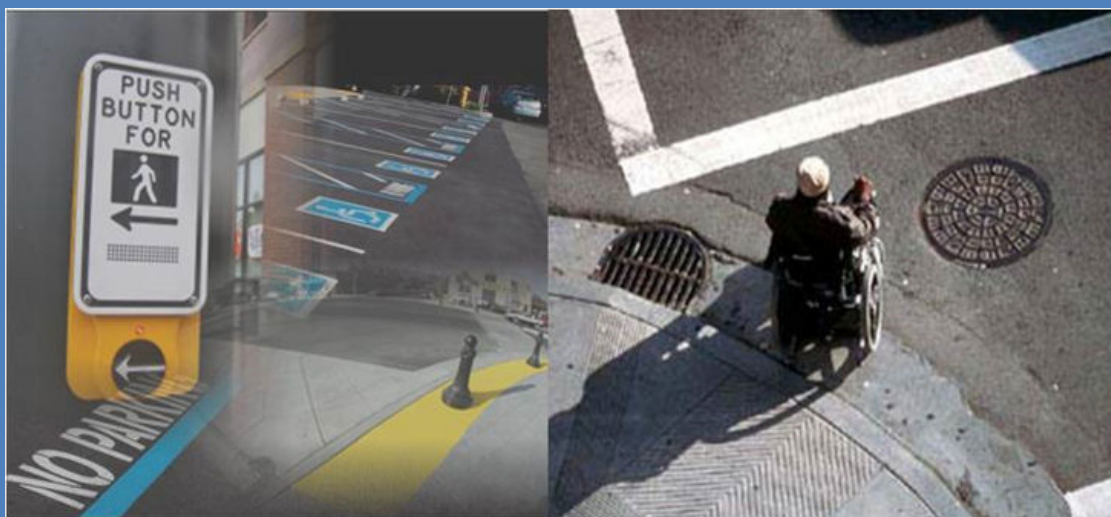


Figure 4: Picture featuring numerous accessible items utilized by FDOT on sidewalks, roadways, and in parking lots.
(Courtesy of FDOT)

3.4.2 Livability

Overview

Livability is about tying the quality and location of transportation facilities to broader opportunities such as access to good jobs, affordable housing, quality schools, and safer streets and roads. The concept of livability has evolved over the years, and is often used to describe a range of initiatives aimed at improving community quality of life, while supporting sustainability goals. Livability encompasses multidimensional issues relative to community design, land use, equity and environmental justice, environmental protection and enhancement, mobility and accessibility, public health, and economic well-being. Livability initiatives may be described as a subset strategy of sustainability and sustainable development focused more on near-term planning, funding, and implementation strategies at the community level.

As part of the U.S. DOT's [Livability Initiative](#), FHWA works within the U.S. Department of Housing and Urban Development/U.S. DOT/U.S. Environmental Protection Agency [Interagency Partnership for Sustainable Communities](#) (PSC) to coordinate and leverage Federal housing, transportation, water, and other infrastructure policies and investments. The Office of Human Environment is continuously supporting practitioners in advancing livability by developing resources such as the quarterly [FHWA Livability Newsletter](#), [case studies](#), [discussion board](#), fact sheets, and webinars. FHWA's livability efforts assist State DOTs, MPOs, practitioners, and other interested organizations to advance livability. FHWA is also taking a leadership role in deploying research and best practices for design that meet mobility as well as safety and livability goals. FHWA focuses on innovative design to help do more with less and to better integrate roadway facilities into communities. Designs such as traffic calming, lane reductions, roundabouts, and innovative interchanges (such as the diverging diamond) are tools that FHWA researches and promotes through [Every Day Counts](#) and its partnership with AASHTO to help meet livability goals.

Sustainability Practices

Case Studies – Through its livability program, FHWA uses case studies to highlight innovative approaches to improving community quality of life through transportation investments. They are categorized according to the six livability principles of the Interagency PSC, with an additional category for crosscutting innovative approaches to fostering livability. The callout box on page 16 highlights one of these case studies, focusing on Arizona DOT's use of innovative highway materials to support livability.

Fostering Livable Communities Newsletter – This publication provides transportation professionals with real-world examples to help them improve the relationship between transportation agencies and communities. The articles are written by practitioners working in the field and draw heavily from the Interagency PSC for ideas and contacts. The content of the newsletter focuses on recent and current events and programs.

Livable Communities Discussion Board – The Livable Communities Discussion Board is an online public forum that allows users to participate in discussion threads and engage with colleagues on questions and ideas related to livable communities. Users of the site include practitioners in public, private, and non-profit agencies at the local, State, and Federal levels, who are interested in creating more livable communities by providing more transportation choices, encouraging access to good jobs and affordable housing, supporting quality schools, and promoting safer streets and roads. Participants come from a range of fields, including transportation, land use, housing, environment, and economic development.

Context Sensitive Solutions (CSS) – [CSS](#) is a collaborative, interdisciplinary approach that requires stakeholders to provide a transportation facility that fits its physical setting and preserves scenic, aesthetic, historic, and environmental resources, while maintaining safety and mobility. The CSS approach addresses the total context

within which a transportation facility is planned, implemented, maintained, and operated. Implementing CSS supports all of the triple bottom line sustainability principles by ensuring that environmental resources, community values, and economic context of a project are considered during project development. FHWA is committed to advancing CSS nationwide through quarterly newsletters, monthly webinars, and supporting a [Community of Practice website](#). The objective is to improve the environmental quality of transportation decisionmaking by incorporating CSS principles in all aspects of planning and the project development process.

Looking Forward

In the near future, FHWA will continue to provide a broad scope of resources to advance livability working through the Office of Human Environment. FHWA will provide additional information to State and local stakeholders through the continued dissemination of the quarterly FHWA Livability Newsletter, promotion of case studies and fact sheets, an email digest with information related to the human environment, and management of the livability discussion board. Additionally, FHWA is refining its Community Vision Metric livability performance measure tool. The tool is an electronic database that allows users to choose specific categories and attributes to identify livability performance measures. It enables users to search for a specific performance measure relevant to their unique circumstances, communities, and quality of life goals. The tool prioritizes livable community attributes on a voluntary basis.

Arizona Livability Case Study

This case study illustrates the use of innovative highway materials to support livability. Arizona Department of Transportation (ADOT) began a pilot program in 2003 to see how well rubberized asphalt would reduce traffic noise. Using sustainable, renewable technologies such as rubberized asphalt promotes highway's role in livability. Creating pavement that is smoother, safer, and quieter is one way Arizona has improved the quality of life for its residents. Public response was so positive that ADOT eventually used rubberized asphalt on the entire Phoenix Freeway system. Figure 5 shows the placement of 1" thick Rubberized Pavement, also known as quiet pavement, on concrete to reduce the noise on Interstate 10 near Phoenix, Arizona.



Figure 5: Rubberized Pavement on Interstate 10 near Phoenix, Arizona. (Courtesy of ADOT)

3.4.3 Multimodal Transportation

Overview

Multimodal refers to a transportation system that provides travelers with well-connected and seamless bicycle, pedestrian, and transit networks, in addition to motor vehicle infrastructure. A multimodal transportation network supports all of the triple bottom line sustainability principles by increasing transportation options and reducing traffic congestion and emissions, while encouraging the use of active modes to enhance public health. Through legislation, guidance, funding, training, technical assistance, and other endeavors, FHWA is actively supporting and enhancing multimodal transportation networks throughout the United States. Advancing multimodal transportation is a crosscutting objective of many FHWA offices including the Office of Human Environment, the Office of Planning, and the Office of Safety.

Sustainability Practices

Planning for Bicycling and Walking – State DOTs and MPOs are required by Federal law to consider and plan for the transportation needs and safety of those who use or would like to use non-motorized transportation modes. This includes providing pedestrian and bicycle access to transit services as well as expanding the destinations non-drivers can reach conveniently and safely. Currently, the FHWA Planning Oversight and Stewardship Team within the Office of Planning is sponsoring a joint project with the Volpe Center to identify, summarize, and share noteworthy statewide bike plans, policies, and projects.

Pedestrian and Bicyclist Safety – FHWA's [Office of Safety](#) develops projects, programs, and materials for use in reducing pedestrian and bicyclist fatalities. Since 2004, the Office of Safety has been working aggressively to reduce pedestrian deaths by focusing extra resources on the cities and States with the highest pedestrian fatalities and/or fatality rates. [Pedestrian safety focus cities](#) were selected based on the number of pedestrian fatalities or the pedestrian fatality rate per population. States with a focus city were automatically identified as focus States. As part of this effort, FHWA created a guidance document entitled "How to Develop a Pedestrian Safety Action Plan," which provides a process for State and local officials to start to address pedestrian safety issues. The callout box on page 18 highlights the Pedestrian Safety Plan developed by Pinellas County, Florida. In addition, FHWA offers free technical assistance and courses to each of the States and cities, and free quarterly webinars on subjects of interest, which are available for free to other States as well. The training is available at a cost to non-focus States and cities through the [Pedestrian and Bicycle Information Center](#), and is also available through the National Highway Institute (NHI). Additional resources to support pedestrian and bicyclist safety and mobility, such as Road Safety Audit materials, can be found on the Office of Safety website.

The Office of Safety also offers resources on its website to support pedestrian and bicyclist safety and mobility. One such resource is "[A Resident's Guide for Creating Safe and Walkable Communities](#)" that includes information, ideas, and resources to help residents learn about issues that affect walking conditions; find ways to address or prevent these problems; and promote pedestrian safety. The guide provides examples from other communities that are working to improve pedestrian safety. It contains fact sheets, worksheets, and sample materials that can be distributed or adapted to meet the needs of a community.

Bicycle and Pedestrian Initiatives – FHWA's Livability Team leads the [Office of Human Environment's pedestrian and bicycle initiatives](#). The team is spearheading an intra-office working group to provide information and outreach about [flexibility in pedestrian and bicycle facility design](#) via webinars, case studies, fact sheets, and white papers. The Livability Team will be developing a national resource on cycle track planning and design best practices, while also working to update the pedestrian and bicycle provisions in the Code of Federal Regulations and coordinating with partners such as AASHTO, National Association of City Transportation Officials, and ITE.

Transportation Alternatives Program (TAP) MAP-21 Guidance – The Office of Human Environment issued [guidance](#) in June 2013 for the TAP to detail the program’s requirements and provisions. The TAP will be an important source of funding for bicycle and pedestrian projects. The TAP provides funding for programs and projects defined as transportation alternatives, including on and off-road pedestrian and bicycle facilities, infrastructure projects for improving non-driver access to public transportation and enhanced mobility, community improvement activities, and environmental mitigation; recreational trail program projects; Safe Routes to School projects; and projects for boulevards largely in the ROW of former divided highways.

Looking Forward

This year, the Office of Planning will complete its project related to noteworthy practices of State DOTs to create and execute plans, policies, and projects to advance bicycling. The Office of Safety will continue to provide resources and assistance to States and cities to reduce pedestrian fatalities. The Office of Human Environment will be conducting outreach and providing information about design flexibility for bicycle and pedestrian projects, developing a planning and design information resource for cycle tracks, and revising FHWA’s bicycle and pedestrian regulations.

Pinellas County Pedestrian Safety Plan

In 2008, stakeholders in Pinellas County, Florida attended one of the first Pedestrian Safety Action Plan workshops. FHWA pedestrian safety experts used a template based on the national guide to help participating engineers, planners, law enforcement professionals, and other stakeholders develop a comprehensive plan for addressing pedestrian safety. Building off this plan, Pinellas County and FDOT invested more than \$4 million for numerous countywide pedestrian safety efforts, including countdown signals, high-visibility crosswalks, pedestrian and school safety audits, a midblock crossing study and improvements, a multimedia educational campaign, and a pedestrian law enforcement program. Figure 6 shows before and after photos representing some of the enhancements included as part of Pinellas County’s pedestrian safety improvements.



Figure 6: Before and after photos of pedestrian crossing enhancements in Pinellas County, Florida. (Courtesy of the Pinellas County MPO)

3.4.4 Integrating Transportation and Land Use

Overview

Integrating transportation planning with economic development and land use supports the economic triple bottom line sustainability principle by creating opportunities to improve access and mobility, while increasing the social, environmental, and economic returns on both public and private investments in transportation projects and programs. FHWA's Office of Planning offers resources to transportation and land use professionals, elected officials, stakeholders, and the public to more [successfully coordinate land use and transportation](#).

Sustainability Practices

Toolkit for Linking Land Use and Transportation Decisionmaking – This [toolkit](#) provides a wide array of case studies and examples of what organizations and jurisdictions across the country are doing to better integrate and coordinate land use and transportation planning and project implementation. The toolkit is designed to assist MPOs and regional planning organizations, State DOTs, transit agencies, and other organizations involved in the transportation planning process in incorporating land use considerations into their planning and project development activities. The toolkit also serves as a resource for local government land use and transportation planners, community groups, and others who wish to better understand and implement linkages between transportation and land use planning. Many of the tools are relevant to making neighborhoods, communities, and human/natural systems more sustainable. Many of the processes, approaches, and programs described in this toolkit were supported by or funded through FHWA/FTA programs.

Transportation Planning Capacity Building (TPCB) Program – The [TPCB Program](#) is designed to help decisionmakers, transportation officials, and staff resolve the complex issues they face when addressing transportation needs in their communities. This comprehensive program for training, technical assistance, and support targets State, local, regional, Tribal governments, transit operators, and community leaders. Many of the reports, studies, and summaries of peer exchanges developed as part of the TPCB Program relate to sustainability and emerging areas of interest within the transportation community such as better integrating land use and transportation (see case study on page 20). The Land Use and Transportation Linkages category, a focus area for peer exchanges and the Transportation Planning Excellence Awards, encompasses plans, projects, or planning processes that link land use planning, development, and investment to objectives of both short- and long-range transportation planning and programming.



Looking Forward

FHWA will continue to offer useful resources, website links, and other program information including tools and techniques, examples, and case studies that address the growing demand for delineating the interrelationships between land use and transportation. This information will help transportation and land use professionals, elected officials, stakeholders, and the public to more successfully coordinate land use and transportation planning and decisionmaking.

Community and Transportation Linkage Planning Program, Albany, New York

The Community and Transportation Linkage Program, overseen by the Albany MPO, helps local governments better support community transportation needs by providing assistance in developing and adopting local land use plans, highway and transit system concepts, zoning ordinances, and pedestrian and bicycle accommodations. Since 2000, 76 studies have been funded, including the Schenectady Route 5 Transit Gateway Study (Figure 7), with a combined financial commitment from Federal, State, regional, and local resources of over \$5 million.



Figure 7: Conceptual land use plan for the Schenectady Route 5 Transit Gateway Study in the city of Schenectady, New York. (Courtesy of Capital District Transportation Committee Metropolitan Planning Organization)

3.5 Financial Assessment

3.5.1 Financial Planning and Fiscal Constraint

Overview

[Financial planning and fiscal constraint](#) have remained key components of transportation planning and program development since enactment of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and have been carried through to the most recent transportation authorization, MAP-21. Financial planning is the process of defining and evaluating funding sources, sharing the information among transportation agencies and policy makers, and deciding how to allocate those funds. Fiscal constraint provisions within Federal law require that revenues (from Federal, State, local, and private sources) forecasted through financial planning and programming, are reasonably expected to be available to implement the projects and programs that come out of metropolitan and statewide planning processes. Additionally, MPOs and States should understand these funding considerations while also taking into account the operation and maintenance of the existing highway and transit systems.

The primary purpose of requiring transportation agencies to develop realistic financial budgets, for the short and longer term, is to help ensure that the transportation systems and projects that come out of today's planning process can be implemented and maintained over the long run. Planning for future transportation systems requires that these systems, and related projects and services, will be financially sustainable to serve the purposes and needs intended without creating unexpected financial burdens. Financial sustainability supports the economic triple bottom line sustainability principle by improving economic prosperity for current and future generations and ensuring that there are sufficient financial resources to advance the projects that help achieve broader goals of the community. The FHWA Office of Planning, with help from several other FHWA and U.S. DOT offices, has developed many resources including training and technical assistance materials to support realistic and viable financial plans for transportation planning.

Sustainability Practices

Major Project Financial Plan Guidance – In response to the enactment of MAP-21, FHWA issued [interim guidance](#) on the requirements for Major Project Financial Plans in September 2012. This interim guidance provided recommendations to amend the existing FHWA 2007 Financial Plan Guidance to incorporate the MAP-21 changes. Changes to the requirements for a Financial Plan include requiring a phasing plan when there are insufficient financial resources to complete the entire project and an assessment of a public-private partnership to deliver the project. FHWA issued a draft [Major Project Financial Plan Guidance](#) in August 2013. This draft guidance outlines the procedures FHWA will follow when reviewing and approving financial plans. Formal revisions to the 2007 Financial Plan Guidance to integrate more thorough implementation are underway and will be issued at a later date through the release of a final guidance document.

Fiscal Constraint in Long-Range Transportation Planning – Published in January 2012, FHWA's [Fiscal Constraint in Long-Range Transportation Planning](#) report presents and synthesizes the findings from eight case studies that examine best practices in financial planning applied in the long-range transportation planning process conducted for metropolitan area and statewide transportation systems. The case studies document experience and lessons learned that can advance understanding of financial planning elements that are most important to developing high-quality long-range transportation plans (LRTPs). The callout box on page 22 describes the 2005-2035 Georgia Statewide Transportation Plan, which was included in the FHWA Fiscal Constraint in Long-Range Transportation Planning report.

TPCB Focus Page –The [TPCB focus page](#) contains resources for fiscal constraint and financial planning for transportation, including links to regulations, guidelines, case studies, presentations, peer exchanges, and research. Materials included on the TPCB focus page are written specifically to help transportation agencies meet the financial planning and fiscal constraint requirements for metropolitan and statewide planning (23 USC 134 and 135), as well as the requirements of associated regulations.

Looking Forward

In light of new requirements under MAP-21 and the emerging focus on financial sustainability, FHWA will continue to offer guidance, support, and training on financial planning and fiscal constraint. A final Major Project Financial Plan Guidance document is anticipated to be published later this year.

Georgia Fiscal Constraint Case Study

The FHWA Fiscal Constraint in Long-Range Transportation Planning report includes a case study that examines the 2005-2035 Georgia Statewide Transportation Plan (GSTP). The GSTP is an example of two elements of financial planning best practice: (1) public involvement as an integral element of financial planning, and (2) rigorous revenue analysis and forecasting. With respect to public involvement, the outreach effort conducted in support of plan development included specific activities to collect information on public priorities related to financial planning.

The GSTP is being updated with recent revenue data serving as the basis of its financial forecasts. This forecasting includes consideration of new fuel efficiency standards and their potential impact on State motor fuel tax receipts. The GSTP will also provide a fiscally constrained plan, as well as an unconstrained financial forecast, consistent with the guidance for MPOs. Figure 8 shows the cover page of the 2005-2035 GSTP.



Figure 8: Cover image from the 2005-2035 GSTP. (Courtesy of Georgia DOT)

3.5.2 Economic and Life Cycle Cost Analyses: Benefit-Cost Analysis



Overview

Economic analysis in the context of sustainability and transportation investment decisions examines how to make the best use of constrained resources over time. It evaluates the return on investment (ROI) of alternatives to provide a sustainable transportation system. For public agencies, [benefit-cost analysis](#) (BCA) is used as a measure of ROI. Traditional BCA for transportation includes user benefits for travelers (reductions in delay and vehicle operating costs, and improvements in safety) and reductions in potentially adverse environmental effects (air quality, noise) along with capital, operations, preservation, and maintenance costs. The evaluation of costs is typically referred to as [life cycle cost analysis](#) (LCCA) and is part of BCA. The [U.S. DOT Tiger BCA Resource Guide](#) provides a reference for values on benefits to be used in the BCA.

FHWA's Office of Transportation Performance Management encourages the use of BCA for evaluating transportation investments. BCA is a critical component of a comprehensive project or program evaluation methodology. It allows transportation agencies to identify, quantify, and value the economic benefits and costs of highway projects and programs over a multiyear timeframe. Agencies are then better able to target scarce resources and put them to their best use in maximizing net-benefits to the public, and are more accountable for those decisions. Conducting an economic analysis supports the triple bottom line of sustainability by ensuring that user benefits exceed the investment costs for the project through analysis of impacts to safety, infrastructure condition, congestion, system reliability, freight movement, and environmental sustainability.

FHWA, through the Office of Transportation Performance Management and the Office of Infrastructure Research and Development (R&D), also promotes LCCA, a step in the BCA that allows transportation officials to evaluate the differential costs of alternative investment options for a given project. LCCA can be used to study either new construction projects or examine preservation strategies for existing transportation assets. Conducting a life cycle cost analysis promotes efficient use of materials and resources.

With the enactment of MAP-21 and its emphasis on transportation performance management, transportation agencies have been increasingly focused on utilizing economic analysis. To adhere to national performance goals, develop and submit plans to meet performance targets, and report on progress toward achieving targets, States and local agencies across the country will be drawing upon BCA and resources to quantify the impact of transportation decisions and investments, and assess ROI of transportation projects and programs.

Sustainability Practices

Roadway Investment Analysis 101 Workshop – FHWA offers a one-day workshop on the application of economic analysis to highway decisionmaking to State and local governments. This free workshop covers a broad range of economic subjects, including inflation, BCA, LCCA, traffic forecasts, and risk analysis. The workshop does not require prior training in economics.

BCA.net – Developed and funded by FHWA, this free web-based software application performs a BCA at the project level. The [BCA.net tool](#) facilitates the analysis of alternative strategies for highway management and improvement and supports resource allocation and investment decisions. It enables State and local decisionmakers to consider a broad range of design, timing, and strategic alternatives based on an array of benefit-cost measures. Benefit categories, such as time savings, reduction in injuries and loss of life, and reduced emissions, capture and quantify the social, economic, and environmental advantages of a particular project. BCA.net is best suited to evaluate small- to medium-scale highway capacity projects that are not anticipated to cause system-wide traffic

changes. In addition to managing the software, FHWA provides training and technical support to transportation agencies that use the tool.

Surface Transportation Efficiency Analysis Model (STEAM) – [STEAM](#) assesses the efficiency of multimodal transportation alternatives and demand management strategies on a corridor or regional level. This model employs economic methods linked with travel demand models and is useful in evaluating very large projects that would cause regional changes in traffic patterns, such as new expressways or major corridor enlargements. FHWA developed STEAM and provides it at no cost to transportation agencies. For an example of a State utilizing STEAM, see the callout box on page 25 discussing Florida’s use of BCA analysis.

National Bridge Investment Analysis Software (NBIAS) – At a network or system level, FHWA offers agencies the [NBIAS](#) to evaluate bridge investments. The software uses performance data every State currently collects on bridges to calculate performance trends, financial needs for maintaining specified performance levels, and the outcomes of various funding scenarios. FHWA offers this software free of charge, provides ongoing support to users, and facilitates NBIAS workshops upon request.

Bridge Life Cycle Cost Analysis (BLCCA) – MAP-21 has numerous sections that relate to bridge performance including the development and implementation of a State asset management plan for the NHS as well as bridge performance reporting. Given these additional performance requirements, FHWA provides State transportation agencies with guidance and resources to carry out [BLCCA](#). Including BLCCA in the overall decisionmaking process helps bridge engineers plot a course for bridge performance under budgetary constraints. Results from the BLCCA process can also assist agencies in developing a plan or program that supports long-term network goals based on expected funding levels.

RealCost – Developed and maintained by FHWA, this free Microsoft Excel based software tool supports the application of LCCA in the pavement project-level decisionmaking process. [RealCost software](#) automates the application of LCCA for pavement selection in accordance with FHWA best practice methods and enables the consideration of initial and future agency costs and road user impacts in making pavement investment decisions. Recognizing uncertainty is inherent with long-term projections, RealCost employs a stochastic framework for incorporating this uncertainty in the LCCA process. State highway and local public agencies have widely adopted RealCost for project-level pavement LCCA application. Additionally, though RealCost was developed with a focus on pavement applications, the software is equally applicable to project-level bridge investment decisionmaking and is being adopted for bridge LCCA applications. FHWA provides training and technical support to transportation agencies that use the tool.



Looking Forward

FHWA will continue promoting the application of economic analysis methods to highway decisionmaking by developing, collecting, and distributing relevant information and tools to the transportation community. FHWA will also develop and deploy analysis tools and provide resources and technical assistance to State highway agencies in conducting BCA and LCCA for infrastructure investment decisions. In the near future, FHWA will publish a number of documents, including various fact sheets on economic analysis topics and case studies of successful State and local applications of economic analysis, as well as sponsor peer exchanges, trainings, and workshops.

Florida Cost-Benefit Analysis Integration

In 2009, FDOT investigated the feasibility of integrating BCA procedures with the statewide travel demand modeling platform, Florida Standard Urban Transportation Model Structure (FSUTMS). FDOT carried out this assessment as incorporating cost-benefit analyses into travel demand modeling enhances project planning and prioritization. Researchers used FHWA's STEAM in order to determine the viability of cost-benefit analysis for Florida's Strategic Intermodal System (SIS). Researchers estimated the transportation efficiency benefits of the SIS at two points in the future, 2018 and 2030. The benefits included savings from reduced travel times, vehicle operating costs, accident costs, emissions, and other costs that would result from the implementation of the projects in the SIS over a 20+ year timeframe. Additionally, at the regional level, as part of the Central-East Palm Beach Mobility Study, FDOT performed a benefit-cost analysis for the I-95/State Route 710 interchange. FDOT used FHWA's STEAM software to quantify the regional benefits of the proposed interchange.

In recent years, FDOT has also developed the Florida Intelligent Transportation Systems Evaluation Tool (FITSEVAL). The tool is a state of the practice travel demand model post processor designed to estimate the benefit-cost of transportation operational planning (both ITS/non-ITS) projects from the State's standardized FSUTMS, which is available to use by FDOT, MPOs, and local governments.

3.6 Roadway Maintenance and Operations

3.6.1 Sustainable Pavements

Overview

FHWA is committed to advancing sustainability through the design, construction, preservation, and rehabilitation of highway pavements. Although primarily addressed by the work of the Office of Asset Management, Pavement, and Construction, many of FHWA's Program and Division Offices promote sustainability initiatives and employ sustainability practices related to highway pavements. This includes the [Sustainable Pavements Program](#), use of recycled materials, and application of warm-mix asphalt (WMA).



Sustainability Practices

Sustainable Pavements Program – Design, construction, and maintenance of highway pavements can create a wide assortment of environmental impacts related to water quality and supply, stormwater management, air quality, and heat absorption. To better address these potentially adverse environmental impacts and employ more sustainable materials and techniques, FHWA created the Sustainable Pavements Program. This program aims to increase the body of knowledge regarding sustainability of asphalt and concrete materials in pavement design, construction, and maintenance and to increase the use of sustainable technologies and practices related to pavements.

A Sustainable Pavements Technical Working Group (SP TWG) was established to provide technical assistance to FHWA program managers regarding sustainability issues as they relate to pavement materials. Members of the SP TWG serve as technical experts and provide technical input regarding the sustainability of pavement systems and materials. The SP TWG is composed of members from State DOTs, other public agencies, industry, and academia.

Towards Sustainable Pavement Systems: A Reference Document is currently being finalized and will be published and distributed later this summer. The document will provide clear information regarding sustainability practices, methods, and techniques for the design, construction, preservation, and maintenance of sustainable pavements and materials. The document will help an engineer or practitioner navigate the subject of sustainability while developing mixture designs, pavement structure designs, and construction, preservation, and maintenance techniques.

Recycled Materials and By-Products – Use of recycled materials in pavement construction advances sustainability and supports the environmental and economic triple bottom line sustainability principles through preserving resources and the natural environment, reducing waste, and providing a cost-effective material for constructing highways. FHWA, through the Office of Asset Management, Pavement, and Construction, has promoted the use of recycled materials in highway applications since 2002. FHWA has contributed to the development of a [Technology Deployment Plan](#) for using recycled concrete aggregates in concrete mixtures, and is interested in advancing the use of ternary concrete mixtures that use supplementary cementitious materials to reduce cement content. Supplementary cementitious materials include industrial by-products, such as fly ash.

Maximizing the use of [Reclaimed Asphalt Pavement](#) (RAP) is a major objective of highway agencies and the industry. RAP has been used for about 30 years; however, only with improved design, testing, and production methods have States recently been able to use high RAP percentages in all asphalt pavement layers. FHWA has produced publications, reports, and best practices, as well as conducted meetings of stakeholders and provided technical on-site project support and analysis to expand the use of RAP nationwide.

Effective reuse of industrial by-products in pavements (e.g. slag, rubber, and fly ash) is also a major emphasis of FHWA that can provide significant environmental benefits. For example, using fly ash in concrete can increase the life of roads by improving concrete durability and reduce the amount of industrial by-products that must be disposed in landfills. Through technology development and partnerships, FHWA advances reuse of industrial by-products in pavements while maintaining a high level of performance. The Office of Asset Management, Pavement, and Construction has a cooperative agreement with the American Concrete Institute. Through this agreement, training courses and materials are being developed to advance the use of ternary concrete mixtures in paving concrete. FHWA has also participated in pooled-fund studies investigating ternary concrete mixtures for use in highway construction.

Another pavement recycling effort, known as in-place material recycling, is a very mature technology for use on lower-volume roads. However, recent emphasis and improvements have made it viable on heavily trafficked roadways. FHWA's efforts are focused on facilitating the implementation of various in-place pavement recycling methods by helping to refine existing design, testing, and construction techniques, providing technical training, and co-sponsoring national conferences and regional workshops. Activities include sponsoring the annual National In-Place Asphalt Recycling Conference with the Asphalt Emulsion Manufacturers Association-Asphalt Reclaiming Recycling Association, revising the existing NHI course on in-place recycling, and completing a manual on in-place recycling begun in 2012.

The callout box on page 28 provides a summary of activity undertaken by the Western Federal Lands to recycle pavement in highway projects.

Warm-Mix Asphalt – **WMA** is the generic term for a variety of technologies that allow producers of hot-mix asphalt (HMA) pavement material to lower temperatures at which the material is mixed and placed on the road. Application of WMA offers several sustainability benefits, including reducing energy consumption, providing good material workability, and lowering emissions from burning fuels, fumes, and odors at plants and paving sites. WMA technology was recognized and advanced by FHWA starting in 2004. Through efforts with industry, sponsoring an international scan tour and demonstration, and analysis at numerous on-site projects, the technology was part of the Every Day Counts effort in 2011, and has become a normal industry practice. It is envisioned that WMA technology will, in the near future, replace most of the HMA used in this country. Current efforts are focused on evaluating performance, quantifying environmental benefits, developing design practices, testing performance specifications, providing technical guidance, and disseminating information. Using WMA can reduce energy consumption during the manufacturing of asphalt pavement mixture by an average of 20 percent, which decreases total life cycle greenhouse gas (GHG) emissions. Since 2004, the partnering approach for this effort included proposing and assisting in six separate National Cooperative Highway Research Program (NCHRP) studies, conducting a semi-annual WMA meeting of stakeholders, and providing technical on-site project support and analysis. States are implementing the results of completed NCHRP projects on WMA design and testing. WMA usage in 2010 comprised over 17 percent of all HMA produced in this country.

Looking Forward

Under the Sustainable Pavements Program, FHWA is developing a technology transfer outreach plan, which will include enhancing information on sustainability on the program website, creating webinars, and producing technical briefs. Technology transfer activities will educate engineers on pavement and materials sustainability within the greater context of highway sustainability and livability. FHWA will also be educating engineers and practitioners on Life Cycle Assessments for pavements.

Western Federal Lands Pavement Recycling

Western Federal Lands (WFL) Highway Division has participated in pavement recycling efforts since the 1980s. Over the years, WFL has utilized numerous recycling processes such as Cold In-Place Recycling (CIPR), Full-Depth Reclamation, Cement Treated Base, and Foamed Asphalt for many of its projects. For example, the Lakeside-Nelson Road Project in Helena National Forest in Montana used Foamed Asphalt (Figure 9), while the Wise River – Polaris Road Project just south of Wise River, Montana used CIPR.



Figure 9: Construction vehicle on Lakeside-Nelson Road in Helena National Forest. (Courtesy of WFL)

3.6.2 Road Weather Management

Overview

Through its [Road Weather Management Program \(RWMP\)](#), the FHWA Office of Operations seeks to better understand the impacts of weather on roadways and promote strategies and tools to mitigate those impacts.

Implementing an effective and efficient road weather management program supports all of the triple bottom line principles of sustainability by improving safety, increasing mobility, reducing delays and traffic interruptions, increasing labor force productivity, and reducing impacts of materials used for management on the human and natural environments.



Sustainability Practices

Planning for Systems Management & Operations as part of Climate Change Adaptation – One of the gaps in the currently available literature and guidance is an assessment of how agencies’ system operations and maintenance activities adapt to climate change. The challenges climate change poses to infrastructure design and long-term land use planning are more easily described than how an agency needs to adapt its day-to-day operations strategies given the varied nature of the changing climate and travelers’ subsequent responses. In March 2013, the Office of Operations released a white paper entitled “[Planning for Systems Management & Operations as part of Climate Change Adaptation](#).” This paper summarizes potential climate change effects on transportation system management and operations. It also highlights potential issues, challenges, and approaches for State DOTs and local operating agencies to consider under shifting climate-related conditions. In particular, the paper provides options for agencies to assess transportation system vulnerabilities and recommends potential changes that could make transportation operations more resilient to climate change. FHWA plans to carry out gap analysis research as a follow-up to this report.

Road Weather Management Program Performance Measurement: 2012 Update – In 2010, the RWMP conducted a study with stakeholders from the transportation and meteorological communities to define 11 performance measures that would enable FHWA to determine the extent to which its goals were being met. Since then, FHWA has led a task to update these performance measures using information available in 2012 and created a 2012 RWMP performance assessment report. The 2012 RWMP update includes a discussion on the background for the development and revision of RWMP performance measures, the evolution of the measures since 2008, including the approach and data sources used, a description of each RWMP objective and the quantification of each associated measure, and an overall assessment of the RWMP based on the performance measures tracked. The [final report](#) was released in August 2013. One of the key objectives identified in this report focused on engaging the climate change community in transportation maintenance and operations. One performance measure was selected for this category to reflect the role that road weather management plays in climate change adaptation and sustainability. This performance measure tracks the number of public agencies meeting INVEST and/or sustainability criteria related to road weather management.

Best Practices for Road Weather Management – Published in June 2012, Version 3.0 of this [report](#) contains 27 case studies of systems in 22 States that capture state-of-the-art practices to improve roadway operations under inclement weather conditions. Each case study has six sections including a general description of the system, system components, operational procedures, resulting transportation outcomes, implementation issues, as well as contact information and references. Many of the case studies showcase innovative technologies and procedures for minimizing the impact of operations and maintenance activities on roadways, such as the Iowa DOT Salt Usage Dashboard (see the callout box on page 31 for more information).

Winter Roadway Maintenance – FHWA has placed a high priority on identifying and deploying innovative, cost-effective techniques and technologies for winter roadway maintenance. The RWMP advances these efforts through involvement in the AASTHO Winter Maintenance Technical Service Program, as well as participation in peer exchanges and symposiums. Most recently, FHWA worked with the AASTHO Winter Maintenance Technical Service Program to develop a four-year work plan that includes a major emphasis on exploring opportunities to integrate sustainability into winter operations. One of the tasks under this overarching objective is to seek out examples of winter maintenance practices and programs that demonstrate sustainability and post them on AASHTO's [Center for Environmental Excellence website](#).



Looking Forward

FHWA Office of Operations will continue to work on efforts to better address climate change and sustainability as part of the RWMP. One planned activity includes preparing a gap analysis related to the “Planning for Systems Management & Operations as part of Climate Change Adaptation” white paper. Additionally, the FHWA Office of Operations is moving forward with several activities and programs to further winter maintenance efforts related to climate change and sustainability.

Iowa Salt Usage Dashboard

Spreading salt on road surfaces is one of the primary means of removing and preventing accumulation of snow and ice. The Iowa DOT developed a management dashboard featuring actual salt usage during maintenance operations compared to estimated usage amounts, based on road weather conditions (Figure 10). Managers monitor this dashboard to make sure current usage is reasonable given the weather, and is within Iowa DOT's standard application rate guidelines. This tool was implemented in August 2011 before the start of the winter season. Already, the tool is encouraging and allowing maintenance staff to keep a tighter control on salt usage. This dashboard was featured as part of FHWA's Best Practices for Road Weather Management.

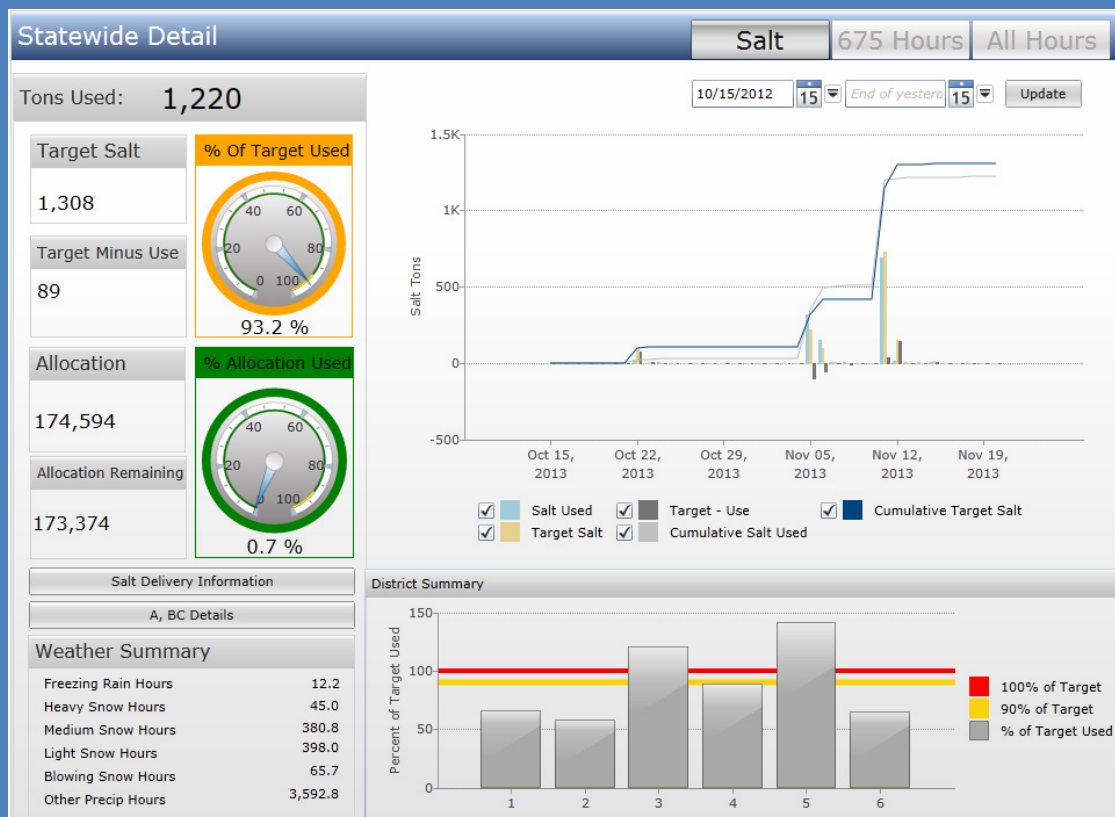


Figure 10: Image taken from Iowa DOT Salt Usage Dashboard showing salt use information. (Courtesy of Iowa DOT)

3.7 Climate Change

3.7.1 Mitigation and GHG Emissions Analysis

Overview

Generally, concern about climate change and sustainability is growing among many local governments, regional planning agencies, and some State governments. Those entities are contacting FHWA to request relevant technical assistance and other resources. Failure to address GHG emissions and lessen the impact of climate change has had and will likely continue to have a detrimental impact on the economy, environment, and society in general. Efforts to mitigate climate change and reduce GHG emissions contribute to all of the triple bottom line of sustainability principles by improving public health, reducing energy usage and costs, and reducing the impacts from associated emissions.

Through the FHWA Office of Natural Environment's Sustainable Transport and Climate Change (STACC) Team and the Resource Center, FHWA provides guidance and technical assistance to transportation agency partners on mitigation strategies and GHG analysis. FHWA also conducts training, webinars, and on-site workshops that address sustainability, livability, and climate change in the transportation planning process.

Sustainability Practices

Development and Pilots of the Energy and Emissions Reduction Policy Analysis Tool (EERPAT) – [EERPAT](#) was developed to help State transportation agencies analyze GHG reduction scenarios and alternatives for use in the transportation planning process. The tool assists States in developing State climate action plans, scenario planning exercises, and measuring the reduction potential of various transportation strategies to meet State GHG reduction goals and targets. The tool also allows agencies to quickly assess policy interactions in hundreds of scenarios. Many States are seeking to perform this type of analysis, but lack the tools to do so. EERPAT was developed to fill this gap. The tool uses GreenSTEP, developed by the Oregon State DOT, as its foundation, and is expected to have regular enhancements moving forward. Currently, the tool is being piloted at the Washington, Colorado, Vermont, and Maryland DOTs. Preliminary results of the pilots will be available later this summer. FHWA will add results and outcomes of the pilots to the EERPAT website as they become available.

Construction and Maintenance GHG Calculator – FHWA is currently developing a calculator to estimate GHG emissions from the construction and maintenance of transportation facilities. The tool is intended to help users voluntarily estimate energy use and GHG emissions in the context of metropolitan and State-level LRTPs, National Environmental Policy Act (NEPA) assessments of transportation projects, and the transportation programming process; as well as to identify opportunities to reduce construction and maintenance emissions. Several State DOTs and MPOs piloted a draft version of the tool in fall of 2013. The final tool is expected to be publicly available in fall of 2014 on the [FHWA Climate Change Mitigation website](#).

Handbook for Estimating GHG Emissions in the Transportation Planning Process – This [publication](#) is designed to provide information on how to analyze on-road GHG emissions at the State and regional level and how to incorporate those analyses into transportation planning efforts. The handbook is intended to help State DOTs and MPOs understand the possible approaches, data sources, and step-by-step procedures for analyzing GHG emissions. It provides an overview of estimating GHG emissions in the planning process and identifies and describes several key methodologies used to estimate emissions. It also provides a discussion of the strengths and weaknesses of each methodology and includes a section designed to help users identify the methodology best suited for their situations. The handbook was released in July 2013 and is available on the FHWA Climate Change Mitigation website.

A Performance-Based Approach to Addressing Greenhouse Gas Emissions – Released in December 2013, this [handbook](#) is designed to be a resource for State DOTs and MPOs engaged in performance-based planning and programming to integrate GHG performance measures into transportation decisionmaking. It discusses key approaches for integrating GHG emissions into a performance-based planning and programming approach, considerations for selecting an appropriate GHG performance measure, and using GHG performance measures to support investment choices and to enhance decisionmaking. The performance-based approaches outlined in this handbook reinforce FHWA's commitment to helping State agencies and MPOs make more efficient investments, increase accountability and transparency, and establish outcome-based programs, as outlined in MAP-21.

Transportation, Land Use, and Climate Change Scenario Planning Project – The project will inform transportation and land use decisionmaking in a selected study area by using scenario planning to analyze strategies to reduce GHG emissions and adapt to climate change impacts. The goals of the project are to: (1) advance climate change analysis in scenario planning; (2) develop a transferrable process; (3) build partnerships; and (4) impact decisionmaking. The project will utilize lessons learned from an earlier study that focused on Cape Cod, Massachusetts. The selected site for this [project](#) is Albuquerque, New Mexico (see callout box on page 34 for more information).

Feasibility and Implications of Electric Vehicle Deployment and Infrastructure Development – FHWA recently initiated a [study](#) to evaluate the prospects and expectations for short- and long-term deployment of electric vehicles (EVs). FHWA has undertaken this study for the following reasons: (1) to provide information on the expected market penetration and viability of EVs in both the short and long term; (2) to analyze the implications for FHWA's mission; (3) to analyze the potential financial implications for available highway revenues; and (4) to assist State and local transportation agencies in understanding if, and how, transportation infrastructure may have to change to facilitate, support, and/or provide emergency response to EVs.

Eight EV market penetration scenarios have been developed as part of this project, which will be used as input to analyze the implications of EV deployment and infrastructure development on FHWA's mission and revenue impacts. A report related to this EV work will be completed later this summer.



Looking Forward

In addition to the work described in this section that is anticipated to be completed this year, FHWA, through its STACC Team, is also currently addressing work pertaining to GHG performance measurement.

Central New Mexico Climate Change and Scenario Planning Pilot

Planning for a rapidly growing region like Central New Mexico in an arid climate means addressing challenges stemming from congestion, sprawl, energy use, vehicle emissions, and water scarcity exacerbated by climate change. A unique partnership between Federal agencies and the Mid-Region Metropolitan Planning Organization, located in Albuquerque, New Mexico, is embarking on a project to help the region address these intertwined challenges using the powerful analytical tool of scenario planning. Scenario planning allows participants to consider the impacts of growth and evaluate the costs and benefits of various future scenarios. The project will influence transportation and land use decisionmaking in the Central New Mexico region by using scenario planning to analyze strategies to reduce carbon pollution and prepare for the impacts of climate change. Figure 11 shows stakeholders participating in a Scenario Planning Workshop.



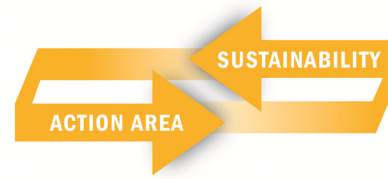
Figure 11: Stakeholders participate in a Regional Themes Identification Exercise at an FHWA Scenario Planning Workshop in June 2013. (Courtesy of the Volpe Center)

3.7.2 Infrastructure Resiliency

Overview

Resiliency has been defined as the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events.

Enhanced resilience allows better anticipation of disasters, better planning to reduce disaster losses, and faster recovery after an event. Planning for infrastructure resiliency in the face of potential hazards supports all of the triple bottom line principles of sustainability by reducing spending from infrastructure replacement, improving the safety and security of multimodal transportation system users, and providing energy savings from long-lasting investments, among others. Creating a more resilient transportation system is a priority for FHWA, especially as it relates to adaptation to climate change. The STACC Team and the FHWA Office of Infrastructure are currently spearheading efforts to advance sustainability through [infrastructure resiliency projects and programs](#).



Sustainability Practices

Climate Change Resilience Projects – FHWA is partnering with State DOTs, MPOs, and Federal Land Management Agencies to pilot approaches to conduct climate change and extreme weather vulnerability assessments of transportation infrastructure and analyze options for adapting and improving resiliency. This pilot program is being jointly sponsored by the FHWA Office of Environment, Planning, and Realty, and the Office of Infrastructure. See the callout box on page 36 for information on a Climate Resilience Pilot project in Austin, Texas.

Gulf Coast Study – This research comprises a comprehensive, multiphase study of climate change impacts in the Central Gulf Coast region. Phase 1 (completed in 2008) examined the impacts of climate change on transportation infrastructure at a regional scale, while Phase 2 (ongoing, with expected completion later this summer) focuses on a smaller region of enhancing regional decisionmakers' abilities to understand potential impacts on specific critical components of infrastructure and to evaluate adaptation options.

HEC-25 - Highways in the Coastal Environment – The FHWA Office of Infrastructure is developing a second volume of FHWA's existing Hydraulics Engineering Circular 25 (HEC-25), "Highways in the Coastal Environment." This second volume (HEC-25b) will provide technical guidance and methodologies on how to incorporate extreme event and climate change considerations when addressing highway planning and design in coastal environments. HEC-25b has a national scope, focusing on the different issues associated with Gulf Coast, Atlantic Coast, Great Lakes, West Coast, and Pacific areas of the U.S. transportation system. FHWA anticipates that there will be multiple uses for this information, including risk and vulnerability assessments, design procedures, and planning activities.

Hurricane Sandy Follow-up and Vulnerability Assessment and Adaptation Analysis – The objective of this project is to assess the impacts of October 2012's Hurricane Sandy, (and to a lesser extent, Hurricane Irene, Tropical Storm Lee, and the Halloween Nor'easter in 2011) on the transportation assets within the greater New York-New Jersey-Connecticut metropolitan region. The project will also assess the vulnerability of transportation assets to extreme weather events and the possible future impacts of climate change and identify adaptation strategies to increase the resilience of the transportation system.

Looking Forward

The STACC Team will continue to host webinars, workshops, and peer exchanges related to infrastructure resiliency and climate change adaptation. The Office of Infrastructure Research and Development intends to further develop novel connection systems that facilitate the construction of resilient bridge structures. Research to facilitate the drafting of structural design provisions for these advanced connections and to demonstrate appropriate connection systems for a variety of bridge types is underway.

Capital Area Metropolitan Planning Organization (CAMPO) Climate Resilience Pilot

CAMPO, the Austin area MPO, was selected as a 2013-2014 Climate Resilience Pilot. Using FHWA's framework to conduct a vulnerability assessment of transportation infrastructure in their region, CAMPO will consider temperatures and extreme heat, extreme precipitation and flooding, drought, and wildfire. At the conclusion of the study, CAMPO will conduct a regional symposium to broadly share the report findings. Figure 12 shows the wide impact of a major fire in Bastrop County, Texas.



Figure 12: Major fire in Bastrop County, Texas in 2011 along State Highway 71. (Courtesy of CAMPO)

3.7.3 Energy Efficiency and Renewables

Overview

FHWA is spearheading numerous efforts to advance energy efficiency and promote the use of renewable energy sources. Many of these efforts focus on research and development of emerging technologies. Reducing energy and fossil fuel consumption from the transportation sector provides multiple sustainability benefits and supports all of the triple bottom line of sustainability principles by reducing fuel spending, GHG emissions, and energy dependence. Moreover, converting to renewable energy sources contributes to FHWA's environmental and economic principles by reducing fossil fuel usage and associated emissions, and reducing long-term energy costs.

Through the FHWA Office of Natural Environment's STACC Team, Office of Real Estate Services, and the Office of Infrastructure R&D, FHWA is overseeing projects to bolster energy efficiency and increase the use of renewable energy sources.

Sustainability Practices

Small Business Innovation Research (SBIR) Contract with Solar Roadways Inc. – FHWA is leading a SBIR project called [Solar Roadways](#). The intent is to demonstrate the potential for developing structural pavement panels that can convert solar radiation to electricity and disseminate the power to meet local electricity demands. Each panel would be controlled by an integrated circuit and wired with LED lighting for programmable demarcation or messaging and would be able to be illuminated from below rather than painted on the surface. Some of the energy collected might also be applied to prevent snow and ice buildup in northern climates via resistance heating similar to a car's rear window defogger. The panels would be mounted on existing roadway surfaces and composed of materials that maximize use of recyclables. Initial evaluation and demonstration will be conducted on a parking lot near the Solar Roadways facility in Sagle, Idaho.

Exploratory Advanced Research (EAR) Program “Roadway Wind-Solar Hybrid Power Generation and Distribution System Towards Energy Plus Roadways” – This [cooperative agreement](#), overseen by FHWA and awarded to the University of Nebraska-Lincoln, focuses on examining technology that could lead to transformational changes in the way the public ROW is used to harvest and utilize renewable energy. This project evaluates the potential of small wind turbines combined with solar cells to provide an independent electricity source for traffic signals and lighting on existing urban and suburban infrastructure. The system would be a “microgrid” able to interact with and contribute to the “macrogrid” but also be independent in the case of a power outage.

EAR Program “New Technologies for Development of Renewable Energy in the Public Right-of-Way” – When a vehicle is driven on a road, part of its driving energy is turned into mechanical energy in the form of deformation and vibration. The energy is ultimately lost as heat, but part of this excess mechanical energy may be harnessed and converted into usable energy. This [project](#) examines a kinetic-to-electric conversion (KEEC) system that could be used to harvest this mechanical energy as vehicles pass over. The technology implemented by the KEEC system exploits the electric charge that accumulates in certain solid materials when a force or stress is applied. The aim is to use this technology to capture excess kinetic energy from within pavements up to 1.5 inches below the surface.

Alternative Uses of Highway Right-of-Way – Published in January 2012, this [paper](#) investigates the state of the practice in accommodating renewable energy technologies and alternative fuel facilities within the highway ROW, both activities that might help curb climate change. This report provided transportation agencies with information to better enable them to consider the implications and evaluate the feasibility of implementing renewable energy

and fuel options in the ROW. The findings presented in this report are based on a review of the relevant literature and a series of interviews with stakeholders representing State highway ROW renewable energy and alternative fuel facility projects that are in varying stages of completion and that utilize, or are pursuing, a range of technologies. In addition to creating an interactive website on highway renewable energy projects, FHWA also sponsored a pilot project to provide technical assistance to States seeking to pursue alternative uses of ROW. See the callout box below for an example of a project in Oregon focused on generating energy in the highway ROW.

Looking Forward

Through existing and planned research and deployment efforts, FHWA will continue to advance new technologies that promote energy efficiency, reduce fossil fuel use, and support use of renewables. FHWA is also committed to continuing to assist State DOTs with determining what is necessary in establishing an infrastructure that supports and maximizes the benefits of EV deployment, including reducing energy consumption and improving the sustainability of the transportation system (for more information see the Mitigation and GHG Analysis section).

Oregon Solar Highway

In 2008, the Oregon Department of Transportation (ODOT) partnered with the State's largest utility, Portland General Electric (PGE), to create the Nation's first solar highway. The program's first solar highway project, located inside the interchange of Interstates 5 and 205 in Tualatin, Oregon, incorporates 594 solar panels and produces over 120,000 kilowatt-hours (kWh) annually (Figure 13). Further down the interstate is the Baldock Solar Station, the Nation's largest solar highway project, which features a 6,994 solar panel array on roughly seven acres of ODOT-owned land. The Baldock project produces almost 2 million kWh annually. Both projects feed directly into the PGE grid, providing renewable power to PGE customers, including ODOT. The Baldock project provides ODOT a share of the Renewable Energy Certificates generated. The projects are licensed for at least 25 years. If the land is needed for transportation purposes before then, ODOT has the right to require removal of the solar panel arrays.



Figure 13: Aerial view of the Oregon Solar Highway. (Courtesy of Oregon DOT)

3.8 Air Quality

Overview

Improving air quality supports the environmental and social principles of sustainability by reducing emissions and enhancing quality of life. In 1990, Congress amended the Clean Air Act to strengthen National efforts to attain the National Ambient Air Quality Standards (NAAQS). The amendments required reductions in tailpipe emissions, initiated stronger control measures in areas that failed to attain the NAAQS (nonattainment areas), and provided for a stronger connection between transportation and air quality planning through the transportation conformity provision. Shortly thereafter, in 1991, the Congestion Mitigation and Air Quality Improvement (CMAQ) program was created with ISTEA in order to fund transportation projects or programs that will contribute to attainment or maintenance of the NAAQS for ozone, carbon monoxide (CO), and particulate matter (PM). The FHWA Office of Natural Environment works to further the goals of improving air quality through the implementation of the CMAQ program and addressing the requirements of the Clean Air Act requirements.

Sustainability Practices

Congestion Mitigation and Air Quality Improvement (CMAQ) Program –The [CMAQ program](#) supports surface transportation projects and other related efforts that provide air quality improvements and relieve congestion. Jointly administered by FHWA and FTA, the CMAQ program has provided nearly \$30 billion to State DOTs, MPOs, and other sponsors across the country to support approximately 29,000 transportation projects.

As does its predecessor legislation, MAP-21 provides funding primarily to nonattainment or maintenance areas for ozone, CO, and/or PM to support transportation projects or programs that will contribute to the attainment and maintenance of these NAAQS. MAP-21 provides just over \$2.2 billion in CMAQ funding for each year of the authorization (fiscal years 2013 and 2014). In November 2013, FHWA issued [Interim Program Guidance Under MAP-21](#) to provide updated information on the CMAQ program, including authorization levels and apportionment changes, project eligibility provisions, and performance management additions. The guidance document updates and replaces the 2008 CMAQ Program Guidance to reflect amendments made by MAP-21. For additional information, see [FHWA's MAP-21 website](#).

Transportation Conformity – A provision in the Clean Air Act, transportation conformity is a process to ensure that Federal funding and approval goes to those highway and transit activities that are consistent with State's air quality goals to achieve attainment of the NAAQS. Conformity applies to metropolitan transportation plans, metropolitan transportation improvement programs, and projects funded or approved by FHWA or FTA in nonattainment or maintenance areas for ozone, CO, particulate matter (PM10 and PM2.5), or nitrogen dioxide. PM2.5, or fine PM, refers to particles that are 2.5 micrometers in diameter or less and PM10 refers to particles 10 micrometers in diameter or less. Regulations governing transportation conformity are found in Title 40 of the Code of Federal Regulations ([40 CFR Parts 51 and 93](#)). For additional information, see [FHWA's transportation conformity website](#).

Mobile Source Air Toxics (MSAT) – In addition to criteria pollutants, the Clean Air Act Amendments of 1990 also made controlling air toxic emissions a national priority. Congress mandated that the EPA regulate 188 air toxics, also known as hazardous air pollutants. Some of these air toxics are unique to on-road mobile sources. What we know about mobile source air toxics is still evolving. FHWA is working with stakeholders, EPA, and others to better understand the strengths and weaknesses of analysis tools and the applicability on the project-level decision and documentation process. In December of 2012, FHWA published [Interim Guidance on Air Toxic Analysis in NEPA Documents](#) to update the September 2009 interim guidance that advised FHWA Division Offices

on when and how to analyze MSAT under the NEPA review process for highway projects. This update reflected recent changes in methodology for conducting emissions analysis and updates of research in the MSAT arena.

Looking Forward

Looking forward, FHWA will continue coordinating with EPA, FTA, and our partners to reduce emissions and improve outcomes. MAP-21 requires an assessment of the emission reductions achieved under the CMAQ program. This report will be released in fall of 2014.

New York City Refuse Trucks

Starting in 2007, the New York City Department of Sanitation (DSNY) used \$10 million in CMAQ funds to retrofit approximately 828 refuse trucks. Diesel particulate filters were installed on 616 trucks (Figure 14), while diesel oxidation catalysts were used on the remaining vehicles. Benefits from retrofitting the trucks included improved local air quality and considerable emissions reductions. In fact, these upgrades resulted in a 5,067.4 kilogram (kg) reduction of nitrogen oxides per year. Additionally, PM emissions were reduced by 281.5 kg per year for PM_{2.5} and a 356.0 kg per year for PM₁₀. In 2013, DSNY installed diesel particulate filters on an additional 51 trucks and diesel oxidation catalysts on 236 trucks.



Figure 14: Image of a refuse truck is outfitted with a diesel particulate filter. (Courtesy of FHWA)

3.9 Environmental Streamlining and Mitigation

Overview

FHWA, through its Office of Project Development and Environmental Review, is working with its partners to integrate ecosystem-based environmental considerations and mitigation efforts into transportation planning to help streamline the environmental review and permitting processes, to improve predictability and outcomes, and to produce transportation and infrastructure projects that meet both mobility and environmental objectives. Additionally, FHWA provides support, guidance, and tools to enhance ecological functions, such as stormwater management, during the transportation planning and project development process. From the triple bottom line perspective, environmental streamlining and mitigation supports all of the principles (economic, social, and environmental) by reducing costs, accelerating project delivery, improving collaboration and decisionmaking, avoiding or minimizing environmental impacts, and maintaining ecosystem health.

Sustainability Practices

Eco-Logical – Developed by a team of representatives from FHWA and seven other Federal agencies, [Eco-Logical](#) articulates a vision for an infrastructure development process that endorses ecosystem-based mitigation through integrating plans and data across agency and disciplinary boundaries. In 2007, FHWA launched the [Eco-Logical Grant Program](#) providing approximately \$1.4 million to fund 15 projects nationwide. More recently, through [Implementing Eco-Logical](#), FHWA continues to advance implementation of the Eco-Logical approach by working with transportation, resource, and regulatory agencies. Implementing Eco-Logical is an ongoing effort to implement research products from the [Second Strategic Highway Research Program \(SHRP2\)](#) and integrate activities into FHWA's Eco-Logical Program. The goal of Implementing Eco-Logical is to advance the state of practice for all transportation practitioners and their partners, so that an Eco-Logical approach is better integrated into their daily business practices. In 2013, FHWA distributed 14 [Implementation Assistance Grants](#) to State DOTs and MPOs to advance implementation of Eco-Logical in these agencies. See the callout box on page 43 for more information on one of the Implementation Assistance Grant recipients, the Ohio-Kentucky-Indiana Regional Council of Governments.

Programmatic Approaches (PAs) – PAs, which include programmatic agreements, streamline the process for handling routine environmental requirements for common project types. These approaches set procedures for consultation, review, and compliance with Federal laws. PAs allow frequently repeated actions to be considered on a program basis rather than project by project. As part of [Every Day Counts](#), FHWA is focusing on identifying and assisting in the expansion of new and existing programmatic agreements to a regional or national level. As part of this effort, FHWA is publicizing existing tools and resources available for developing programmatic approaches, developing case study examples, and documenting best practices. Both FHWA Headquarters and Resource Center staff are also providing technical assistance and guidance during the expansion, revision, or creation of new programmatic approaches. Additionally, FHWA is also working with FTA to address Section 1305 of MAP-21 requiring a rulemaking allowing for the use of programmatic approaches to conduct environmental reviews for transportation projects. Input from a recent National Online Dialogue will allow FHWA and FTA to consider all stakeholder perspectives and ideas received when preparing the Notice of Proposed Rulemaking.

Stormwater Mitigation – Stormwater mitigation is a part of every Federal-aid project and is strategically considered during the transportation planning process in association with community watershed management goals. As part of meeting the EPA's National Pollutant Discharge Elimination System (NPDES) Phase II requirements for stormwater under the Clean Water Act, State and local governments must meet certain standards or requirements with regard to stormwater runoff. State DOTs are required to do “on-site” treatment of stormwater runoff to comply with applicable local and Federal laws. However, space limitation within the right-

of-way is a major obstacle to on-site treatment of stormwater. Borrowing from the concept of wetland mitigation banking, FHWA is exploring a similar potential framework for stormwater quality banking or trading. This research will investigate the current status of stormwater quality banking and credit systems across the nation. Information collected in this assessment will be used as guidance for the development of a future stormwater quality mitigation banking framework and implementation of pilot projects.

Stormwater Performance Measurement – FHWA is spearheading an effort to assess the state-of-the-practice in stormwater performance measurement and data collection among State DOTs. This effort will include evaluations of current State DOT data collection capabilities and measures to establish a baseline of effective Best Management Practices (BMPs) and where they are being utilized. The work will also examine the extent that State DOTs have tracking systems in place, which DOTs are mapping their stormwater locations and outfalls, which DOTs have retrofit prioritization processes, and whether any standard practices among State DOTs can be used as guidance nationwide. Once this research has been carried out, FHWA will move forward with developing a draft framework for potential performance measures based on the current state-of-the-practice, which can be used nationwide.

Watershed Resource Registry (WRR) – The WRR is a tool which evaluates watershed conditions and creates a database of sites in a watershed for the protection of high quality resources, restoration of impaired resources, and the establishment of treatment systems and BMPs. A methodology for developing the WRR and for integrating its use in existing policy and regulation is being developed. A pilot effort focused in Southwestern Maryland is being used to help to create the broad-based methodology. FHWA is working with EPA Region III's Office of State and Watershed Partnerships to develop the WRR and provide regulatory streamlining for addressing the Clean Water Act Section 402 NPDES permit requirements for stormwater management and the Section 404 requirements under the Compensatory Mitigation Rule. The WRR will aid all those involved in watershed management decisions at the local, state, and national levels by providing the best available information, on which to base decisions, in one centralized location.

National Ocean Policy Implementation – In April of 2013, the National Ocean Council released the [National Ocean Policy Implementation Plan](#), an action-oriented framework for fulfilling President Obama's [National Policy for the Stewardship of the Ocean, Our Coasts, and the Great Lakes](#). The Implementation Plan describes specific actions Federal agencies, including the U.S. DOT, will take to tackle key ocean challenges, improve collaboration and coordination, advance streamlining efforts, save money, and spur economic growth. One such action that the FHWA is spearheading is to create an inventory and evaluate best management practices to address stormwater runoff from the Federal-aid highway system, the efficiency of measures implemented to reduce sediments and common pollutants found in highway stormwater runoff, and the costs associated with construction, operation, and maintenance. FHWA anticipates that the results of this research will be completed by 2015 and could inform the establishment of performance measures used at a national level.

Green Infrastructure – FHWA has worked with numerous partners to provide webinars and trainings on green infrastructure including multiple presentations through the U.S. Fish and Wildlife Service's National Conservation Training Center in Shepherdstown, West Virginia. Most recently, in March of 2014, FHWA co-sponsored a webcast with the EPA Office of Wastewater Management entitled "Innovative Transportation Stormwater Management: Green Infrastructure in Road Projects." Green infrastructure techniques are one solution that can be used to reduce and treat stormwater runoff from roads and improve water quality. This webcast focused on how to better incorporate green infrastructure into the roadway funding and approval process and showcased a programmatic approach to the design and construction of stormwater BMPs.

Looking Forward

With several strategies already underway, FHWA will continue to work with its partners to execute different aspects of Implementing Eco-Logical throughout the rest of 2014. FHWA will develop new resources for practitioners of Eco-Logical, such as implementation workshops, peer exchanges, case studies, and on-call technical assistance. FHWA will also move forward with its efforts to address stormwater management and advance programmatic mitigation.

Ohio-Kentucky-Indiana Regional Council of Governments (OKI) Implementing Eco-Logical Project

OKI is using SHRP2 implementation assistance funding to advance the Eco-Logical approach, which promotes planning and delivering infrastructure projects using an ecosystem-scale, advanced planning framework. With the SHRP2 funding, OKI is negotiating long term agreements to collect mapping data from three State Natural Heritage Databases and integrating that data with the OKI Regionally Significant Environmental Resource database to inform the development of its long range transportation plan, the 2040 OKI Regional Transportation Plan (Figure 16). To date, OKI has finalized agreements with the three State agencies within its planning area and has met with the agencies to discuss and begin the collection of data. Once OKI receives natural heritage data from each State, it will prepare a series of maps based on the data, produce a summary of the method and criteria used to map the datasets, and draft a report on the new data's impact on regionally significant environmental resources. OKI will also update its project prioritization criteria accordingly. The expected completion date for this project is later this year.



Figure 15: Graphic for 2040 OKI Regional Transportation Plan. (Courtesy of OKI)

4 Conclusion

Advancing a Sustainable Highway System: Highlights of FHWA Sustainability Activities captures and highlights a wide variety of existing, new, and emerging sustainability activities at FHWA. As interest in sustainability principles and best practices among State DOTs, MPOs, and the transportation industry continues to grow, FHWA will work to integrate sustainability into relevant initiatives, programs, and projects. FHWA expects that creating more sustainable highways will play a significant role in facilitating the creation, operation, and maintenance of the Nation's highway infrastructure in the years and decades ahead.

Next Steps

FHWA will continue to advance efforts related to sustainability through the Sustainable Highways Initiative, SWG, and the activities and practices of its various Program Offices. FHWA will also engage the SWG to move forward with defining sustainability goals and plans for the agency, recommending and assisting with outreach efforts, and providing input on current and future research activities. In addition, FHWA will continue to support technical assistance and training efforts related to INVEST and will update INVEST as sustainability practices develop over time. Since sustainability is an emerging and evolving theme within the transportation community and a major focus of FHWA and the U.S. DOT, FHWA will periodically provide updates to this report.

5 Appendices

5.1 Appendix A: Additional Information/Resources

Section	Resource(s)
Background on Sustainable Highways	Sustainable Highways Initiative: www.sustainablehighways.dot.gov/ INVEST: www.sustainablehighways.org/ FHWA Sustainability Working Group: www.sustainablehighways.dot.gov/sustain_working_group.aspx
Safety	FHWA Safety Program: www.safety.fhwa.dot.gov/ Safety Strategic Plan: www.safety.fhwa.dot.gov/ssp/ Highway Safety Improvement Program: www.safety.fhwa.dot.gov/hsip/ Roadway Departure Safety: www.safety.fhwa.dot.gov/roadway_dept/ Intersection Safety: www.safety.fhwa.dot.gov/intersection/ Pedestrian and Bicycle Safety: www.safety.fhwa.dot.gov/ped_bike/ www.pedbikeinfo.org Data and Analysis: www.safety.fhwa.dot.gov/tools/data_tools/ Proven Safety Countermeasures: www.safety.fhwa.dot.gov/provencountermeasures/
Freight and Goods Movement	Freight Technology and Operations: www.ops.fhwa.dot.gov/freight/technology/index.htm Truck Parking: www.ops.fhwa.dot.gov/freight/infrastructure/truck_parking/index.htm Performance Measurement: www.ops.fhwa.dot.gov/freight/freight_analysis/perform_meas/index.htm Smart Roadside: http://www.fmcsa.dot.gov/research-and-analysis/technology/smart-roadside-initiative

Section	Resource(s)
Linking Asset Management and Planning	<p>Transportation Planning and Asset Management: www.fhwa.dot.gov/infrastructure/asstmgmt/tpamb.cfm</p> <p>FHWA Asset Management Position Paper: www.fhwa.dot.gov/infrastructure/asstmgmt/ampplan.cfm</p> <p>Transportation Asset Management Plans: www.fhwa.dot.gov/asset/plans.cfm</p> <p>Pilot Projects- Development of Transportation Asset Management Plans: www.fhwa.dot.gov/asset/tamp/</p> <p>Generic Work Plan for Developing a TAMP: www.fhwa.dot.gov/asset/tamp/workplan.pdf</p> <p>Performance-Based Planning and Programming: www.fhwa.dot.gov/planning/performance_based_planning/</p> <p>Performance-Based Planning and Programming Guidebook: www.fhwa.dot.gov/planning/performance_based_planning/pbpp_guidebook/index.cfm</p>
Human Environment and Civil Rights: Access and Affordability	<p>Office of Civil Rights: www.fhwa.dot.gov/civilrights/</p> <p>Americans with Disabilities Act (ADA)/Section 504 Program: www.fhwa.dot.gov/civilrights/programs/ada.cfm</p> <p>Title VI Program: www.fhwa.dot.gov/civilrights/programs/tvi.cfm</p>
Human Environment and Civil Rights: Livability	<p>Livability Initiative: www.fhwa.dot.gov/livability/</p> <p>Livability Case Studies: www.fhwa.dot.gov/livability/case_studies/</p> <p>Fostering Livable Communities Newsletter: www.fhwa.dot.gov/livability/newsletter/</p> <p>Livable Communities Discussion Board: www.transportationresearch.gov/dot/fhwa/livablecommunities/default.aspx</p> <p>Every Day Counts: www.fhwa.dot.gov/everydaycounts/</p> <p>Context Sensitive Solutions: www.fhwa.dot.gov/context/ and http://contextsensitivesolutions.org/</p>
Human Environment and Civil Rights: Multimodal Transportation	<p>Office of Human Environment Bicycle & Pedestrian Program: www.fhwa.dot.gov/environment/bicycle_pedestrian/</p> <p>Planning for Bicycling and Walking: www.fhwa.dot.gov/environment/bicycle_pedestrian/overview/bp-broch.cfm#planning</p> <p>Memorandum on Bicycle and Pedestrian Facility Design Flexibility: www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/design_guidance/design_flexibility.cfm</p> <p>Office of Safety Pedestrian & Bicycle Safety: www.safety.fhwa.dot.gov/ped_bike</p> <p>Pedestrian Safety Focus States and Cities: www.safety.fhwa.dot.gov/ped_bike/ped_focus/</p> <p>Pedestrian Safety Strategic Plan: www.safety.fhwa.dot.gov/ped_bike/pssp/</p> <p>Transportation Alternatives Program MAP-21 Guidance: www.fhwa.dot.gov/map21/guidance/guidetap.cfm</p>

Section	Resource(s)
Human Environment and Civil Rights: Integrating Land Use and Transportation	Coordinating Land Use and Transportation: www.fhwa.dot.gov/planning/processes/land_use/ Tool Kit for Integrating Land Use and Transportation Decision-Making: www.fhwa.dot.gov/planning/processes/land_use/toolkit.cfm Transportation Planning Capacity Building Program: www.planning.dot.gov/
Financial Assessment: Financial Planning and Fiscal Constraint	Fiscal Constraint and Financial Planning in the Transportation Planning Process: www.planning.dot.gov/focus_fiscal.asp Interim Major Project Financial Plan Guidance: www.fhwa.dot.gov/map21/guidance/guidemajorproj.cfm Major Project Financial Plan Guidance: www.fhwa.dot.gov/ipd/pdfs/2013-21738.pdf Fiscal Constraint in Long-Range Transportation Planning: www.planning.dot.gov/documents/fiscalConstraint_rpt.pdf Transportation Planning Capacity Building Focus Page: www.planning.dot.gov/focus_fiscal.asp <u>RealCost:</u> http://www.fhwa.dot.gov/infrastructure/asstmgmt/lccasoft.cfm
Financial Assessment: Economic and Lifecycle Analyses	Economic Analysis: www.fhwa.dot.gov/infrastructure/asstmgmt/economic.cfm Roadway Economic and Investment Analysis I01: www.fhwa.dot.gov/asset/economic/decision.cfm Benefit Cost Analysis: www.fhwa.dot.gov/publications/publicroads/12marapr/05.cfm Life Cycle Cost Analysis: www.fhwa.dot.gov/infrastructure/asstmgmt/lcca.cfm BCA.net: www.fhwa.dot.gov/infrastructure/asstmgmt/bcanet.cfm Surface Transportation Efficiency Analysis Model: www.fhwa.dot.gov/steam/ National Bridge Investment Analysis System: www.fhwa.dot.gov/tpm/resources/nbias/ Bridge Life Cycle Cost Analysis: www.aspirebridge.com/magazine/2013Summer/FHWA_Sum13_Web.pdf
Roadway Management and Operations: Sustainable Pavements	FHWA Pavements: www.fhwa.dot.gov/pavement/index.cfm Pavement Recycling: www.fhwa.dot.gov/pavement/recycling/index.cfm A Technology Deployment Plan for the Use of Recycled Concrete Aggregates in Concrete Paving Mixtures: www.intrans.iastate.edu/reports/RCA%20Draft%20Report_final-ssc.pdf Asphalt Pavement Recycling with Reclaimed Asphalt Pavement: www.fhwa.dot.gov/pavement/recycling/rap/index.cfm Recycled Materials Policy: www.fhwa.dot.gov/legsregs/directives/policy/recmatmemo.htm Warm-Mix Asphalt: www.fhwa.dot.gov/pavement/asphalt/wma.cfm

Section	Resource(s)
Roadway Management and Operations: Road Weather Management	Road Weather Management: www.ops.fhwa.dot.gov/weather/index.asp Planning for Systems Management & Operations as part of Climate Change Adaptation: www.ops.fhwa.dot.gov/publications/fhwahop13030/fhwahop13030.pdf Best Practices for Road Weather Management: www.ops.fhwa.dot.gov/weather/mitigating_impacts/best_practices.htm
Climate Change: Mitigation and GHG Analysis	Ongoing and Current Research Mitigation Research: www.fhwa.dot.gov/environment/climate_change/mitigation/ongoing_and_current_research Energy and Emissions Reduction Policy Analysis Tool: www.planning.dot.gov/FHWA_tool/ Albuquerque Climate Change and Scenario Planning Pilot: www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/albuquerque/index.cfm Handbook for Estimating Transportation Greenhouse Gases for Integration into the Planning Process: www.fhwa.dot.gov/environment/climate_change/mitigation/resources_and_publications/ghg_handbook/index.cfm Feasibility and Implications of Electric Vehicle Deployment and Infrastructure Development: www.fhwa.dot.gov/environment/climate_change/energy/ongoing_and_current_research/
Climate Change: Infrastructure Resiliency	Climate Change Adaptation: www.fhwa.dot.gov/environment/climate_change/adaptation/resources_and_publications/ Ongoing and Current Resiliency Projects: www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/
Climate Change: Energy Efficiency and Renewables	Solar Highways: www.solarroadways.com/intro.shtml Roadway Wind-Solar Hybrid Power Generation and Distribution System Towards Energy Plus Roadways: http://energyplusroadways.unl.edu/ New Technologies for Development of Renewable Energy in the Public Right-of-Way: www.fhwa.dot.gov/advancedresearch/pubs/13094/13094.pdf Alternative Uses of Highway Right-of-Way: www.fhwa.dot.gov/real_estate/practitioners/right-of-way/corridor_management/alternative_uses.cfm
Air Quality	CMAQ program: www.fhwa.dot.gov/environment/air_quality/cmaq/ Interim Program Guidance Under MAP-21: www.fhwa.dot.gov/environment/air_quality/cmaq/policy_and_guidance/2013_guidance/index.cfm MAP-21 website: www.fhwa.dot.gov/map21/ Air Quality Conformity Rule: www.fhwa.dot.gov/environment/air_quality/conformity/rule.cfm Transportation Conformity website: http://www.fhwa.dot.gov/environment/air_quality/conformity/rule.cfm Interim Guidance on Air Toxic Analysis in NEPA Documents: www.fhwa.dot.gov/environment/air_quality/air_toxics/policy_and_guidance/aqintguidmem.cfm

Section	Resource(s)
Environmental Streamlining and Mitigation	<p>Eco-Logical: www.environment.fhwa.dot.gov/ecological/eco_entry.asp</p> <p>Eco-Logical Grant Program: www.environment.fhwa.dot.gov/ecological/eco_grant_program.asp</p> <p>Implementing Eco-Logical: www.environment.fhwa.dot.gov/ecological/eco_implementing.asp</p> <p>Second Strategic Highway Research Program: www.fhwa.dot.gov/goshrp2/</p> <p>Implementation Assistance Grants: www.environment.fhwa.dot.gov/ecological/eco_implementing.asp#lead</p> <p>Every Day Counts Expanding Use of Programmatic Agreements: http://www.fhwa.dot.gov/everydaycounts/projects/toolkit/programatic.cfm</p> <p>National Ocean Policy Implementation Plan: www.whitehouse.gov/administration/eop/oceans/policy</p> <p>National Policy for the Stewardship of the Ocean, Our Coasts, and the Great Lakes: www.whitehouse.gov/the-press-office/executive-order-stewardship-ocean-our-coasts-and-great-lakes</p>

5.2 Appendix B: Contacts

For general inquiries regarding this report, the Sustainable Highways Initiative, and/or the Sustainability Working Group, please contact the FHWA Sustainable Transport and Climate Change Team in the Office of Natural Environment:

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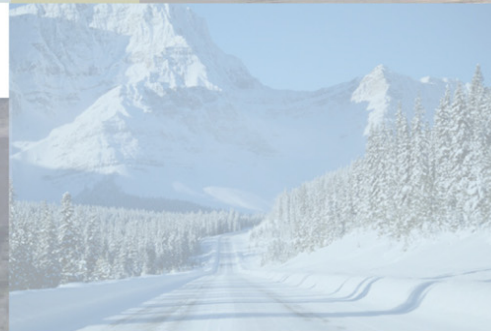
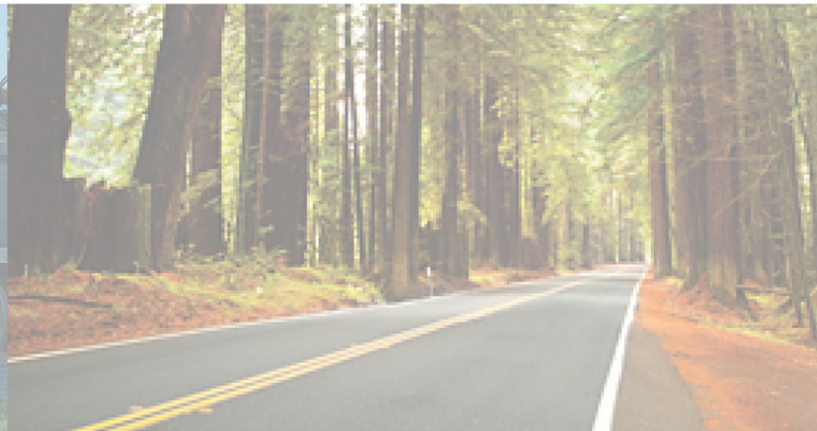
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