Public Roads

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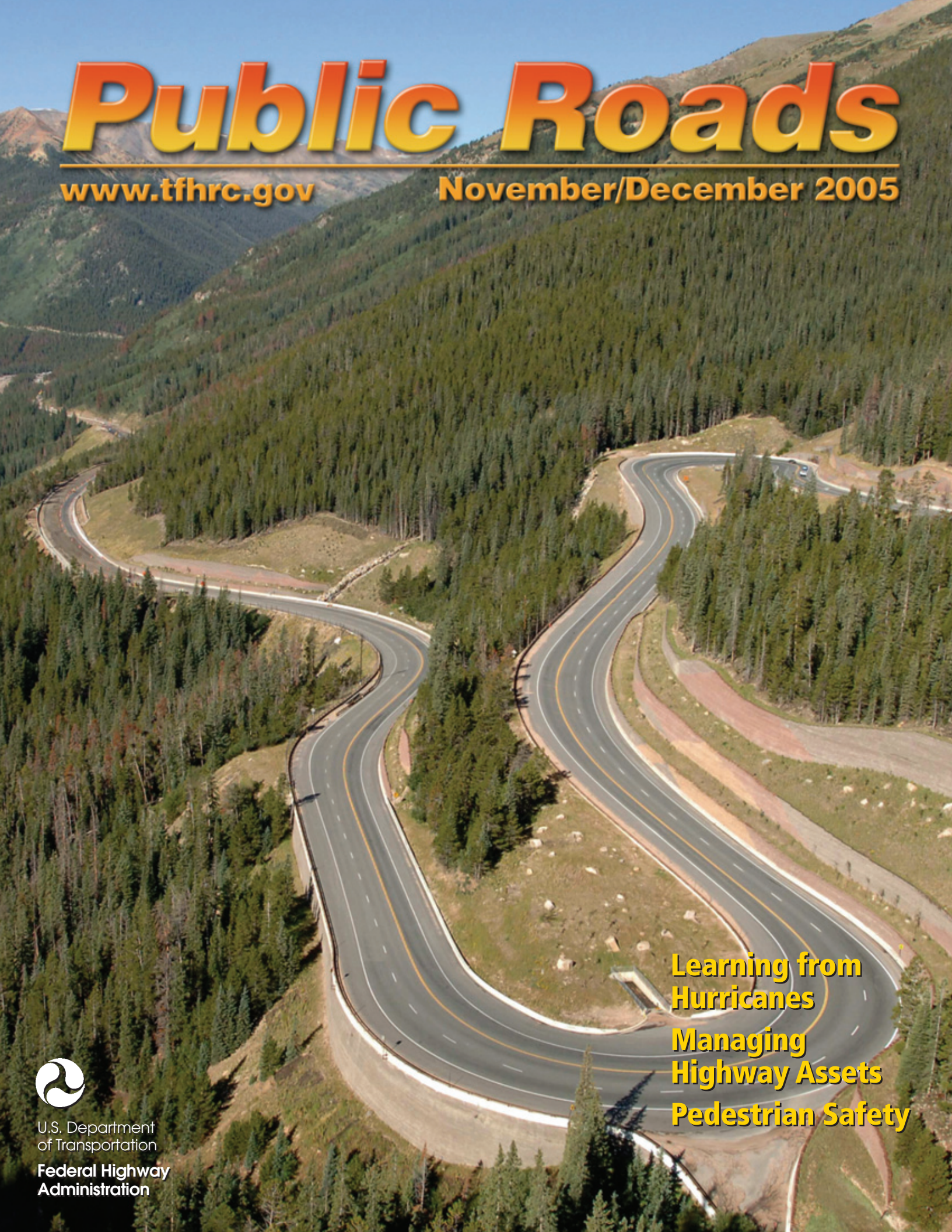

Learning from Hurricanes

Managing Highway Assets

Pedestrian Safety

U.S. Department of Transportation
Federal Highway Administration

Public Roads

November/December 2005 www.tfhrc.gov Vol. 69, No.3

—featuring developments in Federal highway policies, programs, and research and technology—

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Front cover—Originally opened in 1874 as a wagon road over Berthoud Pass, this segment of U.S. 40 in central Colorado has evolved into an award-winning, state-of-the-art mountain highway. Rising to an elevation of 3,448 meters (11,315 feet) over unforgiving terrain, this new section features switchbacks and steep grades. The Colorado Department of Transportation (CDOT) implemented sophisticated measures to control erosion and mitigate landslides, and constructed aesthetic retaining walls that enhanced safety while improving the environment. *Photo: Gregg Gargan, CDOT.*

Back cover—This stretch of Interstate 26 between the Tennessee State line and Mars Hill, NC, offers views of the Blue Ridge Mountains and is one of 49 scenic byways in North Carolina. FHWA recently recognized the North Carolina Department of Transportation (NCDOT) with an environmental excellence award for its efforts to develop an educational curriculum for fourth graders that highlights the State's scenic byways. *Photo: Charlie Jones for NCDOT.*

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Federal Highway Administration

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The editorial office of *Public Roads* is located at the McLean address above.
Phone: 202–493–3468. Fax: 202–493–3475.
E-mail: martha.soneira@fhwa.dot.gov.

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Guest Editorial

Public-Private Partnerships

Transportation is an industry in transition, moving away from a government-only endeavor to a partnership between government and the private sector. Federal, State, and local governments have been exploring public-private partnership (PPP) initiatives and already have embarked on a number of projects that involve variations on the concept.

The growing level of interest in this concept became clear at the 17th annual conference on PPPs hosted by the American Road & Transportation Builders Association. The conference drew three times the number of attendees than it did 5 years ago, with participants representing a number of disciplines in the transportation industry, including planners, designers, builders, system operators, and financiers.

For the transportation community, PPPs promise the possibility of greater innovation and efficiency in the delivery of highway projects and additional revenue streams to fund needed transportation improvements. For taxpayers and motorists, PPPs mean that projects often are completed more quickly, at lower cost, and with more and better travel choices. These partnerships can maximize the resources, efficiencies, and expertise of the free market system, bringing these advantages to surface transportation projects. However, implementing PPPs will require educating the public and managing its expectations for those benefits to be fully realized.

Currently, 19 States and territories have passed legislation that enables them to make use of PPPs: Alabama, Arizona, California, Colorado, Delaware, Florida, Georgia, Louisiana, Maryland, Minnesota, Missouri, Nevada, North Carolina, Oregon, Puerto Rico, South Carolina, Texas, Virginia, and Washington.

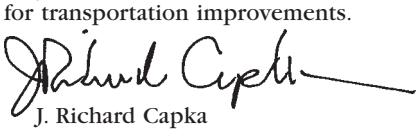
In addition, some of these States have active PPPs underway. The Trans-Texas Corridor (TTC), for example, originally was approved in February 2004 to proceed under Special Experimental Project No. 14 (SEP–14), a construction program focused on evaluating innovative contracting methods. Later, the Federal Highway Administration (FHWA) upgraded the TTC to SEP–15 status, which focuses on PPP approaches to project delivery, giving Texas greater flexibility to employ innovation and PPPs as the project progresses.

Through a partnership with a consortium of engineering, construction, and financial firms, the Texas Department of Transportation will develop a transportation corridor that roughly parallels Interstate 35, running north-south from Oklahoma to Mexico. The multiuse corridor could include lanes for passenger vehicles, trucks, and rail, as well as dedicated zones for water, electric, telecommunications, and other utility lines.

A recent initiative in Oregon, the Oregon Innovative Partnerships Program (OIPP), is designed to develop an expedited project delivery process, maximize innovation, and develop partnerships with private entities and various units of government. The OIPP will be used on three projects.

This issue of PUBLIC ROADS explores a number of facets of PPPs. One article, "Working With the Private Sector to Meet Transportation Goals," features excerpts from a panel discussion hosted by the Transportation Research Board in January 2005, during which former Federal Highway Administrator Mary E. Peters and private-sector representatives explored how PPPs could help advance critical transportation projects. Another article, "The Future of Highway Financing," shares highlights from a roundtable discussion involving finance and policy experts looking at ways to fund tomorrow's surface transportation projects.

On a practical level, many States are viewing roads and bridges as assets instead of liabilities. Leasing these assets, for the long term, means States may have additional financial resources for transportation improvements.



J. Richard Capka
Acting Administrator
Federal Highway Administration

On the Road to Environmental Excellence

by Patricia A. Cazenas

FHWA honors the 2005 award-winning transportation projects and the people who protect or enhance natural and community resources.

An increasing number of transportation projects are yielding innovative approaches that not only improve highway safety but also protect or enhance the natural and cultural environments. The scale of projects can vary from performing a major makeover on a congested urban landscape to making more subtle improvements such as modifying winter maintenance activities to protect a watershed and educating young people about the value of scenic byways.

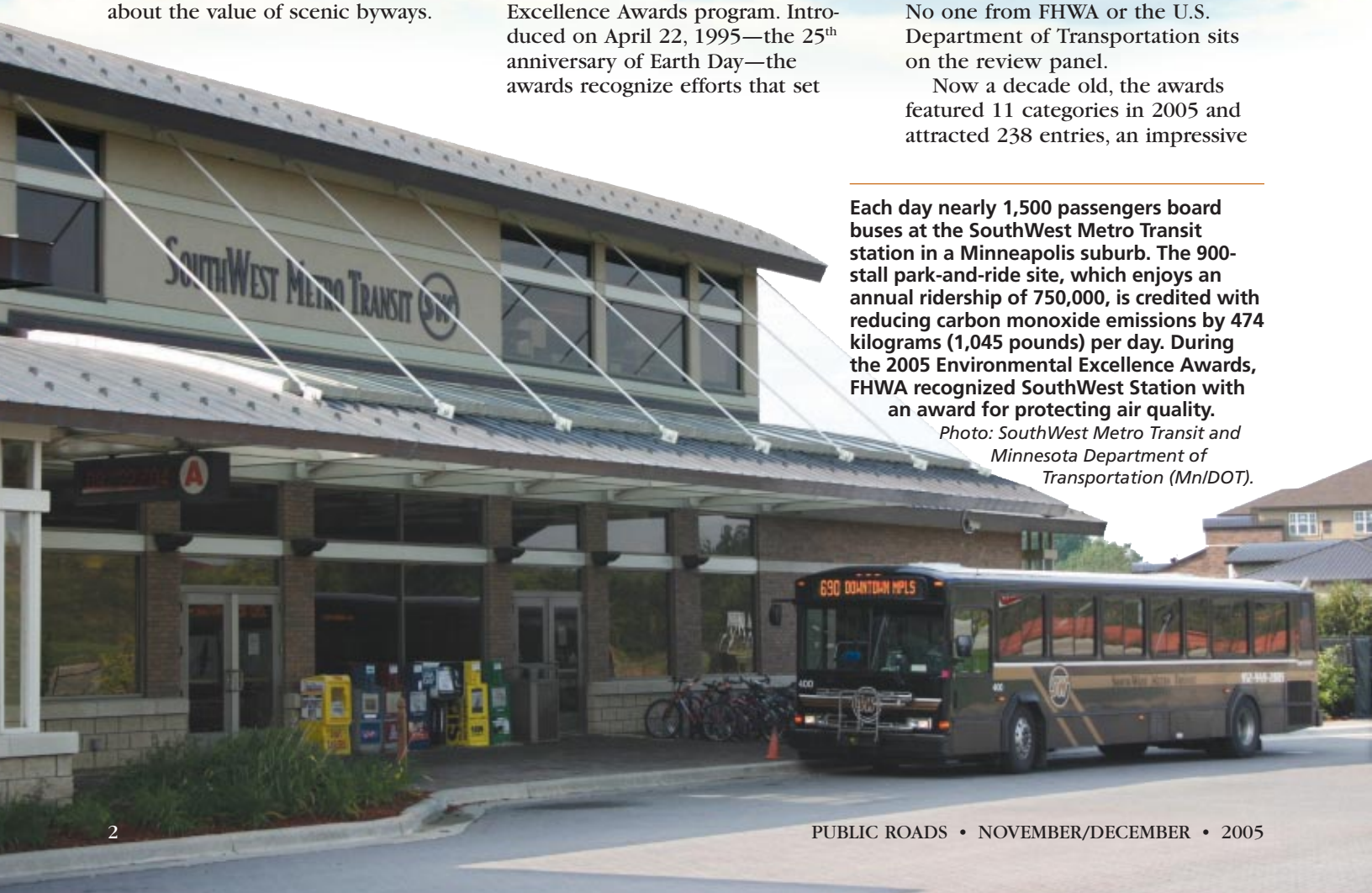
Yet the common thread tying them together is that State departments of transportation (DOTs) are partnering with other government agencies, contractors, private groups, and individuals to create better, safer roads and leave a greener footprint on the natural environment.

Every 2 years, the Federal Highway Administration (FHWA) honors outstanding achievements in environmental sensitivity in highway projects through its Environmental Excellence Awards program. Introduced on April 22, 1995—the 25th anniversary of Earth Day—the awards recognize efforts that set new standards for transportation and environmental solutions.

"The awards are designed to showcase projects that surpass normal requirements and expectations," says Fred Bank, an ecologist and FHWA team leader in the Office of Natural and Human Environment. "The top candidates are those that enhance the environment beyond requirements."

Judges hail from a variety of backgrounds, including academia, Federal agencies, and private firms. No one from FHWA or the U.S. Department of Transportation sits on the review panel.

Now a decade old, the awards featured 11 categories in 2005 and attracted 238 entries, an impressive



Each day nearly 1,500 passengers board buses at the SouthWest Metro Transit station in a Minneapolis suburb. The 900-stall park-and-ride site, which enjoys an annual ridership of 750,000, is credited with reducing carbon monoxide emissions by 474 kilograms (1,045 pounds) per day. During the 2005 Environmental Excellence Awards, FHWA recognized SouthWest Station with an award for protecting air quality.

Photo: SouthWest Metro Transit and Minnesota Department of Transportation (Mn/DOT).

increase from the 60 candidates in 1995. And over the years, the quality of the projects continues to prove extraordinary.

"These are not ordinary projects," Bank adds. "They all excel in different ways, which makes for hard choices for the judges. With so much quality, the winners really are the cream of the crop."

Here is a closer look at this year's Environmental Excellence Award winners.

Oregon Launches Stewardship Program For Bridge Replacement

When the Oregon Department of Transportation (ODOT) decided to tackle the problem of repairing or replacing more than 300 aging highway bridges—many of them located along key freight transportation routes—the agency huddled with 11 other State and Federal environmental and resource agencies to develop a plan that would streamline the rebuilding process. The goals were to reduce administrative processes, save time and money on construction projects, and protect the Beaver State's wetlands and endangered species.

The result was Oregon's Bridge Replacement Environmental Stewardship Program, a unique approach that includes long-range benefits intended to reap financial and environmental dividends far beyond the initial bridge repair projects. According to ODOT officials, the program provides a holistic approach that helps eliminate or reduce delays and expenses caused by environmental concerns. For example, one ongoing benefit is that design costs are expected to drop by as much as 15 percent for all future projects.

One of the program's key innovations is the creation of an environmental baseline report that informs design teams of opportunities to avoid or minimize the environmental impacts of individual bridge projects. Another new element is a set of environmental performance standards that serve as a single, common set of terms, conditions, and design targets that apply to all bridge projects and form the basis of permits from multiple agencies.

To protect wildlife areas, a Comprehensive Mitigation and Conservation Strategy (CMCS) integrates wetlands mitigation with habitat conservation. The CMCS enables ODOT to evaluate impacts at the ecosystem level and uses a single accounting system for assigning mitigation credits and debits across all agencies. The strategy establishes a program-level approach to mitigation and conservation, and creates specific conservation and mitigation banks that serve regional ecological priorities.

An outstanding example of interagency coordination and collaboration, the Oregon Bridge Replacement Environmental Stewardship Program provides significant benefits to transportation and the environment by fundamentally changing how a major construction program and numerous State and Federal environmental laws are administered and implemented within existing legal frameworks.

North Carolina Touts Scenic Byways to Elementary Students

From the shores of the Atlantic Ocean to the Blue Ridge Mountains, North Carolina offers motorists more than 2,700 kilometers (1,700 miles) of visually breathtaking scenic byways. Each of the 49 officially designated byway routes presents vistas of North Carolina's diverse historic, cultural, and natural treasures, not to mention a more leisurely alternative to traveling on the State's high-speed interstates and more heavily trafficked commercial routes.

As the sixth most visited State in the country, North Carolina already attracts drivers of all ages to enjoy a scenic drive. However, the North Carolina Department of Transportation (NCDOT) recently mapped out a route to draw future travelers—the State's elementary school students.

"We realized that the future drivers and passengers on these roads are now in North Carolina's schools," says North Carolina Scenic Byway Coordinator Jeff Lackey. "So we developed a program that would inform students about the historic and scientific importance of those routes. We worked with the [North Carolina] Department of Public Instruction to develop a curriculum that would reach out to children in the fourth and eighth grades, when their studies focus on North Carolina history. The reception has been very positive. We constantly get calls from teachers who want additional curriculum packages."

NCDOT's Scenic Byways Teacher's Guide emphasizes the importance of discovering the pristine natural environment and rich cultural history along the State's roadways. The program's materials and hands-on lesson plans and activities help educators and students gain a greater knowledge of North Carolina's byways, while providing a valuable resource on the State's geographical, historical, and cultural significance. Since 2003, NCDOT has

North Carolina's award-winning scenic byways curriculum provides teachers with a variety of materials, including this binder, video, and fact-sheets, to encourage fourth- and eighth-grade students to explore their State's natural history and culture by visiting the less-traveled back roads.
Photo: NCDOT.

NCDOT

Along the rolling hills of U.S. 501, a scenic byway in North Carolina, motorists pass this beautifully preserved 19th-century barn, now home to a hunting club.

distributed the curriculum to more than 1,500 classrooms. Each package includes a DVD and videotape of select scenic byways. Nine byways are already included in the teacher's guide, and more routes will be added in the future.

Minnesota's SouthWest Station Enhances Air Quality

Located about 24 kilometers (15 miles) southwest of Minneapolis, Eden Prairie, MN, is one of the fastest growing suburbs of the Twin Cities region. To accommodate the growing demand for more mass transit from Eden Prairie to the larger metropolitan area, SouthWest Metro Transit designed a state-of-the-art, pedestrian-friendly, transit-oriented, and environmentally sensitive development strategically located near two major freeways. SouthWest Station provides more than a traditional transit bus station. The 8.5-hectare (21-acre) site includes park-and-ride facilities, a 900-space parking garage, restaurants, retail businesses, offices, and housing units.

"SouthWest Station is a mixed-use development geared to transit," says SouthWest Transit Executive Director Len Simich. "The station has 60,000 to 65,000 square feet [5,575 to 6,038 square meters] of restaurants and commercial space. Commuters can get a cup of coffee in the morning on the way to work and enjoy a relaxing dinner at the end of the day. The condos, entertainment facilities, and station are within a short walking distance for added convenience. The response has been very positive."

With an annual ridership of just under 1 million, SouthWest Transit has enjoyed steady growth in recent years, including a 20-percent increase in passengers in 2004 and another 9-percent jump so far this year. Simich adds that the park-and-ride building is averaging 85- to 90-percent capacity.

Along with extraordinary commuter convenience, the retro-looking SouthWest Station delivers a strong environmental benefit by eliminating 1,630 single-occupant vehicle trips per day—reducing daily carbon dioxide emissions by 474 kilograms (1,045 pounds). The station integrates other environmental concerns into the project with a community park and trail system in the surrounding natural areas, while ensuring that the design of the facility minimizes the time transit vehicles need to enter and exit the site.

The final design includes an exclusive busway entry lane and exit tunnel, the first of its kind in the State, designed to allow easy access to and from adjacent interchanges. Project officials point to strong partnerships as a key component in the success of the SouthWest Station, facilitating the transformation of a prime setting into a high-quality and attractive facility that provides comfort and convenience for transit riders as it promotes improved air quality.

New Jersey's South Riverwalk Preserves Cultural and Historical Resources

Five centuries of history come alive at South Riverwalk Park, a Trenton,

SouthWest Metro Transit and Mn/DOT

SouthWest Station in Eden Prairie, MN, shown here looking down from above, includes the transit station, several restaurants, and more than 200 condominium units. Specifically designed with pedestrian concerns in mind, the station includes walkable connections between the station, the restaurants, and the condos, as well as a number of trails that connect to nearby city and regional parks.

NJ, project built above a reconstructed stretch of road and tunnel on State Route 29. Perched along the Delaware River, the 2.6-hectare (6.5-acre) park features permanent historic exhibits such as five sculptural arches depicting 500 years of Trenton history, a timeline of 97 granite stones marking important dates, informative bronze plaques, and signs that enhance park users' understanding of New Jersey's capital.

"The response has been terrific," says Pamela Garrett, environmental project manager with the New Jersey Department of Transportation. "From the start, we got everyone involved, including Boy Scouts, county and city officials, permitting agencies, resident associations, the parks department, and many others, through a tremendous community outreach effort. Since the riverwalk opened 2.5 years ago, it's been used as an outdoor classroom. A couple was married there. Historic preservation groups have used it as a case study and hosted field trips and seminars there. People have been excited by the project, every step of the process."

Creating the 3.2-kilometer (2-mile)-long park involved significant research, complex and multifaceted historical and archaeological issues, subsurface testing, data recovery, and monitoring during construction. From the project's earliest stages, workers uncovered many artifacts relating to the region's past. As a result, planners decided to include a historical and archaeological emphasis in the park's design to provide users with a tangible educational component, spanning Trenton's history from Native Americans to industrial giant and Brooklyn Bridge architect John Roebling, who manufactured wire rope cable in the city.

With a bikeway and pedestrian trail, esplanade, three pavilions, and two children's playgrounds, the riverwalk connects the nearby community to the Delaware River in a historically informative and enriching fashion. Improved access to downtown Trenton, as well as sports, recreational, and entertainment facilities on the waterfront, provides economic opportunities and supports tourism. The park also serves as an outdoor classroom, capable of educating visitors about the heritage of the Delaware Valley.

Vollmer Associates

Created by sculptor Gary Price, "Circle of Peace" invites visitors to enjoy Trenton's South Riverwalk in a spirit of harmony and cooperation. The dancing children symbolize the city's future and potential.

Bill Hall, Caltrans

When Caltrans discovered that sound waves produced by pile driving activities could adversely affect fish, the agency developed the Energy Attenuation System to protect marine life during the Bay Bridge Skyway project. The system produces an underwater curtain of air bubbles around a series of six battered piles, such as the one in the photo, to diffuse the sound waves.

Caltrans Uses Bioacoustics To Mitigate Impacts on Fisheries

Sound travels faster underwater than it does on dry land. During bridge-building projects, pile driving can create sound waves that may be harmful to fish and other sea life.

The California Department of Transportation (Caltrans) and its Federal partners developed an innovative technique to minimize adverse impacts on marine organisms during pile-driving work for the new east span of the San Francisco-Oakland Bay Bridge and other Bay Area seismic retrofits. With the assistance of expert consultants, Caltrans studied the impacts on aquatic species during a pile installation demonstration. Researchers monitored the underwater sound pressure waves, observed the impacts on fish, and evaluated the effectiveness of innovative mitigation technologies.

Caltrans, FHWA, and the National Oceanic and Atmospheric Administration's National Marine Fisheries Service collaborated to streamline

the environmental process through rapid response and emergency consultations on this cutting-edge issue. The researchers developed a highly effective bubble curtain system that substantially diffused pile-driving noise and significantly reduced the project's impacts on fish.

"The bubble curtain is actually a system of manifolds that surround a pile while it is being driven," explains Bart Ney, public information officer for Caltrans District 4. "There are a series of concentric rings that have small openings on the inside that blow air out of them and create an insulating field of air bubbles. A barge at the site pipes air through the manifolds. As the pile is driven, the bubbles around it attenuate the sound wave."

The successful results from this and other Bay Area projects led to the formation of the multiagency Fisheries and Hydroacoustics Working Group. Composed of agency representatives supported by a panel of scientific experts, the workgroup developed *Effects of Sound on Fish*, a report that establishes the current national scientific framework and common understanding of hydroacoustic effects on fish. The report also includes recommendations to guide the analysis of pile driving and suggests further research that will support the development of final guidelines for managing and minimizing the effects of pile driving on aquatic ecosystems.

NCDOT Leads Nation in Environmental Research

The NCDOT environmental research program is recognized as one of the Nation's most comprehensive and diverse. Through effective collaboration and partnerships with regulatory and resource agencies, NCDOT is able to deliver efficient and environmentally sensitive transportation projects.

The NCDOT program includes research in wetland and stream mitigation, freshwater mussels, genetic isolation of species, wildlife passages, and water quality. In addition, the researchers actively study issues involving air quality, alternative fuels, historic resources, and community impact assessments.

For each project, a technical steering and implementation committee directs the research, reviews progress, and participates in implementation of the results of the research. Although NCDOT solely funds the environmental studies, it invites experts from a number of regulatory agencies to participate on the committees and provide advice on research needs and direction. These partnerships enable NCDOT and the other agencies to work together to discover innovative solutions to environmental concerns. The regulatory agencies develop a sense of ownership in the solution rather than just the problem. In addition, the environmental research program has created positive relationships with the academic community, including a number of colleges and universities.

Dr. R. A. McLaughlin, NC State University

Two researchers from North Carolina State University are reading a stream gauge to check the water level of a tributary of the Old Fields Creek in Ashe County, NC. This project, which involves evaluating systems to reduce the impact of road construction on mountain streams, is among those that helped NCDOT earn an award for excellence in environmental research.

NCDOT has made great strides with its environmental research program and has contributed to the important mission of providing safe, cost-effective, environmentally compatible transportation projects.

Boston's Big Dig Contributes to a Livable and Sustainable Community

Officially, it's called the Central Artery/Tunnel Project. Around Boston, MA, most people know it as the "Big Dig"—a construction project widely regarded as the largest, most complex urban highway undertaking in America's transportation history. This wide-reaching project is transforming the city's historic landscape as it replaces an elevated highway with an underground roadway that will enhance the compact, walkable character of downtown Boston.

To relieve congestion, the project decreased the number of on and off access ramps to help separate local and interstate traffic. Along with dramatically easing surface traffic, the project will yield several first-rate parks and greenways that will benefit Boston's residents, workers, and visitors. One park, called the Rose Kennedy Greenway, will be created on land once occupied by the old central artery elevated expressway that cut off downtown Boston from its waterfront.

Further, the Big Dig involved one of the most comprehensive environmental impact statements since the establishment of the National Environmental Policy Act. Throughout the design and planning stages, project contributors collaborated and held hundreds of community meetings with a number of constituencies, including stakeholders living

or doing business in directly affected areas, as well as Federal, State, and local agencies.

Ultimately, the project will help increase accessibility, improve environmental quality, and enhance the livability and vitality of the neighborhoods in downtown Boston.

NYSDOT's Route 25 Project Improves Water Quality In Greenport

Improving transportation safety was just one of the goals of the New York State Department of Transportation's (NYSDOT) State Route 25 (Front Street) project. The reconstruction also aimed to preserve the natural environment and scenic quality of the village of Greenport in eastern Long Island.

Developed as part of a waterfront redevelopment effort, the multifaceted project maintained the community's historic character and demonstrated environmental sensitivity while improving mobility. Through partnerships with community stakeholders, NYSDOT and village officials made enhancing wetlands and water quality a major focus. A significant achievement was the overhaul of the entire stormwater drainage system, with resulting improvements in the quality of the roadway runoff before it reaches Greenport Harbor.

Other key elements included eliminating deficiencies in the treatment of stormwater, repairing deteriorated drainage structures, improving water quality in the harbor area and waterfront, and creating two functional basins near the waterfront that resemble natural ponds. These basins fit harmoniously with the waterfront ecosystem and village improvements, while filtering sediments from runoff, providing wetland habitat, and attracting waterfowl.

Specific waterfront improvements also included replacement of the headwall and bulkhead and the addition of a boardwalk. The result is a functional drainage system that is in harmony with the waterfront ecosystem, roadway, and village improvements. This project illustrates that government agencies and communities can work together to resolve aesthetic, traffic safety, and environmental concerns by integrating innovative and emerging techniques for stormwater management and wetland creation into an overall transportation plan to protect and enhance water quality in an urban area.

Raleigh's Reedy Creek Greenway Honored as Boon for Nonmotorized Traffic

Located in west Raleigh, NC, the Reedy Creek Greenway system provides a paved, multiuse pathway for bicyclists and pedestrians, connecting residential areas to two college campuses, the North Carolina Museum of Art, the Prairie Ridge education center, a university research forest, and William B. Umstead State Park. The planning and implementation of the greenway system was a collaborative effort involving many private and public stakeholders.

One of the greenway's highlights is a 200-meter (660-foot) pedestrian bridge over the I–440 Beltline, a major six- to eight-lane freeway around the city. An important link in the region's alternative transportation system, the greenway offers residents an opportunity to walk, run, and bicycle on a safe, scenic trail that connects neighborhoods inside the Beltline to some of the area's most visited cultural and recreational sites.

CDOT Creates Plan for Managing Snow on Mountain Pass

As it crosses the Continental Divide, U.S. Route 40 reaches an elevation of 3,446 meters (11,307 feet) above sea level on Colorado's Berthoud Pass

A special event organized by the North Carolina Museum of Art celebrated the opening of the new Reedy Creek Greenway in April 2005. Here, actors dressed as the sun, moon, birds, and plants are personifying elements of the natural environment. *Photo: Mary P. Meletiou, Institute for Transportation Research & Education, NC State University.*

These cyclists, led by NCDOT Board of Transportation Member Nina Szlosberg, wait to try out the newly completed Reedy Creek Greenway, a project that earned NCDOT an Environmental Excellence Award from FHWA in 2005. *Photo: Mary P. Meletiou, Institute for Transportation Research & Education, NC State University.*

Honorable Mentions

White River-Cotter Bridge Repair

The Arkansas State Highway and Transportation Department repaired or replaced at least 60 percent of Cotter Bridge over the White River. The original historic arched bridge was completed in 1930. To eliminate the need for building a costly and time-consuming framework under the bridge, workers used the rainbow arch construction technique, assembling steel arches on the ground and then lifting them into place on the piers.

New York Avenue Station

The Washington Metropolitan Area Transit Authority's New York Avenue Station in Washington, DC, integrates pedestrian and bicycle facilities into the new transit station, providing multiple transportation connection options for the local and regional community. The District of Columbia Department of Transportation worked with the transit authority to include its planned bicycle path in the station design and subsequent construction.

Indian Street Bridge Project Development And Environmental Study

With its project development and environmental study for the Indian Street Bridge, which crosses the St. Lucie River between the south Florida towns of Palm City and Stuart, the Florida Department of Transportation's District 4 Office of Planning and Environmental Management showcased an innovative approach to public involvement. The department used a consensus-building process to work with communities to develop innovative ideas to address the concerns of elected officials, the residential and business communities, and local, State, and Federal agencies.

Mill Ruins Park

The Minnesota Department of Transportation, Minnesota Park and Recreation Board, and URS, Inc. created Mill Ruins Park as an interpretive centerpiece that is playing a major role in the revitalization of the historic Minneapolis West Side Milling District. The park has historical and archaeological importance and offers statewide and local scenic, recreational, and cultural attractions.

Mountain. Built as a wagon trail in 1874, the two-lane road measures as little as 7.6 meters (25 feet) wide in places. As might be expected, snow—approximately 1,270 centimeters (500 inches) of it annually—causes problems on the narrow pass during many months of the year. After heavy storms, maintenance crews have limited space to plow and pile the mounds of snow cleared from the road. And although sand spread on the roadway helps provide traction for motorists during winter, it also causes sedimentation problems once warmer weather arrives.

To improve safety and reduce maintenance issues on the mountain pass, the Colorado Department of Transportation (CDOT) created a plan for roadside management and maintenance that involves widening the highway to three lanes measuring 20 meters (66 feet) wide, adding safety barriers, and installing snow storage areas between the road shoulders and safety barriers. A system of ditches and culverts, with numerous inlets, will ensure that leftover sand is transported with the snowmelt and runoff through a piped system to a number of strategically placed sediment basins.

Once the sand reaches the concrete sedimentation basins and settles out, maintenance crews can recover it and return the clean water back into the Hoop Creek watershed. Sloped access ramps permit loaders to enter and easily remove the sand from the storage areas; sweeping operations facilitate removal of any additional sand. Also, cut-and-fill slopes from the original highway construction were terraced, stabilized, and replanted to prevent erosion.

CDOT established these measures as permanent best management practices along Hoop Creek, and the agency expects these changes to provide substantial improvements in water quality. This project demonstrates that cost-effective management and maintenance activities can promote environmental protection and protect water quality near roadways.

Excellence in Environmental Leadership: William Ruediger

A longtime advocate of habitat protection, Bill Ruediger is one of the leading practitioners of the emerging science of road ecology. Serving as the ecology program leader for highways in the U.S. Department of Agriculture (USDA) Forest Service, he led numerous interagency efforts over

CDOT

This aerial photograph shows a series of switchbacks on U.S. Route 40 as it climbs toward the top of Berthoud Pass in Colorado. The project involved widening the road and installing a drainage system to capture leftover sand from snow maintenance activities, thereby protecting the water quality in nearby Hoop Creek.

CDOT

The terraced and revegetated slopes shown here along mountainous U.S. Route 40 in Colorado help reduce erosion and protect streams and the local watershed from sedimentation.

the years to address the effects of roads and highways on large, wide-ranging carnivores. During his career, he has led several statewide and regional efforts to identify wildlife habitat linkages and establish habitat conservation plans for use by transportation and resource agencies.

In 2001, he participated in a technology scanning tour cosponsored by FHWA and the American Association of State Highway and Transportation Officials (AASHTO) to examine how countries in Western Europe address the effects of highways on wildlife mortality and habitat connectivity. Transportation agencies also benefited from Ruediger's continued support of the International Conference on Ecology and Transportation series and from his expertise in road and highway development. He played a major role in leading the conference to its current status as the foremost international gathering of transportation and ecological experts.

The 2005 Excellence in Environmental Leadership award recognizes Ruediger's outstanding career, marked by leadership, commitment, foresight, and tireless efforts to improve habitat connectivity and protect wildlife along U.S. highways.

A Place of Honor

For those interested in tossing their hats—or projects—into the ring, the next application period opens April 22, 2006. Starting on that date, the entire process, including obtaining and submitting applications, can be completed online. During the open application period, FHWA will promote the process through newsletters, e-mail, and other venues.

"Any project that uses Federal-aid highway funds is eligible," says FHWA's Bank. "We encourage everyone who qualifies to apply because it's really a win-win situation. FHWA gets to recognize its stakeholders, the State DOTs, and they get to acknowledge their partners, which can include other government agencies, companies, and private environmental organizations. The awards are a great way to create an awareness of how the DOTs are practicing good environmental stewardship, which goes a long way in helping them deal with agencies and the public."

Award winners share the spotlight during a special ceremony at FHWA headquarters. "The winners are very enthusiastic," Bank says. "We cover the expenses for one representative from each winning entry to join us at the presentation and receive their award from the FHWA administrator. In many cases, [the winning organizations] pay for other staff members to come along."

Although this year's ceremony is over, the fanfare continues. More information on the 2005 winners is available at www.fhwa.dot.gov/environment/eea2005/index.htm. In addition, FHWA plans to publish a 2006 daily planner that features a different winner each month.

Patricia A. Cazenas, P.E., L.S., is a highway engineer in the FHWA Office of Natural and Human Environment in Washington, DC. She is the program manager for the Environmental Excellence Awards.

The Future of Highway Financing

by Jim March

FHWA convened a roundtable of transportation finance and policy experts to discuss highway financing options.

Investment requirements to maintain the condition and performance of the Nation's highways, such as this one near Long Beach Harbor, CA, exceed projected revenues from current sources. *Photo: Scott McKenzie, Caltrans.*

Where will the dollars come from? Concerns about the adequacy of revenues from fuel taxes and the indirect link between fuel taxes and specific improvements to highways are leading highway administrators to reexamine long-term options for highway financing. For example, efficient pricing is one solution that may reduce congestion without requiring expensive new highway capacity; however, it "rocks the boat" in terms of existing methods of doing highway business. Exploration of alternatives can raise a number of economic, technological, equity, privacy, and public policy issues.

To discuss some of these key issues, their implications for the future, and options for highway finance, on May 21, 2004, former Federal Highway Administrator Mary E. Peters convened an informal roundtable titled "Future Highway Finance Issues and Options." The roundtable included 22 participants representing the Federal Highway Administration (FHWA), U.S. Department of Transportation (USDOT), American Association of State Highway and Transportation Officials (AASHTO), Transportation Research Board (TRB), and private consultants with expertise in highway finance. The goal was to further the dialogue on the need to explore financing alternatives, but not to come to a consensus on any of the issues or to draw conclusions concerning the most promising financing options.

In laying the framework for the roundtable discussion, former Administrator Peters said, "States face many challenges as they examine new ways to finance their highway systems, including planning for major projects, assessing the long-term viability and stability of new revenue sources, developing implementation strategies for new financing methods, and identifying winners and losers for alternative financing strategies."

Highway Pricing

Much of the roundtable discussion concerned the relative merits of moving toward greater use of pricing to finance new highway capacity and manage demand. Economists have talked for many years about the benefits of more efficient highway pricing—charging more for highway use during peak periods to reduce demand when strains on highway capacity are the greatest.

"Interest in the potential for peak period pricing to reduce highway congestion now is moving beyond the academics to highway administrators who see pricing as a way to reduce congestion without constructing costly new capacity," said FHWA Executive Director Frederick G. "Bud" Wright.

Technological improvements such as open-road tolling now make pricing a more feasible option for addressing congestion, and motorists in highly congested urban areas, such as Washington, DC, are beginning to consider pricing as a potential alternative to relieve congestion. In the near term it is unlikely that many U.S. cities will implement areawide pricing as has been done in some European and Asian cities. More likely, only parts of the network will be priced so that motorists have the choice of paying a toll to travel on uncongested roads or not paying a toll to travel on congested roads. Roundtable participant Robert D. Atkinson, vice president of the Progressive Policy Institute, noted, "We have failed over the past 15 years to provide choices that American motorists want."

The Federal Role in Highway Finance

During the roundtable, the discussion also focused on the Federal role in financing highway improvements. Participants generally were very supportive of the flexibility that was

Background

For many years, fuel taxes and other revenues from highway users levied by the Federal Government and States have been a primary source of funds for Federal and State highway programs. A relatively small number of counties and municipalities also levy fuel taxes to finance highway improvements, but these local governments rely primarily on general funds, property taxes, sales taxes, and other revenues unrelated to highway users to finance local road and street construction, maintenance, and operation.

Historically, States and the Federal Government have viewed fuel taxes as an attractive revenue source for highway construction and maintenance programs for several reasons. First, the revenues from fuel taxes are linked, although imperfectly, with highway use. In addition, fuel tax revenues historically have been relatively stable and predictable. Legislators and/or the electorate have been willing to increase the fuel tax rates when necessary to meet highway improvement needs. Fuel taxes are attractive revenue sources also because costs to administer the programs to collect fuel taxes are low. Finally, fuel tax revenues in most States and from the Federal Government are dedicated at least in part for highways and related purposes, shielding the funds from the uncertainties of annual budgetary processes.

In recent years, several of these factors have undergone a change, leading many in the transportation community to conclude that alternatives to the fuel tax may be needed to fund future highway programs. One development is the growing disparity in vehicle fuel economy, which tends to make the fuel tax less equitable. The relationship between highway use and fuel tax payments is not as direct as it used to be. Another factor is that future vehicle fuel economy is predicted to increase, thereby reducing fuel tax revenues for each mile of travel.

In addition, legislators and the electorate in many States have been increasingly reluctant to approve increases in the fuel taxes. Opposition to raising taxes of any kind is increasing, and raising the fuel tax in particular has been difficult because of the growing disconnect in the view of many motorists between increased fuel taxes and observable improvements in highway condition and performance.

Some jurisdictions have chosen other alternatives to increasing fuel taxes, such as sales and other local option taxes. Martin Wachs, director of the Institute of Transportation Studies at the University of California, Berkeley, indicated that "more than one third of highway funding in California is from local option taxes."

Still another indication that new revenue sources may be needed is that fuel taxes do not automatically increase with rising highway construction costs. With a diminished ability to increase overall fuel tax rates, the revenues are not keeping pace with rising construction costs.

Using value pricing on selected existing or new highway facilities could provide motorists in many cities with an alternative to sitting in traffic congestion like this four-lane gridlock.

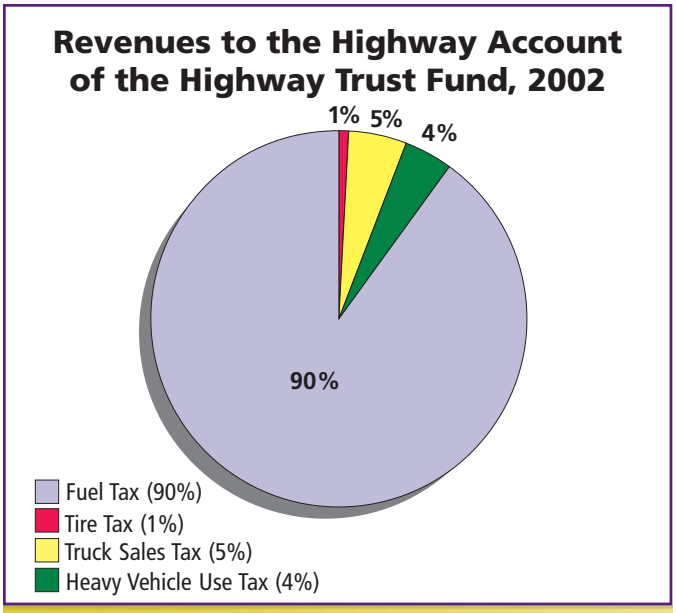
given to State and local transportation agencies to identify and fund transportation improvements that meet their unique needs. Former Administrator Peters emphasized that a strong Federal role may be necessary in certain areas, including "interstate and international commerce, safety, national defense and security, research and standards development, and provision of roads on Federal lands." She summarized, "A clear understanding of the Federal Government's interests in those program areas is necessary to evaluate its future role in highway finance."

A trend in recent reauthorization acts is an increase in the amount of Federal funds earmarked to specific projects by members of the U.S. Congress, and the latest Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) is no exception. This earmarking affects the ability of States to meet State and Federal priorities, and the trend has implications for future highway financing. For a number of years, some transportation policy analysts have maintained that part of the Federal highway program should be devolved to the States. However, there are constraints on the extent to which the Federal highway program can be devolved. Roundtable participants pointed out that a reduction in Federal tax rates would make it difficult politically for States to increase their tax rates to generate the same levels of revenue. Also, needs and revenue-raising capabilities differ dramatically among the States. Sparsely populated States may not be able to fund improvements to routes essential for interstate commerce and may require more funding than can be generated by motorists in those States.

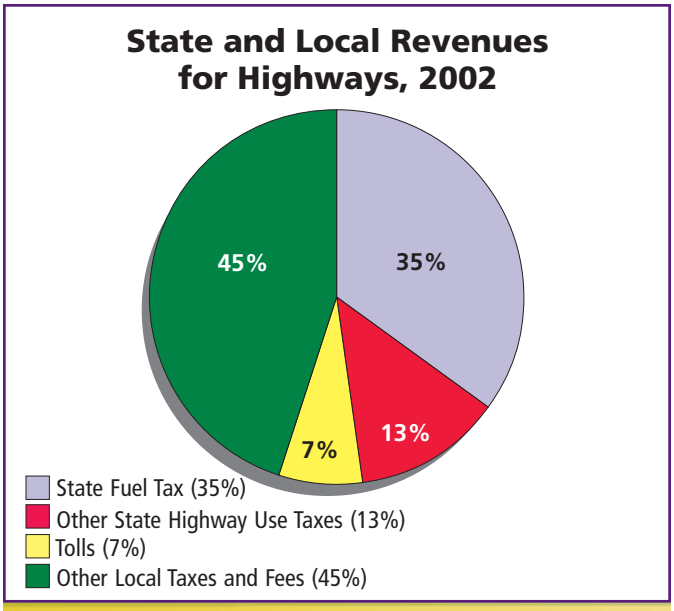
The Federal role in any transition to alternative highway revenue sources also was discussed at the roundtable. As highway agencies move toward new funding mechanisms, one option mentioned would be to have the Federal Government collect the highway taxes and then redistribute them to the States. Administratively, this could save costs and reduce evasion, but States would insist on retaining their authority to set tax rates.

Another long-term model might be for one or more private-sector entities to collect taxes on behalf of Federal, State, and local government. Funds then could be credited to those units of government on the basis of their respective tax rates and the amount of travel in each jurisdiction. This option may have some of the administrative benefits of Federal tax collection but would not compromise the ability of State and local governments to independently adjust tax rates.

The Federal role in helping to facilitate the transition from reliance on fuel taxes to greater use of direct user charges would be to promote standards for transponders and tax



Fuel taxes supply 90 percent of the 2002 revenues to the Highway Trust Fund, with taxes on tires, truck sales, and heavy vehicle use together accounting for only 10 percent. *Source: FHWA.*



State fuel taxes and local taxes and fees account for 35 and 45 percent of State and local highway revenues, respectively, while tolls and other State highway use taxes comprise the remaining 20 percent. *Source: FHWA.*

collection mechanisms. The roundtable participants did not suggest that the Federal Government attempt to impose a single financing mechanism on the States. FHWA Associate Administrator for Policy Charles D. "Chip" Nottingham suggested, "States could test and evaluate a variety of potential financing mechanisms and choose the one or ones that best meet their needs."

The private sector also could play a role in developing innovative solutions to State financing requirements. Because States have quite different financing requirements and capabilities, future State financing structures may be no more uniform than current structures.

Another potential role mentioned for the Federal Government relates to the financing of megaprojects that have national or regional benefits

Property tax revenues could be a financial basis for local road construction around new highway interchanges like the Marquette Interchange in downtown Milwaukee, WI (shown in this artist's rendering). Increases in tax revenues from increased property values can be used to help finance highway construction.

and often cost more than a single State can afford. Examples include the Alameda Corridor in Los Angeles, CA; Chicago Regional Environmental and Transportation Efficiency Project (CREATE); port improvements; and other projects of national significance.

General Taxes

An important issue discussed during the roundtable and in the e-mail dialogue that preceded the meeting concerned the advantages and disadvantages of various types of revenue sources for highway expenditures. Included were user taxes, especially fuel taxes. Revenues to the Federal Highway Trust Fund currently come almost exclusively from highway user taxes. And 90 percent of those are fuel taxes.

Revenues for State highway programs also depend heavily on fuel taxes and other highway use taxes. But local governments tend to rely heavily on property taxes, sales taxes, and general funds as well to support their highway programs.

Most participants agreed that general taxes (property taxes, income taxes, and other general funds) are poor revenue sources to finance highway construction because they bear no direct relationship to highway use. Nevertheless, general taxes now represent about 25 percent of total revenues for highway purposes. About 75 percent of these general taxes are collected and expended for highways by local government agencies. Weaknesses of using general taxes for highways include the following:

- Using general funds for highways draws those funds away from other programs that do not have potential direct revenue streams.
- Because of long-term development associated with road building and the shifting priorities associated with general tax dollars, it is difficult to plan and contract for higher cost, long-term transportation projects.
- Users generally are more receptive to paying charges that are tied to specific improvements.
- General taxes do not reflect external costs associated with highway use, such as vehicle emissions that affect air quality, other environmental costs, and some safety costs.
- Using general funds to supplement or replace user charges can lead to inefficient use of the highway system because general funds are not tied at all to highway system use.

To avoid such inefficiencies, an option would be for users to pay in proportion to their share of the costs of providing transportation facilities and services and the benefits they derive from using those facilities and services.

In general, the roundtable participants agreed that general taxes, especially property taxes, are more appropriate for funding local road improvements than for funding major State highway systems. The reason is that a primary function of local roads is to provide access to local properties, and local property owners are the major beneficiaries of that access. Highway improvements can increase property values, so there is some rationale for financing some local road improvements from property tax revenues. Many roundtable participants believed, however, that too large a revenue share for highways now comes from property and other general taxes.

Specialized Taxes

In recent years, local areas have begun to use specialized taxes, such as local sales taxes, special assessments, improvement district fees, and related taxes, to finance highway improvements. Although these specialized taxes suffer from the same problem as general taxes in that they are not directly related to highway use, the roundtable participants believed that specialized taxes may be a somewhat better option for financing highway improvements.

Local sales taxes are among the most popular of the specialized taxes. California, in particular, has made extensive use of local sales taxes to finance road improvements in recent years. Most jurisdictions require a referendum on whether to raise local sales taxes to finance a specific improvement or set of improvements.

Sales taxes collected at stores like this one are among the more popular taxes for financing highway improvements in California.

Fees on new development, such as the new townhouses shown here, adjacent to highway improvements can provide substantial revenues to help fund improvement costs.

Sales taxes and other specialized taxes work particularly well for such focused uses. Not only are they dedicated to specific projects, but local voters must approve the taxes and ultimately pay for the highway improvement—rather than using a general purpose tax that is paid by users from outside the region who do not benefit from the improvement. Less frequently, local sales taxes are simply tapped as an additional source of general funds for highway improvements.

In many States, the sales tax has become the most politically feasible option for local areas looking to finance major new transportation initiatives. The reason is simple, according to a study, *Local Option Transportation Taxes in the United States*, for the Institute of Transportation Studies at the University of California, Berkeley: More than for any other tax option, taxpayers have been willing to approve sales taxes on a scale that makes major new infrastructure projects possible. One explanation appears to be the dedication of revenues for specified improvements.

"Another factor that makes the local sales tax attractive to the electorate is that the tax has such a wide base," said roundtable participant Susan J. Binder, director of the FHWA Office of Legislation and Strategic Planning. "A small increment in the tax rate is barely perceived on individual purchases, but when applied to a large number of items, it can generate substantial revenues."

Another specialized tax that has been used to finance highway improvements is the developer fee. "Many believe that it may be appropriate to require developers to pay at least part of the cost of providing local roads that serve their developments," said roundtable participant David J. Forkenbrock, director of the Public Policy Center at the University of Iowa.

Ultimately these developer fees are passed on to the households and businesses that purchase property in the development. This option is similar to tax increment financing where increases in property values are tapped to pay for part of the cost of road improvements.

Another related specialized tax is an improvement district fee. This alternative is especially useful for transportation improvements that traverse taxing districts because the improvement district can be defined to encompass whatever area is deemed to benefit from the

Tolls and other direct user charges will be increasingly important sources for funding major bridge, tunnel, and roadway facilities, like this tunnel at the Canadian border.

Detroit & Canada Tunnel Corporation

transportation improvement. Within this category of taxes, several different specific types of taxes could be levied. The objective would be to have those users and property owners who benefit from the transportation improvement pay the cost. This option may be especially applicable to megaprojects, because they often cross jurisdictional boundaries.

Direct User Charges

Most of the roundtable participants believed that highway financing should move toward greater use of direct user fees, such as tolls or mileage-based taxes. The advantage of direct user charges is that rates can be set to better reflect the costs associated with the use of highway facilities.

There was less agreement about which costs should be reflected in direct user charges. At present, many toll authorities set toll rates at levels sufficient to generate revenues to pay off bonds issued to construct the toll road; to pay maintenance, operating, and administrative costs; and perhaps to provide a sinking fund for future rehabilitation and enhancements.

In some cases, tolls on highways and bridges are continued after the bonds have been paid off, and the revenues are used to subsidize other transportation improvements. In these cases, overall tolls may be higher than the cost of constructing and operating the toll road.

Recently, interest in value pricing has been increasing, enabling toll rates to be higher during peak than offpeak periods. In these cases, the tolls are intended to reflect the benefits of traveling in less congested conditions, not the cost of constructing, operating, and maintaining the facility.

There was some discussion about the fact that different users impose different costs upon the system. Heavy trucks, for instance, cause greater pavement and bridge wear and contribute more to congestion than do automobiles, so the participants believed that it is appropriate to charge higher rates for trucks. Toll authorities do charge trucks higher tolls than passenger vehicles, but toll structures generally do not reflect a formal estimate of the relative costs associated with the operation of different types of vehicles.

Several potential impediments to direct user charges were discussed. First, administration and collection costs are higher for direct user charges than for fuel taxes. With direct user charges, each driver generally would be responsible for paying charges they owe to tax collection agencies. However, when drivers purchase fuel, Federal and State taxes have already been paid by companies further up the fuel distribution chain. Fewer taxpayers means that collection, enforcement, and other administrative costs would be lower for fuel tax collection agencies than for agencies responsible for collecting direct user charge payments.

Second, fully implementing direct user charges could take considerable time. In certain congested metropolitan areas—such as Orlando, FL, and Dallas, TX—users have demonstrated an increasing willingness to pay tolls for added capacity, particularly where they also receive improved levels of service. But other users generally have not favored tolls.

Third, where variable tolls are charged to maintain free-flowing traffic, the tolled lanes are widely regarded as "Lexus Lanes" out of concern that they benefit the wealthy more than other socioeconomic groups. According to a California Department of Transportation report, *Continuation Study to Evaluate the Impacts of the SR 91 Value-Priced Express Lanes*, actual experience has demonstrated that users come from all income levels.

Fourth, users have resisted tolling existing lanes. One reason for this is that users believe they have already paid for the existing facilities and should not be charged twice.

Fifth, it may be difficult to operate a toll facility when there is a mature system of free roads available to potential users. Where the toll facility is priced to maintain free-flow operations, users will pay when the free roads are congested, but during offpeak periods when the

free roads are uncongested, few motorists may be willing to pay to use the toll facility.

A factor reflecting all of these impediments is an apparent reluctance on the part of politicians to propose or support tolls because of uncertainties about how the electorate will react.

The trucking industry has much to gain if highway performance can be improved, but the industry generally has opposed tolls. Some portions of the trucking industry have indicated that they might support tolls if more productive vehicles were allowed on the toll roads. A recent study by the Reason Foundation, *Corridors for Truck Tollways: Suggested Locations for Pilot Projects*, concluded that exclusive toll roads for trucks might be feasible in a number of corridors.

Despite uncertainties about how quickly direct user charges can be implemented, former Administrator Peters emphasized during the roundtable that transportation agencies should not be timid about implementing this option. "The benefits in terms of more efficient use of roadways through pricing and direct user fees that will help raise revenues needed to improve our Nation's highway system are too great to delay implementation of these tools," she said.

One thing that could help expedite implementation of direct user charges is a defined implementation path for moving forward. Currently, States are implementing direct user charges on an ad hoc basis, although the Federal Value Pricing Pilot Program has encouraged a number of areas to investigate different types of pricing options. Studies of high-occupancy toll (HOT) lanes are underway on I–15 in San Diego, CA, and I–10 and U.S. 290 in Houston, TX. And researchers are looking at express lanes on S.R. 91 and peak pricing on the San Joaquin Hills Toll Road, both in Orange County, CA.

Studies Underway Or Planned

Several initiatives already are underway to begin exploring future highway financing issues and options. To describe the current policy framework for transportation finance and evaluate options for a long-term transition to sources other than fuel taxes, TRB, FHWA, and the National Cooperative Highway Research Program cosponsored a study, *Long-Term Viability of Fuel Taxes for Transportation Finance*. The report is scheduled for publication in January 2006. Specific goals are the following: (1) Determine the extent to which alternatives to fuel taxes will be needed in the next two decades; (2) Analyze the pros and cons of different alternatives; (3) Suggest ways in which barriers to these alternatives might be overcome; (4) Recommend steps for enhancing the efficiency and fairness of the fuel tax; and (5) Recommend, as necessary, a transition strategy to other revenue sources.

Fifteen States and FHWA participated in a pooled fund study, *A New Approach to Assessing Road User Charges,* published by the University of Iowa Public Policy Center (www.ppc.uiowa.edu), to design a mileage-based road user charge. This alternative approach to assessing road user charges would utilize new technology that is currently available and expected to be widely available in the future. A major part of the study involved assessing various institutional barriers such as privacy concerns and public acceptance that would have to be overcome before this new revenue mechanism could be implemented. Recognizing the many technological and public acceptance issues that would need to be overcome, the study recommended a thorough field test and evaluation of the financing method. A large-scale test of this revenue mechanism was called for in Section 1919 of the SAFETEA-LU.

Under the Value Pricing Pilot Program, Oregon plans to test a mileage-based highway financing method that would replace the fuel tax if implemented. The mileage-based method differs in detail from the one analyzed in the pooled fund study noted above, but it also has some common elements.

Conclusions

The fuel tax has provided a stable revenue source that has enabled the United States to construct the finest highway system in the world. However, a number of groups are questioning the long-term viability of the fuel tax to finance future expansion, maintenance, and operation of that system and are examining alternative mechanisms to fund future improvements to the highway system.

Technology will introduce a much broader range of options than could have been considered 10 years ago, but technological issues are perhaps the easiest to address. There will be winners and losers with any new tax mechanism, and nontechnical issues like privacy and public acceptance will be critical in developing revenue alternatives.

The transition path to new mechanisms is not clear, and it likely will vary among different jurisdictions. What is clear is that developing a consensus on alternative approaches will take considerable time and public involvement. Fortunately, alternatives do not have to be implemented immediately, but most transportation finance professionals participating in the roundtable indicated that the transportation community should not postpone addressing the many issues facing Federal, State, and local governments as they look toward how to finance future highway transportation programs.

Jim March is leader of the Industry and Economic Analysis Team in FHWA's Office of Policy. He manages a multidisciplinary team of economists, engineers, and transportation specialists who conduct a broad variety of transportation policy studies on topics such as public-private partnerships, highway finance, highway cost allocation, the Federal role in surface transportation, strategic multimodal freight analysis, and impacts of highways on economic productivity.

For more information, contact Jim March at jim.march@fhwa.dot.gov or 202–366–9237.

This article is the third in a series on innovative financing that will continue to run in the next few issues of PUBLIC ROADS. One of FHWA's priorities is encouraging the use of innovative financing.

FHWA is evaluating new technologies and techniques to determine how well they improve safety.

by Tamara Redmon

Looking Out for Pedestrians

Every year in the United States nearly 5,000 pedestrians are killed and approximately 70,000 are injured. These pedestrian deaths represent nearly 11 percent of all roadway fatalities nationwide. Although the long-term trend indicates that pedestrian fatalities have decreased from a high of 8,096 in 1979 to a low of 4,749 in 2003, the Federal Highway Administration (FHWA) and State departments of transportation (DOTs) recognize that pedestrians are still being killed or seriously injured on the Nation's roadways.

To help further reduce the fatalities, FHWA set an ambitious goal of reducing pedestrian fatalities by 10 percent by 2008. To achieve this goal, FHWA is looking for new strategies and technologies to improve pedestrian safety and is evaluating some new options as part of a 6-year project known as the Pedestrian Safety Countermeasure Deployment Project.

(Above) At test sites like this one in Miami, FL, FHWA is evaluating new safety treatments that may help motorists and pedestrians become more aware of each other. Although the intersection includes a pedestrian refuge area, the continuous right turn lane can prove hazardous for pedestrians. At this site, researchers will install a sign directing turning traffic to yield to pedestrians. *Photo: Dan Nabors, BMI-SG.*

FHWA's Pedestrian Safety Countermeasures Deployment Project

The goal of the Pedestrian Safety Countermeasure Deployment Project, scheduled for completion in December 2006, is to evaluate the effectiveness of various pedestrian safety treatments, or countermeasures, in three cities: Las Vegas, NV; Miami, FL; and San Francisco, CA. The findings from these studies then could be applied to other cities across the country.

During phase one of the two-phase study, three teams of researchers documented the pedestrian incident problems in each of the cities to identify the optimal

locations to install safety countermeasures. The researchers first collected data on all fatal and nonfatal crashes involving pedestrians and then mapped them using geographic information system (GIS) technology. "The 'zone analysis' method that we are using for this study was developed [by the National Highway Traffic Safety Administration] to identify high density collision locations," says Dr. David Ragland, director of the Traffic Safety Center (www.tsc.berkeley.edu/html/home.html) at the University of California-Berkeley (UC Berkeley). "This method helps us to focus resources on locations with a high promise for collision and injury reduction."

Phase two of the study is implementation, which is currently underway. During implementation, teams are deploying countermeasures at specific sites in the zones they identified during phase one. For the Miami and San Francisco studies, the researchers are treating one site at a time in a staged manner, so they can be sure that any change measured was caused by the countermeasure. Because the other sites along the corridor are untreated, they serve as controls for comparisons to the treated sites.

"We felt that conducting the study in this staged manner would provide better data than the usual before-and-after study," says Ron Van Houten, chair of the Transportation Research Board's Pedestrian Committee, who has been coordinating the Miami portion of the research through the University of Florida. "The problem with the typical before-and-after study is that in the after period other factors can change that affect results. In our case, we collected data at the other untreated sites as well, so we had these control sites to compare to the sites where we implemented treatments. We treated the control sites as well at a later time, which served to replicate the results obtained at the earlier sites."

The researchers are evaluating a wide range of countermeasures. "Some [measures] focus on clarifying rules for who has the right-of-way, [while others provide] pedestrians with more exclusive space by the use of medians and extended curbs," says Ragland from UC Berkeley. "Another approach is to increase the awareness of potential conflicts for both pedestrians and drivers, and for this, ITS [intelligent transportation system] technologies can be very helpful."

Some countermeasures the researchers are evaluating include low-technology techniques, such as signs that are used in new ways, like in-roadway knockdown signs. "Sometimes technology isn't necessarily the only answer," says W. Scott Wainwright, a highway engineer at FHWA who helped to define the standards for traffic control devices in the most recent *Manual on Uniform Traffic Control Devices* (MUTCD). "Sometimes it's just a

At locations with high volumes of pedestrians, like this one in San Francisco's Chinatown neighborhood, traffic signals may be programmed for an exclusive pedestrian phase, also known as a pedestrian scramble. All traffic is stopped, and pedestrians are given a walk phase on all four crosswalks, so they may cross the intersection in any direction, including diagonally. Targeted educational material is essential in advance if such a system is to work properly.

Dan Nabors, BMI-SG

ITE Pedestrian Bike Council

Countdown pedestrian signals like this one have proven popular with the public because they take the guesswork out of how much time a pedestrian has to cross or finish crossing the street.

matter of applying existing technologies in a better way. But if new technologies come along that can help reduce crashes or even make mobility more convenient for pedestrians, then that's worth investigating."

Although the project is still underway, the researchers are finding that some of the more promising ITS technologies in the study include pedestrian signals that count down the time available for crossing, roadway signs that light up to warn motorists of the presence of pedestrians, and pedestrian-activated crosswalk illumination.

Pedestrian countdown signals and animated eye displays are among the safety treatments incorporated into the latest edition of the MUTCD, shown here.

Using Lighting to Improve Safety

Researchers are evaluating smart nighttime lighting in Las Vegas and Miami to determine if using high-intensity light-emitting diode (LED) lighting above crosswalks helps alert motorists to the presence of pedestrians. The study has shown that a sudden increase in lighting intensity alerts motorists that pedestrians are in the crosswalk more effectively than lighting with a continuous intensity. The high-intensity lighting remains lit only while pedestrians are in the crosswalk.

The lighting is activated either when a pedestrian pushes the button to cross or when an automated device detects the pedestrian. "Special lighting that only comes on when a pedestrian is present provides an effective signal to the driver at night," says Van Houten, noting that nighttime crashes account for a high percentage of pedestrian fatalities. "It's also cost effective from an energy standpoint because you can use very bright lighting only when it is necessary."

In-roadway warning lights (IRWLs) also help increase awareness of pedestrians by illuminating the crosswalk from the pavement. "More IRWLs are being [installed] with LED technology to try to reduce the cost," says FHWA's Wainwright. "With LEDs, because they require less electrical power, there are systems being developed that are battery operated and use solar power that recharges the battery. This technology seems to get even better as time goes on, and it should bring the cost down so cities could use them at more crosswalks." FHWA is considering providing additional funding to Las Vegas to evaluate IRWLs as a part of the pedestrian safety countermeasures study. For more information on IRWLs, see "Seeing Crosswalks in a New Light" in the January/February 2004 issue of PUBLIC ROADS.

Pedestrian Countdown Signals

Researchers in all three cities are evaluating pedestrian countdown signals, which show pedestrians exactly how much time they have to cross a street before the light will change. FHWA already has incorporated this technology into MUTCD standards. "The feedback from pedestrians has been really positive, and the studies show positive impacts as well," Wainwright says. "The studies have found that the percentage of pedestrians making what's called a 'successful crossing,' meaning they got to the far side of the crosswalk before the light changed, is considerably larger with countdown signals."

He adds that pedestrians also can make better decisions about whether to start crossing based on the time display. "Particularly, we found [that] someone who is halfway across the street and sees the time winding down will speed up to get across faster," Wainwright says.

These signals also may encourage more pedestrians to use the

Thomas Burnham, Spot Devices, Inc.

A wirelessly activated solar-powered in-roadway warning light, like the one shown here, can provide energy-efficient, in-pavement lighting for crosswalks.

pushbutton rather than jaywalk. "For countdown timers, our study's preliminary data seems to be showing that when you put them in, more pedestrians push the button," says Van Houten. "The more information you give people, the more reason there is to push the button."

The same holds true for pushbuttons that provide feedback to pedestrians. "We know that if the button lights up like an elevator button or sounds a tone after it's pushed, then significantly more pedestrians will push the button, and significantly more will also wait to cross because they can see the pushbutton has been activated," Van Houten says. "So for a very little bit of cost, you get a modest improvement."

Animated Eyes Displays

Animated or "roving" eye displays on pedestrian signals are being evaluated in Las Vegas and San Francisco to determine whether they encourage pedestrians to watch for vehicles turning into the crosswalk from another street. During the walk indication, the animated eyes scan from side to side, reminding pedestrians to look both ways. Animated eye displays for pedestrian signals also have been incorporated into MUTCD standards.

LED animated eyes also may be used to warn motorists of crossing pedestrians. These displays are mounted overhead before a marked but unsignalized crosswalk to alert drivers that a pedestrian is crossing. Pedestrians may activate the sign using the pushbutton, or the system may be automated to detect pedestrians. The animated eye display either looks left, right, or both ways, depending on where pedestrians are crossing. The research teams in Las Vegas and Miami are evaluating whether these animated eye displays help alert motorists to the presence of pedestrians in crosswalks.

In-Roadway Knockdown Signs

In the arena of taking an existing device—a traffic sign—and using it in a new application, engineers are now installing what are known as "in-roadway knockdown signs" to alert drivers to pedestrian crossings. Recently added to the MUTCD, these

Lighting the Way to Pedestrian Safety

For more than a decade, California municipalities have been using in-roadway warning lights (IRWLs, also known as in-pavement flashers and up-lights) as an option to improve pedestrian safety at uncontrolled crosswalks. After San Francisco installed lighted crosswalks at selected school crossings, residents requested that they be put at all of them. As quoted in the *San Francisco Examiner*, former Mayor Willie Brown said, "[We'll] figure out some way to fund them."

IRWL systems offer a number of benefits. First, they activate when a pedestrian is crossing, enabling drivers to learn to associate them with a need to yield or slow down for pedestrians in crosswalks. Second, IRWLs delineate the crosswalk and draw the driver's attention to the roadway. Further, they provide a warning for drivers in the left lanes of a four-lane road, even when the driver's view of the curbside lane and crosswalk may be blocked by other vehicles. Finally, IRWLs can help minimize capital expenses compared to other safety measures that serve the same purpose.

A number of studies have shown that IRWL systems can improve safety for pedestrians. According to a recent study for the New Jersey Department of Transportation, *Pedestrian Crosswalk Safety: Evaluating In-Pavement, Flashing Warning Lights*, by the Lighting Research Center at the Rensselaer Polytechnic Institute, the use of IRWL systems increases vehicular yielding to pedestrians and decreases crosswalk approach speeds. A recent FHWA-sponsored study, *The Effects on Safety of In-Roadway Warning Lights at Crosswalks: Novelty or Longevity?*, reported similar results for driver yielding.

There are, however, some issues localities should consider before implementing IRWL systems. Some traffic engineers are concerned that the small IRWL lights may not create attention-getting visibility during the brightest part of the day, especially when backlit by a setting sun. Maintenance is another concern, especially given the lack of ongoing funding to support grant-based installations. The Intelligent Transportation System Unit Cost Database estimates annual maintenance costs at 10 percent of the initial system cost.

Nevertheless, many cities remain enthusiastic about IRWLs as one tool in the traffic engineer's toolbox for addressing pedestrian safety concerns at uncontrolled crosswalks.

Thomas Burnham, Spot Devices, Inc.

Combining techniques such as IRWL systems, LED-enhanced signage, and midroad 'refuges,' as shown here, can further improve pedestrian safety.

"I think you're going to continue to see more use of IRWLs," says Gerry Meis, chief of the Office of Signs, Markings, and Permits at the California Department of Transportation (Caltrans) and a longtime participant in IRWL discussions at Caltrans.

For more information, see Resource Guide, Regional Pedestrian Committee, Oakland, CA, Metropolitan Transportation Commission, www.mtc.ca.gov, or see www.spotdevices.net, or contact Thomas Burnham at 888–266–6728 or tburnham@spotdevices.net.

by Thomas Burnham

ITE Pedestrian Bike Council

This photo shows a pedestrian signal with animated or "roving" eyes. The eyes serve as a reminder to pedestrians to look out for traffic while they are crossing the street. FHWA's partners are installing animated eye signals like this one as part of its study of countermeasures to improve pedestrian safety.

signs remind approaching drivers that State law requires yielding to pedestrians.

In the past, placing signs in the middle of the road was not permitted because they represented fixed-object hazards. "But new technology has made it possible to fabricate signs from rubber-like material and mount them on flexible posts that bend over and bounce back into position if a vehicle accidentally hits them," Wainwright says. These signs are a direct and very visible reminder to motorists that they must yield to pedestrians in the crosswalk. All three cities are testing in-roadway knockdown signs.

Detecting Pedestrians Automatically

Because many pedestrians do not push the crosswalk button, which both provides pedestrians with adequate time to cross and also can trigger a warning sign for motorists, engineers are evaluating technologies that can detect pedestrians automatically. "Pedestrian detection is an emerging technology," UC Berkeley's Ragland says. "If it works well, it can be used to activate pedestrian crossing signals for pedestrians and also to extend signal timing for a pedestrian who may be delayed in crossing. It also could warn drivers that a pedestrian is crossing, either through electronic signs, or possibly in the future, directly to the driver in a vehicle."

Researchers in Las Vegas and San Francisco are evaluating whether the current technologies are reliable enough. "With respect to having pedestrians detected without having to push a button, there are some very promising technologies that aren't yet quite reliable enough," FHWA's Wainwright says. "In some cases you have to detect every pedestrian, and you have to be 100-percent reliable. At the same time, you don't want false calls when pedestrians aren't there."

Another concern is whether they are affordable. "The big thing we're hoping to see in the future is a cost-effective way of reliably detecting pedestrians without pushbuttons," says Van Houten. One way of doing that is through cameras, but those are typically expensive. "If we can automatically detect pedestrians crossing, not those passing by and not mistaking a vehicle for a pedestrian, then we're becoming more intelligent in monitoring pedestrians so we can alert the motorists."

An additional benefit of automated detection is that if a pedestrian leaves the area and decides to cross elsewhere, the pedestrian signal crossing time can be shortened so vehicular traffic is not delayed unnecessarily.

One Size Does Not Fit All

Until this study is complete at the end of 2006, the researchers will not be able to provide detailed evidence on the most promising techniques to improve pedestrian safety. In the

ITE Pedestrian Bike Council

This photo shows a pedestrian "roving" eyes display that is intended for drivers. The signal is hung over a pedestrian crossing, and when it turns on, the "roving" eyes remind drivers to watch out for pedestrians. The signal is activated by a pedestrian and indicates, by placement of the pedestrian on the sign (right or left), which direction the pedestrian is crossing from.

In-roadway knockdown signs, such as this one installed near the Golden Gate Bridge in San Francisco, are placed in the crosswalk as a highly visible reminder to motorists to yield to pedestrians in the crosswalk. Made from flexible materials, the signs bounce back up if knocked down by a vehicle.

meantime, however, local and State governments can begin to consider whether some of these treatments may be appropriate in their own cities and communities. The researchers selected the various countermeasures for use in the study based on a complete analysis of the safety problem, including the crash data for the location, the factors leading up to each crash, observed "unsafe" behavior of pedestrians and motorists, and assumptions made about each countermeasure and the impact they would likely have on the specific locations.

As with any new traffic control device, engineers should carefully consider their road users and facilities before deciding on a particular treatment. "What works at one site may not work in another, because the roads and other characteristics are different," says Van Houten. "For example, Las Vegas has some very wide roads, while in Miami the roads tend to be narrower. This can be an issue because some pedestrian signs or signals are currently made in only a certain size, so they could be hard to read across a very wide road."

Local engineers must first evaluate the characteristics of a particular intersection or crossing area before selecting a treatment. "For any kind of traffic control device, you can't make generalizations that it will work well in any urban location, because in reality every place and every intersection is different," Wainwright says. "Traffic control devices have to be deployed based on engineering studies of individual locations. Every situation is different, and the engineer makes an assessment of the problems and alternatives for those traffic conditions." Also, because not all of the devices being evaluated are currently approved under the MUTCD, localities must obtain permission from FHWA to experiment before installing any unapproved devices.

Finally, pedestrians and motorists may initially be confused by a new treatment, so localities should make a special effort to educate community members about the use of any new treatments.

This photo of one of the test sites illustrates a typical problem for pedestrian crossings in Las Vegas, where roads tend to be wide, with little or no median, making it difficult and dangerous for pedestrians to cross.

Tamara Redmon is manager of the pedestrian and bicyclist safety program for the FHWA Office of Safety. Redmon has worked for FHWA for more than 14 years, and she develops products and programs to help reduce pedestrian and bicyclist crashes, fatalities, and injuries. She holds a bachelor of science degree from Virginia Polytechnic Institute and State University and a master of science degree from Marymount University.

For more information on pedestrian safety, please visit http://safety.fhwa.dot.gov/ped_bike/ped/index.htm.

Weathering the Storm

Guidance is now available for siting sensor stations that collect data on weather conditions on or near road surfaces.

by Roemer M. Alfelor

According to the Federal Highway Administration (FHWA), more than 1.4 million highway crashes occur under adverse weather and road conditions each year. Maybe nothing can be done to change the weather, but something *can* be done about measuring and alleviating its effect on road conditions. By observing and predicting the impacts of weather on highways, transportation experts who operate the Nation's roadways can determine appropriate management strategies, such as applying anti-icing chemicals, reducing speed limits, or closing hazardous areas, to make driving safer during and after inclement weather.

Transportation managers use anemometers (wind speed and direction sensors) and other meteorological and pavement monitoring equipment to provide real-time observations and data that can help them prepare for, or respond to, a variety of emergency conditions, such as flooding, roadway icing, and strong winds, caused by adverse weather. To make driving safer during extreme events, these managers need to know how the weather is affecting the vehicles, the drivers, and the road surfaces *right now* in real time.

(Above) Foul weather like the rain that this truck is driving through calls for traffic countermeasures, such as variable message signs that reduce speed limits on slick roads.

To collect real-time weather observations along highways, transportation managers use environmental sensor stations (ESS) that are strategically located to help them identify appropriate maintenance and traffic management strategies. These sensor stations are the building blocks of a road weather information system (RWIS)—which includes the hardware, software, and communications equipment used to collect and transfer road weather data to a central location.

Although established guidelines are available to help determine appropriate locations for installing atmospheric weather observing equipment, siting information geared specifically to roadways, or surface transportation in general, is limited. To fill that gap, FHWA, the American Association of State Highway and Transportation Officials (AASHTO), and the Aurora RWIS Pooled Fund Program partnered to publish *Road Weather Information System Environmental Sensor Station Siting*

Guidelines (FHWA-HOP-05-026). The new publication, available at www.ops.fhwa.dot.gov/publications/ess05/index.htm, provides guidelines to help State and local departments of transportation (DOTs) site sensor stations and thus improve real-time data about weather conditions on the roads.

"State and local DOTs are the only agencies collecting environmental sensor information about the road surface," says Dan Roosevelt, research scientist with the Virginia Department of Transportation (VDOT). "These unique data are used to determine road conditions and forecast changes, but a forecast is only as accurate as the data backing it. Proper siting of weather sensors is an important first step in the data-gathering process."

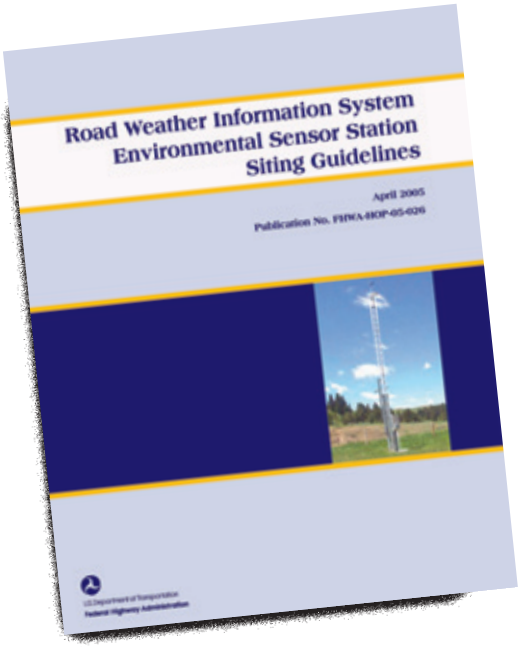
Types of Sensors

Environmental sensors such as anemometers and wind vanes can help determine the direction that the wind is blowing. Other equipment can help traffic managers ascertain the rate at which the rain or snow is falling, the speed of the freeze cycle, and myriad other weather and pavement observations.

Road weather information systems, originally developed to address winter weather, now operate year-round and monitor a variety of weather and pavement conditions. An ESS may have multiple sensors that detect atmospheric conditions. For example, it can provide data for informing motorists about strong crosswinds. Pavement sensors, on the other hand, monitor conditions such as wet, snowy, icy, or flooded surfaces. Still other sensors provide data on subsurface conditions, such as soil temperatures.

Other road weather data of interest include precipitation, humidity, and visibility; atmospheric pressure; the concentrations of chemicals on pavements from de-icing treatments; and solar and terrestrial radiation to determine the potential for nighttime cooling. Water-level sensors may be needed in flood-prone areas and along coastal roadways.

A typical ESS installation includes a thermometer to measure air temperature, a hygrometer for water vapor (dewpoint or relative humidity), an anemometer and wind vane,



The environmental sensor tower on the cover of the siting guidelines (shown here) is located on Route 528, the Beeline Expressway, near Cape Canaveral, FL.

Purpose of the Guidelines

To develop the siting guidelines, the researchers began by reviewing the published literature on placement of weather sensors. They also interviewed nearly two dozen road weather experts from DOTs around the country, as well as meteorologists, equipment suppliers, and transportation consultants.

The publication describes the ESS equipment and its benefits, discusses how to assess road weather data requirements, examines how to select sites for sensor stations, recommends siting criteria, encourages partnerships to share ESS resources, and considers other relevant factors, such as power and communications; aesthetics, safety, and security; and periodic siting reevaluation.

The purpose of the siting guidelines is to establish uniformity in the placement of sensor stations and thereby improve the accuracy and usefulness of the data obtained from the observations. It is important to note that the guidelines provided in the publication are recommendations for DOTs to consider, not standards mandated for transportation agencies or vendors to follow.

"Siting guidelines give the users the best advice available," says Dan Roosevelt, research scientist with the Virginia Department of Transportation (VDOT), "and help to assure that they consider all aspects concerning placement of the sensors. Knowing an agency has followed specific guidelines will give the user more confidence in the data."

The siting guidelines also will help DOTs maximize the return on their investment in ESS and RWIS equipment. For example, following the guidelines will help ensure that the data collected adequately support the purpose of the observation site. And using the guidelines will help DOTs determine whether potential sites for sensor stations are appropriate locations that will remain useful for years to come.

The guidelines also can help facilitate development of a nationwide, integrated road weather observation network, which will aid in mitigating the effects of adverse weather on the highway system. In addition, the guidelines will improve the comparison and integration of road weather information with other meteorological data.

Mike Adams, RWIS program manager with the Wisconsin Department of Transportation (WisDOT), adds, "The new siting guidelines bring the RWIS community in line with much of the rest of the weather community, which has used standardized siting guidelines for years."

and a pavement sensor to monitor temperature, freeze point, and chemical concentration. A rain gauge and infrared sensor can measure precipitation occurrence, type, and intensity. By using sensors and video cameras mounted on a tower or next to it, operations and maintenance personnel can determine appropriate strategies and evaluate the outcome of those strategies.

But sensors do have limitations. There are no reliable instruments to remotely measure roadway conditions such as snowpack depth. Also, there are no automated sensors to provide observations of thunderstorms, tornadoes, waterspouts, and sun glare.

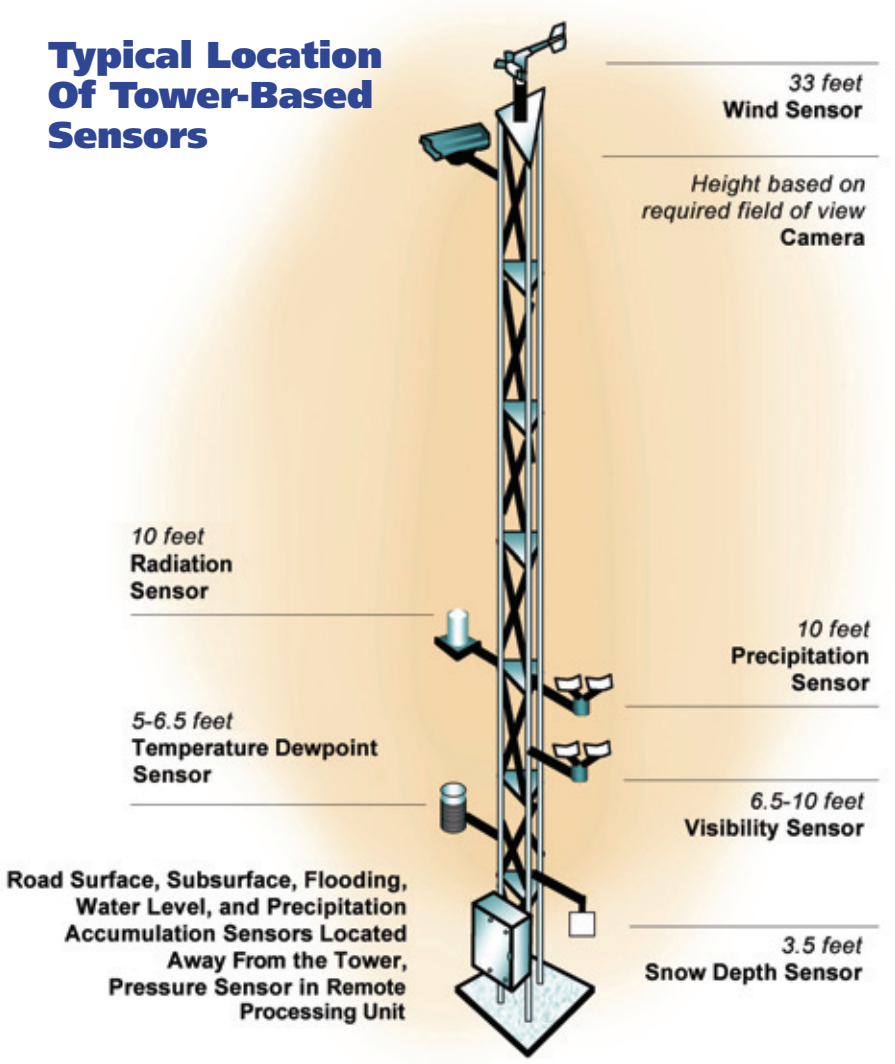
Types of Data

The sites that provide data on local weather phenomena have different requirements than the regional sites that support broad, real-time monitoring across a large geographic area or road segment. Local sites are selected to detect road weather conditions of interest for a specific road segment, bridge, or other transportation-related feature. Conditions of interest are typically the result of topographic variations, road construction techniques, pavement types, roadway geometry, or subsurface characteristics.

Regional sites support broad, real-time monitoring across an area or region. They can provide empirical verification (ground-truthing) for comparing specific forecasts for surface transportation with real-time observations to evaluate the accuracy of road weather prediction models. A key difference between regional sites and weather-observing locations that satisfy the requirements of the National Oceanic and Atmospheric Administration's National Weather Service or the U.S. Department of Transportation's (USDOT) Federal Aviation Administration is that the ESS sites may include roadway-specific pavement and subsurface sensors.

The FHWA siting guidelines recommend a spacing of 30 to 50 kilometers (20 to 30 miles) for regional ESS sites. For local sites, the sensors are placed close to the point of interest on the roadway or bridge deck.

Some sensor stations can satisfy both local and regional requirements for road weather information. When multiple sensors are installed on a regional ESS, for example, they might include one or more instruments focused on conditions of interest on a specific road or bridge segment. Siting a single ESS to satisfy both information requirements requires considerable planning.



This illustration shows a typical ESS tower and sensor configuration, including a wind sensor and camera mounted near or at the top of the tower, precipitation and radiation sensors several feet above ground level, and a snow depth sensor just above the roadway surface. The siting guidelines provide recommendations for placement of the sensors shown in this diagram.

Selecting ESS Sites And Sensors

An ESS installed at a poorly chosen location can result in servicing difficulties, sensor readings that are not representative of conditions, and possibly damage to the sensors from water runoff and ponding in low-lying areas. The site selection team also needs to minimize nonweather influences that can result from nearby buildings, billboards, tall vegetation, bridges, topography, or elevated portions of the highway.

Site conditions can change significantly from summer to winter when sun angles are low and trees lose their foliage. The ideal ESS site will rarely be found, given narrow rights-of-way and even the traffic itself. The planners will most often be in the position of needing to make tradeoffs.

"There is no mythical perfect siting location for an RWIS-ESS," says Ralph Patterson, weather operations

and RWIS manager at the Utah Department of Transportation (UDOT), "just the best spot you can find to meet the intended purpose as best you can."

However, there are some better locations for sites than others. For example, a regional ESS should be sited on relatively flat, open terrain. Also, a regional ESS should be on the upwind side of the road, based on predominant wind directions.

For local sites, the circumstances that may require a sensor station include surface conditions such as a historically cold spot that creates slippery pavement; a location where significant drifting of snow or flooding occurs; local environmental conditions such as fog, smoke, or dust that reduce visibility; crosswinds along a confined valley or ridgetop; and roadway segments abnormally susceptible to ice or frost.

In areas prone to road frost, DOTs may consider mounting a dewpoint sensor close to the pavement. For segments prone to low visibility, DOTs might consider providing safety warnings via dynamic message signs. Visibility sensors should be installed 2 to 3 meters (6.5 to 10 feet) above the roadway so they are high enough to avoid frequent maintenance because of salt spray from snow- and ice-control operations.

For dangerous crosswind conditions, sensors can take wind measurements at 10 meters (33 feet), and an additional sensor at 3 to 5 meters (10 to 16.5 feet) can measure the winds most likely to affect high-profile vehicles. To monitor flooding conditions, DOTs can consider pressure transducers in standing bodies of water, ultrasonic sensors in fast-moving streams, and float gauges installed in standpipes (vertical pipes) to monitor precipitation and runoff. For bridges, sensors used to measure scouring can provide warnings of danger to the integrity of the foundation.

Thermal mapping—the use of vehicle-mounted infrared radiometers to map warm and cold spots along a roadway—can be a useful tool in selecting local ESS sites. Analysis of the data from thermal mapping can determine locations where frost and ice tend to form and thus suggest the need for an ESS

Types of Sensors

Weather/Roadway Element	Sensor
Air Temperature	Thermometer
Water Vapor (Dewpoint or Relative Humidity)	Hygrometer
Wind Speed and Direction	Conventional and Sonic Anemometer and Wind Vane or Combined Sensor (Aerovane)
Pavement Temperature, Pavement Freeze Point Temperature, Pavement Condition, Pavement Chemical Concentration	Pavement Sensor
Subsurface Temperature	Subsurface Temperature Probe
Subsurface Moisture	Subsurface Moisture Probe
Precipitation Occurrence	Rain Gauge, Optical Present Weather Detector
Precipitation Type	Rain Gauge, Optical Present Weather Detector
Precipitation Intensity	Rain Gauge, Optical Present Weather Detector
Precipitation Accumulation	Rain Gauge, Optical Present Weather Detector, Hot-Plate Type Precipitation Sensor
Snow Depth	Ultrasonic or Infrared Snow Depth Sensor
Visibility	Optical Visibility Sensor, Closed-Circuit Television Camera
Atmospheric Pressure	Barometer
Solar Radiation	Solar Radiation Sensor
Terrestrial Radiation	Total Radiation Sensor
Water Level	Pressure Transducer, Ultrasonic Sensor, Float Gauge, or Conductance Sensor

While sensor selection should always reflect operational requirements, the guidelines indicate that a typical ESS installation frequently includes the following:

- *A combined sensor to measure both wind speed and direction (e.g., aerovane or sonic anemometer) or individual wind speed and direction sensors (e.g., conventional anemometer).*
- *Sensors to measure air temperature and moisture. Typically two sensors located in a single housing provide air temperature and one of the following: dewpoint temperature, wet bulb temperature, or relative humidity.*
- *Sensors to measure the temperature of the pavement and to indicate whether the surface is dry, wet, or frozen. Active sensors cool and warm surface liquids to determine the freeze point temperature. Passive sensors commonly monitor changes in roadway surface conductivity as surface changes occur. When road treatment chemicals are in use, the surface conductivity can be an indication of the chemical concentration on the roadway. The presence and concentration of chemicals is important, as it will affect the actual freezing temperature of the road surface. Optical sensors for pavement measurements also are under development.*
- *Sensors to detect the presence, type, and intensity of precipitation. A single, optical, present weather detector can detect the presence of precipitation and measure its intensity. By estimating the water content of precipitation and combining this information with optical forward scatter and temperature measurements, these instruments can also identify precipitation type. Optical weather presence sensors capable of differentiating among rain, freezing rain, drizzle, freezing drizzle, mixed rain and snow, snow, and ice pellets are available.*

Uses and Benefits of ESS Data

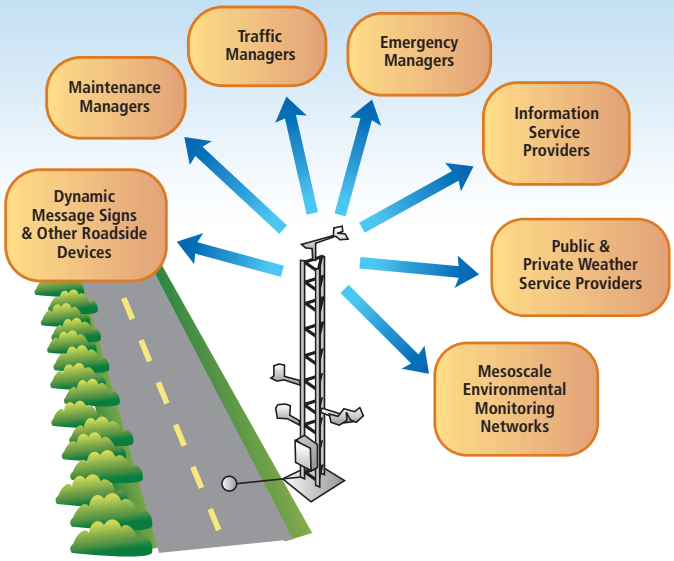
"ESS data enable us to monitor and react to changing road conditions in order to maintain safe driving conditions as best as possible," says Mike Adams, RWIS program manager with the Wisconsin Department of Transportation. In addition to the key benefit of improving road safety during and after storms, ESS data supply information that traffic and weather response managers need to maintain vehicle flow and mobility during adverse weather, and thereby help increase the productivity of the Nation's transportation system.

Other key benefits of ESS data include supplying the information that traffic managers need to provide traveler information. Local, State, and Federal disaster response agencies also may use the information to assess and manage emergencies and response actions. Transportation managers use ESS data to support road maintenance activities.

According to Ralph Patterson, weather operations/RWIS manager and traffic operations manager at the Utah Department of Transportation (UDOT), "The use of ESS data here at UDOT crosses over into almost all aspects of operations, that is, winter maintenance, road rehab projects, construction, risk management, traveler information, planning, and, last but not least, our meteorology staff uses some of the data to produce and verify forecasts."

Additional consumers of ESS data include the National Weather Service and military and private weather service providers, who use the information for developing short-range forecasts. Other applications are forecast models produced by government and university environmental monitoring networks.

State climatologists can benefit from ESS data for developing long-term records and conducting climatological analyses. Insurance companies can use these data to help determine the risks of potential impacts from future weather events. And forensic meteorologists can use ESS data to reconstruct roadway crashes.



Users of ESS data, as shown in this diagram, include traffic and emergency managers, who may use the information to deploy dynamic message signs and other roadside devices that warn motorists of adverse conditions; maintenance managers; information service providers (public or private entities that distribute road weather information to the public); public and private weather service providers; and environmental monitoring networks (collections of weather observation systems and/or equipment that is linked together).

and other locations where an ESS may not be needed. Where thermal mapping reduces the number of ESS installations, it can pay for itself.

Criteria for Siting Towers And Sensors

Several circumstances may affect tower siting, including access requirements for power, communications, and maintenance; geographical terrain, water bodies, and neighboring structures; aesthetic considerations; security concerns; and city, county, or State codes. Where a limited right-of-way precludes the installation of a tower and requirements for road weather information rules out selection of another site, DOTs may find other options, such as installing anemometers on utility poles.

If a tower is used, it should be sturdy, such as the open matrix type, and anchored to a concrete pad. At this time, there are no studies about the minimum distance that transportation personnel should place the tower from the roadway to avoid the effects of traffic on the accuracy of the sensors. According to the research performed for the siting guidelines publication, towers are most frequently installed 9 to 15 meters (30 to 50 feet) from the edge of the paved surface. Sites near steep roadcuts, swampy areas, and bedrock (an impediment to trenching for power cables) should be avoided.

DOTs should maintain complete documentation on the positioning of the tower and the height of the sensors. This metadata (data about data) file should be made available at a central location for data customers. Metadata provide users with a better understanding of what the information collected by sensors really represents.

"One of the most important uses for the guidelines," says UDOT's Patterson, "is to emphasize the importance of metadata. If you know the strengths and weaknesses of a particular site, you can turn the acquired data into more useful information. There are no bad data; it's just that some are more useful than others."

Air temperature and dewpoint sensors should be mounted 1.5 to 2 meters (5 to 6.5 feet) above ground level on a boom extended at least 1 meter (3 feet) from the tower toward the predominant wind direction. For anemometers, a general rule is that they should be positioned at a distance of 10 times the height of the nearest large obstruction. For example, if the obstruction is 6.1 meters (20 feet) tall, the wind sensor should be positioned 61 meters (200 feet) away.

Pavement sensors should be sited in unshaded areas to represent the surrounding road segment under maximum cooling conditions, except in the case of road segments that are predominantly shaded. In an urban

WisDOT

This open matrix sensor tower is located in Wisconsin.

environment, if only one sensor is to be installed, the typical location is the travel lane (the rightmost lane in a multilane roadway). Consideration should be given to siting the pavement sensor in the travel lane of the morning outbound traffic to reduce the influence of heavy vehicle traffic on pavement observations. In general, pavement sensors should be installed near the edge of the inside wheel track.

The guidelines provide similar advice on the location and selection of other types of sensors. For example, on location, subsurface sensors should be installed at a depth of 30.5 or 45.5 centimeters (12 or 18 inches), depending on the manufacturer's guidelines. For selection, in the case of precipitation accumulation sensors, one type—the tipping bucket—often underreports rainfall totals during heavy precipitation. The other type—the weighing gauge—can measure both solid and liquid precipitation and is more sensitive to light rainfalls. Both sensors require a heating device in freezing climates. A new technology for determining precipitation amounts, the hot-plate rain gauge measures the power needed to evaporate precipitation falling on a sensor plate. All precipitation sensors should be placed in an open area and away from the roadway to avoid splashing.

The recommendations for selecting sensors and locating towers reflect a range of values because of the complexity of the roadway environment and the need for additional research. In any case, mounting sensors on a tower requires careful planning so that they do not interfere with one another.

Planning an ESS Network

The siting guidelines also discuss the methods for selecting a team of road and weather experts to plan for the acquisition and installation of sensor stations. In addition to a DOT team lead, the group should include a meteorologist who can help assess information requirements and ESS technologies. The meteorologist can evaluate specific sites for weather influences that could affect the validity of the ESS data, such as the influence of solar radiation on road surface temperature.

Other team members should include maintenance personnel because of their familiarity with weather conditions along their road segments. They may know, for example, the locations of pavements that are frequently slippery, areas with low visibility, or road segments with strong gusty winds that suggest the need for an ESS installation.

Once selected, the team needs to determine the uses of the weather information, including input to winter maintenance operations or support for weather-responsive traffic management or 511 traveler information systems. Another crucial decision is whether the ESS will be used to measure a site-specific condition, such as visibility along a fog-prone road segment, or to provide information that may represent conditions across a general area.

The next questions include what should be measured at each installation and thus which sensors are needed. The DOT may want to create a prioritized list to help in making tradeoffs when data collection needs exceed available funding. A phased approach may be the answer.

Finally, DOTs should consider developing data-sharing partnerships to leverage the information collected by other organizations. Possibilities include the National Weather Service, Federal Aviation Administration, U.S. Department of Agriculture

(USDA) Forest Service, local television stations, universities, water resource weather station networks, and other city, county, and State agencies. Partnerships may avoid the costly duplication of sensors, although it is necessary to recognize that data sharing can be complicated by different data formats and communications incompatibilities.

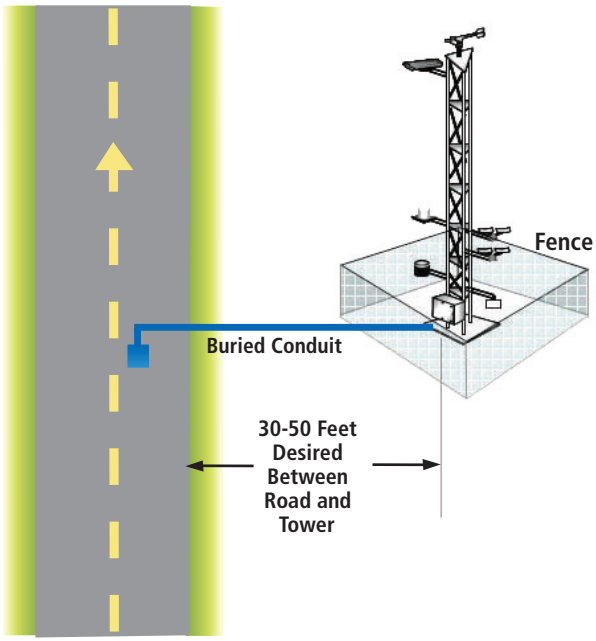
"In the past, VDOT has partnered with the city of Richmond and the National Park Service to share data from stations installed by all three jurisdictions," says Roosevelt. "This has increased the coverage we have on the road system in Virginia and reduced the number of stations each jurisdiction needs."

Similarly, Utah is partnering with two agencies, the USDA Forest Service and the Tooele County Emergency Operations Center (TEOC). "With the Forest Service, we offer manpower and expertise for maintenance of a site owned by the Wasatch-Cache National Forest," says Patterson, "and with the TEOC, we are in the process of putting some of our hardware on their weather stations to gather road and precipitation conditions so their existing mesonet of stations can do double duty."

Additional Considerations

Planning should address data requirements first and then address how to satisfy power and communications requirements. Power options include commercial connections, wind power, or solar with batteries. Commercial power is usually the most economical and reliable. Solar power can support nominal loads but typically is incapable of sustaining heavy power consumption for heated sensors. North Dakota has successfully used wind power for a number of ESS installations.

In some cases, the sensors can be located near other intelligent transportation system (ITS) devices such as traffic counters, dynamic message signs, and traffic signal controllers to share power and communications costs. For critical sites, backup sources of power or communications may be needed.

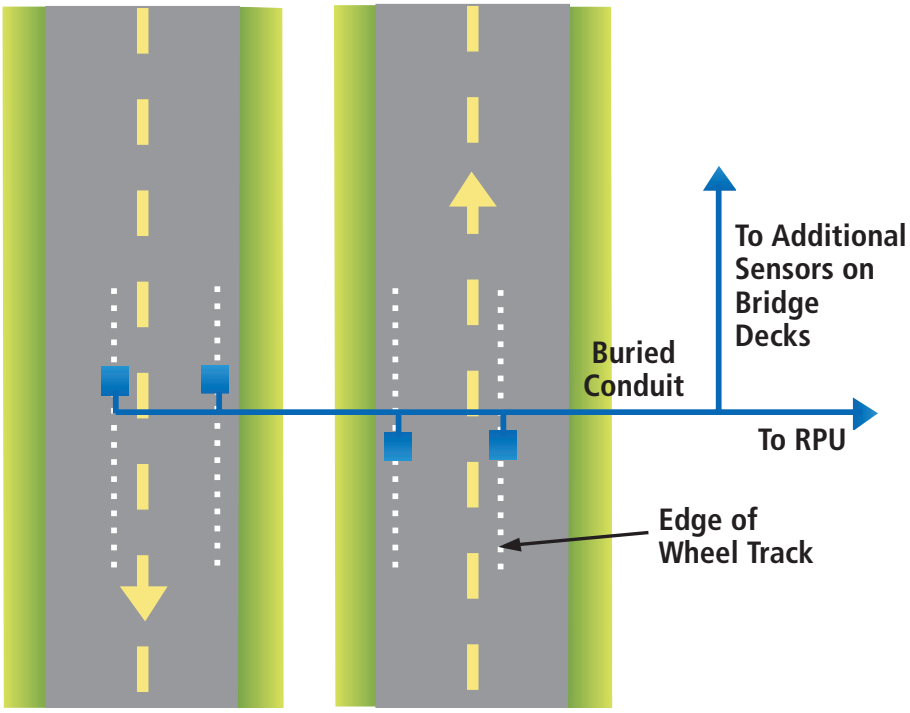


The diagram shows the desired tower location relative to a roadway.

Communications options include hardwired telephone, cellular, copper wire, fiber-optic cable, wireless, radio, microwave, or satellite. Important factors in the selection of the communication method and equipment are how much data are included in each observation (bandwidth) and the frequency of transmittal of observations. For sites with low bandwidth requirements (that is, no video camera or infrequent reporting), telephone lines or some type of wireless communication may be more economical than hardwired options. For high data volumes, a hardwired system (wire or fiber optic) appears more appropriate.

For historical polling (data retrieval), road weather data are stored in the remote processing unit (RPU) and retrieved at set times, such as the top of the hour and every 15 minutes thereafter. This process differs from polling the RPU to obtain only the current road weather observations.

Regarding aesthetic considerations, following the criteria related to maintaining adequate distances from obstructions can result in a sensor tower that is very obvious. Pre-siting discussions with the surrounding stakeholders may forestall any aesthetic problems.



This diagram shows the typical siting for pavement sensors, near the edge of the wheel track.

Siting too close or too far from the roadway may seriously complicate maintenance procedures or unnecessarily jeopardize the safety of maintenance personnel. Likewise, extra security measures may be needed in areas where the threat of vandalism is present. Possibilities include a security fence around the tower, anti-climb panels, or even security cameras.

Over the years, periodic reevaluation is needed to ensure that the data from the site are still valid and that the metadata are still correct. Construction projects and vegetation growth may change the representativeness and usefulness of ESS locations. This reevaluation can be part of an annual preventive maintenance program for sensor calibration.

"One key point is that these are precision instruments and thus need to be looked after and cared for," says UDOT's Patterson. "A lesson learned for us is to make sure that your agency's infrastructure [servers, communication backbone, technical support, financial support] keeps up or preferably slightly ahead of your field device deployment. Have a deployment plan but understand the need to be flexible, because keeping abreast of advances in technology, especially communications, continues to be a moving target."

Metadata about the ESS should include the platform owner, station name and identifier, station coordinates and elevation, sensor types and manufacturers, location of the sensors, sampling interval, reporting frequency, and the history of any changes in the metadata. The final chapter in the guidelines includes a comprehensive table with a recommended ESS metadata set.

At the end of the publication, an appendix includes a list of metadata references, and another contains an exhaustive list of weather conditions for a DOT's consideration during analysis of requirements for road weather observations. A final appendix consists of a detailed checklist that serves as a synopsis of the siting criteria.

The recommendations in the siting guidelines are designed to satisfy as many road weather monitoring, detecting, and prediction requirements as possible. Weather conditions and their consequences affect road operations and the safety, economic value, and efficiency of transportation and road maintenance activities.

Charles Allen, UDOT

This sensor tower, protected by a security fence, is located in Utah on I–15 near Alpine.

"The guidelines give agencies a place to start—a baseline, if you will," says UDOT's Patterson. "An RWIS-ESS can be and is a very useful tool in myriad disciplines."

Emergency Management and Response Plans

The Minnesota Department of Transportation (Mn/DOT) operates several RWIS stations throughout the State. The stations consist of a number of sensors that collect data on weather and pavement conditions. This information is relayed to a central monitoring station, where it is used to facilitate more effective scheduling of work crews and equipment to respond to adverse weather, including emergency situations. RWIS gives an early warning when pavement conditions become critical and provides weather forecasts that enable crews to act before the first icy spots form on the roadway, especially on bridges and ramps. RWIS data also help DOT crews optimize their use of deicing materials. By using chemicals only where needed, the agency saves money and protects the environment. One study concluded that by improving the efficiency of Mn/DOT's winter maintenance efforts, an RWIS system would more than pay for itself, with returns on investment ranging from 200 percent to 1,300 percent.

Roemer M. Alfelor is a transportation specialist with the FHWA Office of Operations Road Weather Management Program. Alfelor has been with FHWA for 5 years, having worked in the Office of Infrastructure before joining the Office of Operations in 2004. Prior to that, he held various positions at a number of transportation consulting firms for 9 years. He holds a master of science degree in transportation from the Massachusetts Institute of Technology and a Ph.D. in civil engineering from Carnegie Mellon University.

For more information, contact Roemer Alfelor at roemer.alfelor @fhwa.dot.gov or 202-366-9242.

Learning from Disaster

by Steve Jacobitz

Florida's 2004 hurricane season provides a number of lessons for improving transportation preparations and response.

(Above left) FHWA Florida Division volunteers served with the transportation unit at the Florida State Emergency Operations Center in Tallahassee during the four hurricanes. Shown here are State Emergency Response Team members Norberto Muñoz (seated) and Bill Wade from the FHWA Florida Division. (Above right) Hurricane Ivan's powerful storm surge foiled the best efforts of owners to protect their boats by mooring in sheltered inlets along Escambia Bay, near Pensacola, FL. (Right) Hurricane Charley's devastating category four wind gusts snapped utility poles and toppled trees as the winds ripped through the small coastal town of Punta Gorda, FL.

Four major hurricanes struck the State of Florida during a brief 5-week period in 2004. This unprecedented series of natural disasters magnified the already enormous impact of each individual storm and tested the Federal and Florida's emergency transportation response and recovery systems.

When the season ended, the Florida Division of the Federal Highway Administration (FHWA) had completed more than 1,200 Detailed Damage Inspection Reports (DDIR), cataloging more than $963 million in damage to Federal-aid highways in the State.

Of course, prior to 2004, Florida's transportation agencies were no strangers to hurricanes. Storms such as Andrew (1992) and Opal (1995) taught valuable if hard-won lessons about the damage potential of a major hurricane. From the rubble of past destruction, FHWA and the Florida Department of Transportation (FDOT) had constructed new rules and new tools to better prepare for future emergencies.

But in the late summer of 2004, it became clear that there was still much more to be learned.

Enter Charley

The destruction of 2004 started with Hurricane Charley on an unlucky Friday the 13th in August. A powerful, fast-moving category four storm, with sustained winds of 240 kilometers per hour (km/h) (150 miles per hour, mph) at its center, Charley traveled into the Gulf of Mexico, turned shoreward at Charlotte Harbor, and continued to the northeast, ripping through coastal communities while hoarding strength for surprised residents as far inland as Orlando. When it exited the State 9 hours later at Daytona Beach, Charley left a bill of more than $14 billion in U.S. property damage.

For FDOT and transportation contractors, the first priority was opening the roads for search and rescue, reconnaissance, and other emergency responder teams. That meant clearing tons of debris from hundreds of miles of Federal-aid highways and State roads, and securing or repairing damaged sections of roadway. County and municipal agencies also fielded employee and contractor crews to clear local roads, and FHWA transportation engineers from the Florida Division were dispatched to begin county-by-county damage assessments for the emergency relief (ER) program.

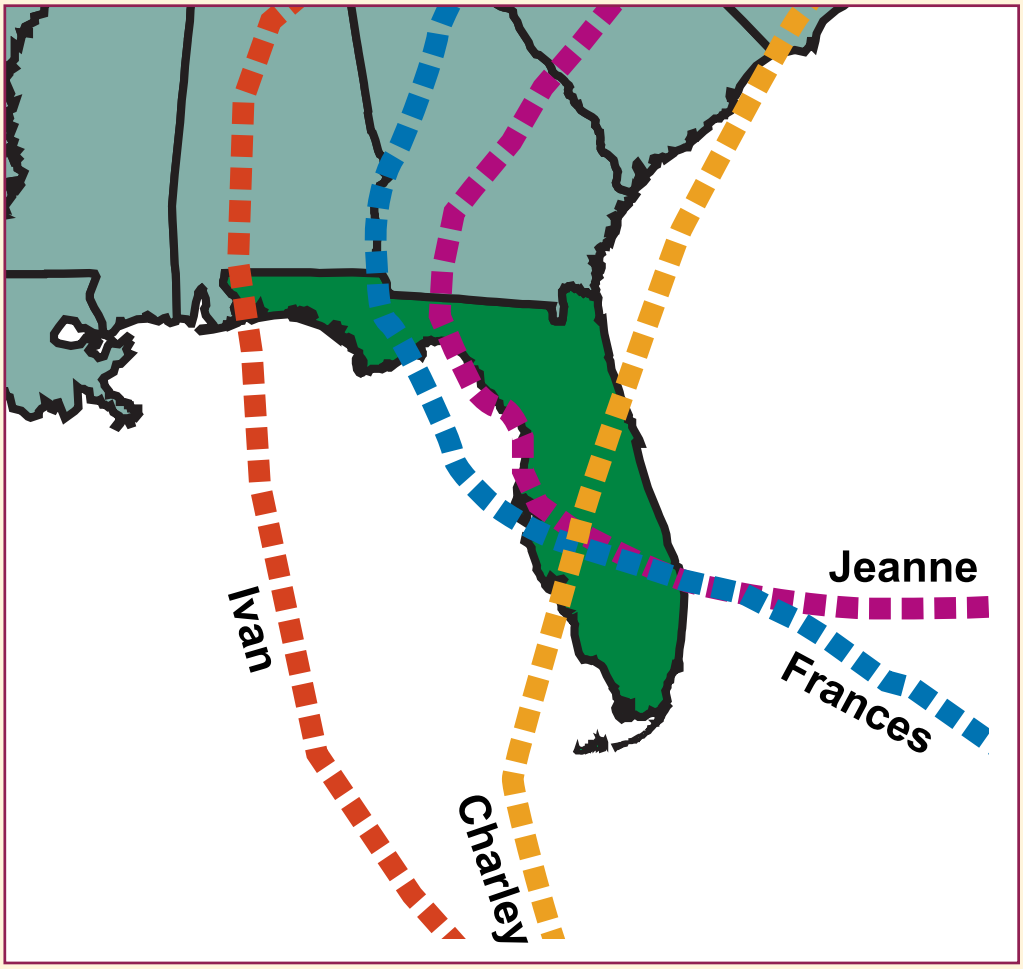
Overall, the recovery efforts were successful in the days following the storm. Water, ice, and food were available, medical and shelter needs were being met, and residents who evacuated were returning to deal with the hurricane's aftermath.

That's when tropical storm Frances was spotted off the coast of Africa.

And Then There Were Four

Just 8 days into the recovery efforts for Charley, Frances was spawned in the Atlantic. By September 2, it was a category three storm slamming into the Bahamas. As the hurricane moved on toward Florida's Atlantic coast, it prompted the largest evacuation in Florida's history, numbering 2.8 million persons. At midnight on September 5, a large but weakening Frances came ashore at Sewall's Point in Martin County with category two sustained winds of 169 km/h (105 mph). Still, the hurricane force winds (119 km/h or 74 mph and higher) extended 137 kilometers (85 miles) and tropical storm force winds (63–118 km/h or 73 mph) ranged more than 322 kilometers (200 miles). Heavy rainfall brought a threat of flooding in many areas.

One outcome of the storm was unexpected—a fuel shortage for the Florida peninsula. The problem may have had its seed from residents and tourists taking advantage of the final days of the State's month-long gasoline tax holiday in August, but it was



This map tracks the four hurricanes that hit Florida in 2004: Charley, Frances, Ivan, and Jeanne.

The Florida State Emergency Operations Center in Tallahassee (shown here) served as the coordination hub when State Emergency Response Team members from key State and Federal agencies, the military, and volunteer organizations were activated for an expected hurricane.

compounded when Charley and now the threat of Frances delayed shipborne deliveries of fuel. Major ports were shut down or had limited access. Even fuel tankers already at port facilities could not pump their vital cargo for fear it could jeopardize the hull integrity of ships riding out the storm.

Next, barely 10 days into the recovery effort for Frances, Hurricane Ivan struck near the northwestern panhandle community of Pensacola. Ivan was a fierce storm that raised waves in the Gulf measured at more than 17.7 meters (58 feet) as the storm approached the coast. Centered at Gulf Shores, AL, Ivan made landfall at 2 a.m. central daylight time, September 16, as a category three storm, with sustained 209-km/h (130-mph) winds at the center and pushing a 4.6-meter (15-foot) storm surge. To the east, the fierce gusts of the deadly northeastern quadrant of the storm struck Florida's gulf coast. A storm surge washed over barrier island resort communities and rushed up Escambia Bay, taking out the bridge approaches for U.S. 98, crippling both spans of the I–10 bridge over the bay, and damaging the approaches to a U.S. 90 bridge at the bay's northern tip. Hurricane-force winds were felt along a 185-kilometer (115-mile) stretch of the gulf coast, with tropical storm force winds extending 354 kilometers (220 miles).

With the Pensacola and Escambia Bay Bridges out, except for two lanes of U.S. 90 open on a restricted basis, transporting first responders and life-sustaining supplies of water, ice, and meals to Pensacola became a logistical challenge. Supply trucks followed a long, slow detour route, and, once runways were reopened, C–130 cargo planes were used to take supplies to the city.

Ivan also resulted in a near-total blackout of the far western panhandle counties. Power was not restored for weeks in many areas.

The fourth storm, Hurricane Jeanne, struck on September 25, 9 days after Ivan. Jeanne was an Atlantic coast storm, and, when it came ashore as a category three with 193-km/h (120-mph) sustained winds, it struck in the same general area Frances had hit 20 days earlier, undoing emergency repairs and further aggravating flooding conditions. Emergency resources across the State were stretched near the breaking point.

For all four storms combined, the Florida Division of Emergency Management's tally included the following statistics:

- 40,000 homes damaged or destroyed
- 41 million cubic meters (53 million cubic yards) of debris cleared, although some areas were still digging out 8 months later
- 9.5 million persons evacuated
- 1,045 shelters opened
- 8.5 million electricity customers without power, many for weeks
- 6,000 Florida National Guard soldiers deployed
- 4,500 U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) personnel working in the State
- 88,000 volunteers helped provide emergency services
- 36 million liters (9.5 million gallons) of water brought in, along with 36 million kilograms (78.5 million pounds) of ice and 14 million military rations known as Meals, Ready to Eat (MREs)

Saffir-Simpson Hurricane Scale

	Wind Speeds	Storm Surge
Category One	74–95 mph (119–153 km/h)	4–5 ft (1.2–1.5 m)
Category Two	96–110 mph (154–177 km/h)	6–8 ft (1.8–2.4 m)
Category Three	111–130 mph (178–209 km/h)	9–12 ft (2.7–3.7 m)
Category Four	131–155 mph (210–249 km/h)	13–18 ft (4.0–5.5 m)
Category Five	Greater than 155 mph (249 km/h)	19 ft (5.8 m) and over

Source: National Hurricane Center.

The storm surge from Hurricane Ivan shifted and toppled deck segments from both spans of the I–10 Escambia Bay Bridge in Pensacola, totally closing the vital east-west highway and causing traffic detour delays of many hours in the weeks until emergency repairs were completed.

U.S. Transportation Secretary Norman Y. Mineta celebrated the reopening of the I–10 Escambia Bay Bridge following emergency repairs to the westbound span, which carried two-way traffic until the eastbound span could be repaired.

Transportation Agencies Respond

From a highway transportation perspective, the heavy part of the hurricane response fell to FDOT. Organized into seven districts, plus Florida's Turnpike Enterprise, FDOT crews and State contractors were out well in advance of the storms, ensuring that preparations were made.

Evacuations were the early priority. According to Frank Day, head of FDOT's emergency operations team, "The DEM [Florida Division of Emergency Management] and each county have an evacuation plan, which we support. We also work with agencies in bordering States since an evacuation may impact them. Our role in the process is to provide staff to DEM at the SEOC [State Emergency Operations Center] and share our transportation expertise. We also provide physical assistance with signs indicating detours and evacuation routes."

Surrounded by a bristling forest of communications devices, Florida mobile command vehicles stand by to deploy for a hurricane emergency.

Removing debris from Federal, State, and local roads was the first order of business for transportation agencies and local governments to clear the way for life-saving search and rescue efforts from homes like this heavily damaged one.

The counties were responsible for making the decisions on which areas to evacuate and when to start. To avoid bottlenecks, Florida's Turnpike Enterprise and other expressway authorities suspended toll operations along the evacuation routes.

As soon as each hurricane passed through an area, and sometimes during the course of the storm, FDOT personnel were on the move. "Our overall priority is to restore all transportation facilities within the State," Day says, "including the interstates, the State highways, the intermodal connectors, and other public roads. The key is to make everything passable for search and rescue missions, as well as for the emergency or first responders who provide food, water, shelter, and medical care.

Responding to the approaching hurricanes, FEMA activated the Federal Emergency Support Function 1—transportation—prompting the U.S. Department of Transportation (USDOT) to begin preparations. The FHWA Florida Division emergency response team was called on to report for shifts at the SEOC in Tallahassee. There, they worked with the FDOT team responsible for coordinating transportation-related missions. FHWA volunteers from Florida and out-of-State divisions also worked with FEMA at central logistical staging areas, coordinating the delivery of vital relief supplies such as water, ice, and food.

In the FHWA Florida Division Office, damage assessment teams were organizing for what would be many weeks of ER work in the impact areas and followup activity back in the office. As each storm passed, FHWA transportation engineers fanned out across the State to evaluate the damage and document the nature and cost of repairs. FHWA Florida Division Program Operations

Damage, debris, and downed signs, as shown here, mark the wide path of destruction left by hurricane winds that swept across interstates and State highways.

Tossed into the weeds after one of the hurricanes, this signal was from one of the more than 3,000 signalized intersections damaged during the 2004 season.

Engineer Don Davis describes the process: "The first thing we had to do as a team was prepare. We made sure the TEs [transportation engineers] had the current ER program requirements and the tools needed for the challenging fieldwork.

"The TEs kept in touch with their assigned FDOT districts before, during, and after each storm. The first task was to work with our State and local partners to assess the scope of the damage. To cover the storm tracks that crisscrossed the State, they put together a game plan to efficiently inspect and document storm damage and needed repairs.

"After going to a site and verifying the damage, the TE would note the type of damage and the cause, the scope and method of any repairs, and the estimated cost. At that point, the engineer was prepared to formally document eligibility for FHWA ER reimbursement on a DDIR."

One problem faced by the FHWA transportation engineers was where to draw the line in identifying each incidence of damage. "Defining a site can be a challenge," Davis says. "It's obvious when it's a roadway. But sign and signal damage was different. We ended up defining a site as a specific geographic area or by a local jurisdiction, such as a town or even a county."

Lesson One—Expecting the Unexpected

If there was one overarching lesson from the hurricanes of 2004, it was to expect the unexpected.

For example, just because no one recalls four major hurricanes striking the State in one season does not mean that it is unusual. Some climatologists remind us that the apparent jump in the number of major storms is really just a return to normal after 40 years of abnormally low activity. For emergency planners, the message is clear: Get ready—it can and very likely will get worse in the years to come.

Common assumptions can lead to serious problems, particularly when they involve predicting where a hurricane will make landfall. The National Weather Service's National Hurricane Center and major news organizations produce tracking maps showing the predicted path of a storm and a surrounding "cone of uncertainty" that delineates the possible error range. In 2004 the problem was that too many people and even some agencies focused on the centerline of a storm's forecast path and not the wider error range.

Charley was a prime example of a hurricane that caught a lot of people off guard. The morning of the day it made landfall, Charley was a category two hurricane headed north along Florida's Gulf coast toward Tampa Bay. As Tampa-St. Petersburg residents and emergency planners prepared for the worst, other areas along the southwestern coast braced themselves for the lesser impact of tropical storm force winds and rain. However, Charley rapidly grew into a powerful category four and turned into Charlotte Harbor, well south of Tampa, surprising much of the local population, particularly those who had chosen not to heed the evacuation warnings for the coastal counties. Charley went on to cross the State and hammer Orlando with hurricane-force winds, shattering another assumption—that the area was too far inland to be harmed.

The bent or broken high-mast light poles along I–75 were part of the price paid by not allowing for the possibility of Charley's last-minute shift. The lights that made the poles top heavy were intended to be lowered to the ground in the event of high winds. Mike Akridge, FDOT deputy State traffic engineer, recalls, "In 2004, some of our districts and contractors didn't clearly understand the requirement to lower the lights if hurricane winds might hit an area. However, we learned quickly and it was a real lifesaver for the poles and the lights."

Lesson Two—Dealing With Inexperience

"Most of us were inexperienced in 2004," FHWA's Davis says. "The State had not been hit by a major hurricane since Irene in 1999. In our FHWA office, there were just a few people who had worked through a hurricane. Only two transportation engineers on my staff had hands-on ER experience, so I paired each one up with another TE and sent them out as teams after Hurricane Charley."

The FHWA ER teams coached State and local personnel on the ER rules and procedures. "The State did a tremendous job in getting the damaged roadways repaired quickly," Davis points out. "We just needed to stress the importance of documenting the hurricane damage."

Florida's use of asset management contracting presented a new challenge. "Dealing with asset management contracts was new to us in handling ER," Davis recalls. "Some Federal-aid roads were being maintained by private contractors hired

USDOT Response to Hurricane Katrina

The importance of the transportation lessons of Florida's 2004 hurricane season was amply demonstrated in 2005 in Alabama, Louisiana, and Mississippi. In a press release dated September 5, 2005 (7 days after Katrina made landfall), the U.S. Department of Transportation (USDOT) reported the following activities in support of the Federal response:

USDOT secured more than 1,639 trucks to deliver more than 3,731 truckloads of goods, including 25 million Meals, Ready to Eat (MREs); 31 million liters of water; 56,400 tarps; more than 19 million pounds of ice; and 215,000 blankets.

The Department oversaw the largest airlift ever on U.S. soil to move supplies into affected regions and evacuate residents out of New Orleans. The Department also provided more than 1,200 buses to evacuate citizens. It coordinated with nearby airports and airlines to provide operations and ground and ramp support to help unload and turn aircraft around as quickly as possible.

For the first time in history, the Secretary of Transportation requested that the Department of Defense release vessels in the U.S. Ready Reserve Fleet for service in moving supplies and personnel into the region, providing temporary housing, and moving people out. The ships *Empire State, Sirius, State of Maine, Wright, Flattery,* and *Diamond State* were set to arrive in coming days to join the *Cape Kennedy* and *Cape Knox* in New Orleans, with three other ships put on standby.

by the State, and there wasn't always a clear understanding by the State or the contractors about how the contractors' repair efforts fit into the ER program. But we were able to assist by clarifying the necessary level of State involvement to help ensure ER eligibility."

Documenting how each new issue was handled was essential to managing the ER process. "As the hurricane season wore on through four major storms, it was important to maintain consistency in the ER process," Davis says. "We developed and continued to refine a question-and-answer document for our TEs, which we also shared with State and local agencies."

Training also took on new importance. FDOT's Day says, "Local government didn't have a good grasp of the Federal-aid system. In particular, they didn't understand the difference between FHWA and FEMA. Going into 2004, our emergency management training sessions in recent years were poorly attended by local agencies. In 2005, we're pursuing this training much more aggressively. We're no longer waiting for an invitation; we're taking it to them."

Lesson Three—Keeping in Touch

Commercial cellular communications were a common casualty of the storms of 2004, with outages of 24 hours or more in many areas and limited service as a system was gradually brought back online. As a result, cell phones could not be relied on for critical emergency communications during early recovery operations.

One key alternative for FDOT was the State's microwave transmission network. Generally it performed well, but even this system suffered due to damaged antennas and power loss at microwave tower sites. Although sites with standby generators were kept in service, finding and installing emergency generators significantly delayed the recovery of radio communications in some areas. Problems also developed with accessing some out-of-service tower sites due to flooding conditions.

FDOT used a limited number of satellite phones, but they were considered a costly alternative. They served well as a reliable backup system, however, and additional satellite equipment was purchased for future emergencies.

The State is now upgrading its radio network to improve the range of mobile-to-mobile communications, and it is installing fixed standby generators at its microwave tower sites. Drainage issues are being addressed at sites susceptible to minor flooding.

Lesson Four—Restoring Signal Operations

Among the first casualties of a hurricane's high winds are traffic lights (signal heads). The wind tears traffic lights from their supporting

This high-mast light pole was snapped when Hurricane Charley's last-minute course change brought the hurricane ashore before the top-heavy lighting units could be lowered. In later storms, lowering the lighting units saved the structures.

Restoring traffic signal lights (shown here) is one priority following a hurricane, preventing collisions and freeing law enforcement officers for other important duties.

hangers, or they plunge to the pavement when their supporting wires or poles are snapped. Even when signals survived the passage of a fierce storm, the power to keep them operating was generally out, a problem that often lasted for days and sometimes weeks.

According to Paul Clark, program manager, FDOT Traffic Incident Management, "Prevention is important to maintaining signal operations following a hurricane. Local governments have the discretion to consider taking down signal lights in advance of the hurricane. They make the request that the local district DOT has to approve."

Of course, not all signals at an intersection are removed. "They basically only took down the nonrequired signals," Clark explains. "As many as half the signals were taken down in some areas of expected impact, with careful attention paid to the standards of the MUTCD [FHWA's *Manual on Uniform Traffic Control Devices*]." (For the MUTCD, see http://mutcd.fhwa.dot.gov.)

Although some agencies removed and secured signal lights as the storms approached, others did not. For some, it was a matter of a hurricane's unpredictable point of landfall. For others, it was a combination of concerns, such as potential liability in the event of a crash and difficulties associated with removing, storing, tracking, and reattaching the signals.

The lights that remained suffered severe damage. FDOT's Akridge explains, "Once the storms were over, we quickly took a look at why we lost so many signals and came up with two areas for improvement. One was signal hangers. The aluminum hangers that were in common use were just not strong enough, so we've worked on redesigning our specifications to achieve much higher survivability." FDOT hopes to patent a new design for hangers capable of withstanding hurricane-force winds.

"The other area for improvement was signal poles," Akridge says. "It was obvious that mast-arm signal supports performed far better than wire-hung signals. In fact, through four hurricanes, there were only about 20 mast-arm failures in the entire State, and those were primarily due to twisting." The 20 failures were a small percentage of the 3,500 signalized intersections sustaining hurricane damage in 2004.

Restoring signal operations was complicated by widespread and often long-term power outages. Not only were replacement signal heads in increasingly short supply with each storm, but also generators were needed urgently. FDOT's Day recalls, "Going into 2004, we only had a reserve supply of 100 generators, tops. Our vendors rushed new generators to us." The agency acquired approximately 650 new generators for emergency recovery use.

The generators had their own unique issues. Refueling every 6 to 8 hours was a constant challenge, particularly with gasoline shortages and the potential to lose track of generators moved to new locations as power was restored.

Further, many signal systems were not designed for use with generators. "There was really no way to power up those signals other than to splice into the electrical lines," notes Akridge. "Now, as signal lights are replaced or repaired, many have a plug-in connection for a generator." The State also has plans to retrofit existing traffic signal control cabinets.

But the most frustrating problem was generator theft. "We learned to secure them to a signal light pole with a cable, not a chain," said FDOT's Akridge. "We had reports of folks plugging electric chainsaws into our generators and then using them to cut through the chains. Cable locks worked best."

Looking ahead, FDOT is much better prepared to deal with emergency power demands. "We needed a lot of generators in a hurry in 2004," Akridge notes. "But now we've got 977 on hand. Most of them are in the districts' inventories, but there are 348 in a central warehouse in Orlando, shrink-wrapped, palletized, and ready to move."

FDOT's Clark adds, "A key advantage to having a good supply of generators is that we can quickly relieve law enforcement officers from traffic duty at key intersections following a hurricane. Last year, they were stretched thin, which compromised their ability to perform other critical functions such as post-storm security. By the time we got to Ivan and had generators ready to go, we could quickly free up hundreds of officers for other missions."

Water, ice, food, and other essentials were rushed to affected populations from this staging area and others set up in advance of each hurricane.

Newer signal head technology also is expected to improve preparedness. "We learned," says Clark, "that generator maintenance and the size of generators needed could be minimized by replacing destroyed incandescent signal lights with the newer LED [light-emitting diode] signal lights with substantially reduced power consumption." The State intends to install only LED signals on all future projects.

This portable base camp was constructed from metal shipping containers modified with electrical connections, air-conditioning, and sanitary facilities to house hurricane first responders and recovery teams. FDOT contracted for similar base camp facilities prior to Hurricane Dennis in 2005.

(Above and right) The storm surge from Hurricane Dennis in 2005 washed out this stretch of U.S. 98 along Florida's panhandle coast. FDOT's emergency contract experience gained from 2004 enabled repairs to be made and the road reopened within 2 weeks.

Lesson Five—Clearing the Debris

A hurricane is a perfect machine for creating debris, as it destroys and scatters the remains of structures, signs, utility poles, and trees. It can take months to clear an area of storm debris completely, but the transportation agencies and local governments have a more immediate target: to open as many roads as possible within a day of the event.

In the rush to accomplish that mission, beginning with Hurricane Charley, it became apparent that not everyone was clear on the Federal-aid emergency assistance requirements. FHWA's Davis describes the process: "FHWA paid for the initial push to clear debris off the Federal-aid highways and the first pass to remove the debris. But local residents and repair crews would often put debris on the already cleared right-of-way as they dug out from the storm's damage. That made it critical for local agencies to document debris removal, so we could

Helpful Web Sites for Hurricane Emergencies

National Hurricane Center, National Weather Service, National Oceanic and Atmospheric Administration

Tropical Prediction Center Page. A source of timely information on approaching hurricanes and historical data on past storms. www.nhc.noaa.gov

Florida Division of Emergency Management

Home Page. State emergency Web sites, such as Florida's, can provide key information for government agencies, emergency management operation, and the public. http://floridadisaster.org

Evacuation Routes. www.floridadisaster.org/PublicMapping/index.htm

Florida Road Status. www.eoconline.org/EM_Live/roadstat.nsf

Florida Traffic Information. www3.dot.state.fl.us/trafficinformation

Citizen Emergency Information. http://floridadisaster.org/citizen_emergency_info.htm

Federal Emergency Management Agency, U.S. Department of Homeland Security

Home Page. Links to key FEMA resources and emergency information. www.fema.gov

Emergency Management Training Institute. Online courses in emergency planning and response for emergency staff and the public. www.training.fema.gov/emiweb

verify what was in that initial push and first pass, and what was not. The most effective method used by local agencies to manage debris removal was to have tickets completed for each load, detailing where and when it was picked up and its disposal."

To further complicate the situation, some agencies did not understand basic differences in disaster assistance from FHWA and FEMA. "Unfortunately, there was sometimes confusion regarding FHWA's ER program and FEMA's emergency aid program," Davis explains. "A few local agencies and some public assistance representatives operated with the understanding that FEMA would reimburse them for all their debris removal costs. Later, when FEMA processed the claims, the expenses that were FHWA-eligible were kicked back to the local communities. At that point, they would notify us, and a much delayed FHWA ER process could begin. That's why we're still hearing about new claims months after a storm hit."

There were also practical lessons to be learned about how to administer a debris removal contract. "Debris removal was a challenge to manage," says Davis. "Contractors who were paid by weight were sometimes inclined to pick up only the heavy debris and leave the lighter limbs and rubbish behind—just as those paid by volume might tend to ignore the heavier debris. Agencies needed to inspect and track the process."

Lesson Six—Preparing the Contracts

Emergency contracts were the order of the day for each hurricane that blew ashore during 2004. They were mostly needed for debris removal, sign and signal repair and replacement, and roadway repairs. And, even in the face of a disaster, contracting rules needed to be followed.

"For the ER program, it's important for State and local agencies preparing emergency contracts to meet Federal requirements, such as including the Bacon-Davis wage rates and FHWA 1273 provisions," Davis notes. "If these requirements are missing, otherwise qualified emergency expenses could become ineligible for reimbursement." Form FHWA 1273 is a collection of contract provisions and notices required by FHWA and other Federal agencies, including such key items as equal employment opportunity and Americans with Disabilities Act of 1990 regulations, as well as U.S. Department of Labor requirements for payment of regional prevailing wages per the Bacon-Davis Act.

FDOT has developed a model contract to serve as a guideline in emergencies and to aid in drafting pre-event contracts, which are permissible immediately before a hurricane is expected to make landfall. "Creating 'hurricane contracts' is an important step for State and local governments," advises FDOT's Akridge. "That way you're ready to handle major short-notice needs such as debris removal and roadway assistance."

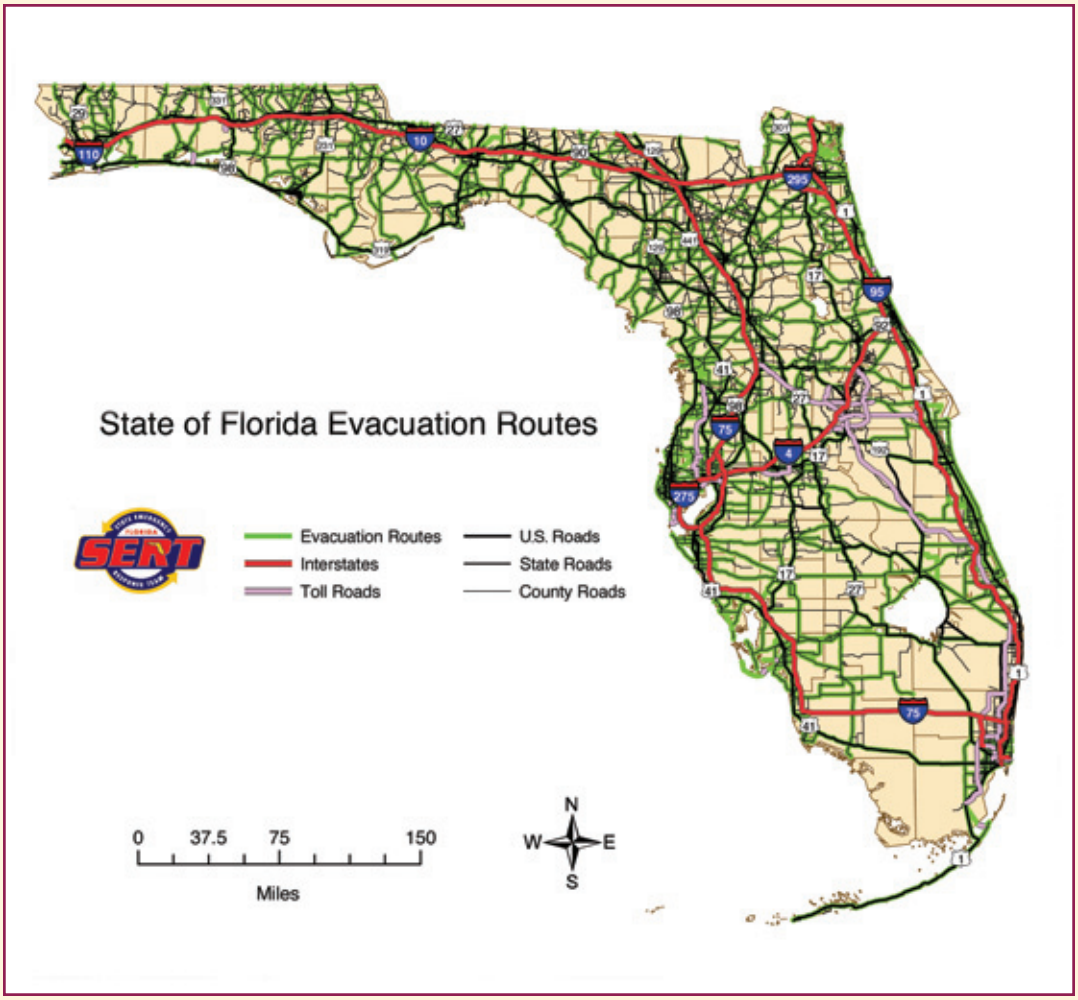
Lesson Seven—Upgrading an Emergency Operations Center

In 2004 the FDOT team working in the SEOC had state-of-the-art facilities and technical support, but their own operations center at the FDOT headquarters was less sophisticated. In 2005 improvements were made that will enable FDOT to respond to hurricanes and address the recovery needs more efficiently. FDOT's Day describes some of the upgrades: "Now we have more full-featured PC [personal computer] stations, with a new internal tracking system to stay on top of FDOT's emergency missions. And, although we always had generator backup, now we have climate control as well."

Bryan Hubbard, FDOT Central Office emergency coordination officer, elaborates on the enhanced emergency center's operations. "Last year we pushed a lot of the missions over from the SEOC using Lotus® Notes®. It worked well, but there were inherent problems. You could come in for the morning shift and find that more than 100 e-mails had come in with updates on missions. Now our folks over at the SEOC can enter the mission directly into our database, without the need to rekey the information.

"When a mission is received, it can be tasked directly to the FDOT Maintenance Office or to the appropriate district, as needed. Each recipient can then update the status of the mission to indicate if equipment or other support is en route, or if the mission is completed."

Along with the new facility, the procedures for coordinating between FDOT offices also were improved. Day explains, "We developed a standardized situation report, or SitRep. So, rather than have each district give a report on the status of their roads at our afternoon teleconference, all that can be reviewed prior to the meeting. That let us concentrate on what's most important to the districts in responding to the emergency. In addition, we provide the SitRep information to our Public Information Office to distribute at its daily press conference to keep the public informed on road status."



This map shows the statewide evacuation routes in Florida. *Source: Florida Division of Emergency Management.*

Graduating From The College of Hard Knocks

The lessons from the hurricanes of 2004 were put to the test on July 10, 2005, when Hurricane Dennis, a category three storm, hit the Florida panhandle just east of Pensacola, following a path similar to Ivan's the previous year. Fortunately, there was abundant evidence that the lessons from 2004 had been turned into action plans.

A few examples of the successful responses include:

- Despite initial uncertainty as to whether and where Dennis would strike Florida, preparations were started early. Fuel providers were asked to beef up supplies in the panhandle to facilitate evacuation, and as the northwestern counties gave orders to evacuate, FDOT dispatched road patrols immediately to assist motorists leaving the area. At the same time, the local FDOT district ensured that inventories of repair supplies, especially generators, were on hand and ready to go.
- High-mast lights at I–10 exits were safely lowered to the ground and survived without damage.
- In Pensacola, along U.S. 90 and other areas, signal heads were taken down and secured onsite to strong mast-arm poles in advance of the storm.
- Stronger cellular towers erected after Hurricane Ivan, coupled with supplemental truck-mounted mobile stations, aided in quickly restoring cell phone communications.
- Emergency contracts and prior maintenance arrangements facilitated rapid recovery, including inspection and reopening of the previously damaged I–10 Escambia Bay Bridge within a day, and repair and reopening of a massively damaged stretch of U.S. 98 along the gulf coast within 2 weeks.
- To avoid a housing shortage for State transportation recovery workers, arrangements were made prior to the storm to provide portable facilities at a base camp.

In short, the 2004 hurricane experience—and a timely analysis of the problems and how to prevent them—resulted in a far better prepared transportation community. Learning from disaster paid off.

Steve Jacobitz is a marketing and communications specialist in the FHWA Florida Division. He also serves as a member of the Florida State Emergency Response Team, and he worked at the SEOC and in the field during the 2004–2005 hurricane emergencies.

For more information, contact Steve Jacobitz at 850-942-9650 or steve.jacobitz@fhwa.dot.gov.

A panel discussion explored increasing the use of public-private partnerships for highway projects.

by Jim March

Working With the Private Sector

Increasingly, the public sector is looking to the private sector for creative, cost-saving solutions to complex transportation problems. Private-sector involvement in design-build projects, intelligent transportation systems, emergency relief, and other program areas has led to such innovations as longer lasting pavements, prefabricated panels, and even seatbelts.

As Federal and State highway funding continues to be stretched and as needs for efficient surface transportation systems continue to grow, transportation officials are looking for new ways to capture the efficiency and value provided by private industry. The Federal Highway Administration (FHWA) and the U.S. Department of Transportation (USDOT) believe that public-private partnerships can contribute to reducing traffic congestion, improving the quality of the Nation's transportation system, and increasing the efficiency of the operation and maintenance of the system. FHWA and USDOT are examining opportunities for increasing private-sector involvement in transportation projects, plus potential challenges. Public-private partnerships (PPPs) are defined as contractual agreements that allow more private-sector participation and investment than is traditionally the case.

The USDOT December 2004 *Report to Congress on Public-Private Partnerships* indicates that public-private agreements usually involve a government agency contracting with a private company to renovate, construct, operate, maintain, and/or manage a transportation system or facility. Although the public sector usually retains ownership of the facility, the private party is typically given additional responsibility for determining how the project or task will be completed or how a particular facility or system of facilities will be operated and maintained. PPPs might be applied to a range of transportation functions, including project origination and conceptualization, design, financial planning and finance, construction, operation, maintenance, toll collection, and program management.

To explore the role of PPPs in more detail, the Transportation Research Board (TRB) hosted a forum titled "Let's Make A Deal!—Fostering Partnerships for Critical Transportation Projects" on January 10, 2005. The session was structured as an open forum between USDOT and private-sector representatives involved in project financing and

(Above) The Chicago Skyway Bridge, shown here at night, is a 12.5-kilometer (7.8-mile) toll road built in 1958. For almost 50 years, the City of Chicago Department of Streets and Sanitation operated and maintained the bridge, which is the only toll highway in Illinois that is not operated by the Illinois State Toll Highway Authority. In a transaction that gave the city a $1.83 billion cash infusion, the Skyway Concession Company, LLC, will assume operation of the skyway through a 99-year lease. *Photo: City of Chicago.*

to Meet Transportation Goals

delivery, focusing on how the parties need to think creatively and strategically to advance critical surface transportation projects through PPPs.

"There are some remarkable, albeit underreported, examples of where the private sector has really come in and helped us innovate," said former Federal Highway Administrator Mary E. Peters during the meeting. "Market forces will give us more options, and I think we can complete projects significantly sooner than we otherwise would."

At the TRB meeting, Peters posed a series of questions to the five panel members: (1) Geoffrey S. Yarema, chair, infrastructure practice group, Nossaman Guthner Knox & Elliott LLP (Nossaman); (2) James T. Taylor II, managing director, public finance, Bear, Stearns & Co. Inc. (Bear Stearns); (3) Allan Rutter, then-deputy and now executive director, North Texas Tollway Authority (NTTA); (4) Robert Prieto, senior vice president, Fluor® Corporation (Fluor); and (5) D.J. Gribbin, former chief counsel, FHWA.

How would you define a successful public-private partnership?

Although the definition of a PPP is clear, the definition of a *successful* PPP is more subjective. The panelists' responses varied based on their unique perspectives; all agreed, however, that successful PPPs are those that produce the maximum value for the traveling public.

Geoffrey Yarema (Nossaman): "Success is when the public sector involves the private sector in delivering sufficient added value for the sponsoring agency to justify deviating from standard procurement and contracting procedures. That added value can come in many forms: new sources of funding, creative financing techniques, operating efficiencies, accelerated project delivery, reduced life-cycle costs, and innovation in project definition and design.

"By the very nature of PPPs, the private sector takes on more project risk, and the public sector takes on more political risk. Profit is not guaranteed for the private sector, and policy issues—such as public dissatisfaction with the protections given to the private sector—may prove to be controversial for the public sector. But success for both private and public sectors should be defined in terms of progress and quicker, more efficient project delivery—not in terms of a friction-free or loss-free environment."

Allan Rutter (NTTA): "Success is when the end user gets more out of the facility in terms of design, materials, and/or the implementation timeframe because the private sector was involved."

D.J. Gribbin (FHWA): "If you end up with a quality project constructed quicker and at less cost, then you have a successful project. Additionally, from a Federal standpoint, a successful project is one that advances knowledge, such as the Chicago Skyway, which people were able to learn from and apply that learning elsewhere."

Bob Prieto (Fluor): "A successful PPP delivers the maximum infrastructure

for the lowest cost to both the taxpayer and the user. Three financial measures can be used to assess whether maximum public infrastructure is being provided. The first is the net present value, or the lowest compliant bid for the infrastructure and project objectives. The second is affordability, to the extent that there's a government subsidy or a user that is able to afford the facility. The third is a comparison of costs between those of the PPP model versus those of a traditional government approach.

"Successful PPPs also require appropriate risk-weighted returns. This doesn't mean that every return and every investment will produce the kind of return you want. But both the public sector and private sector need to make those risk judgments and set return levels that make it worth taking the risk.

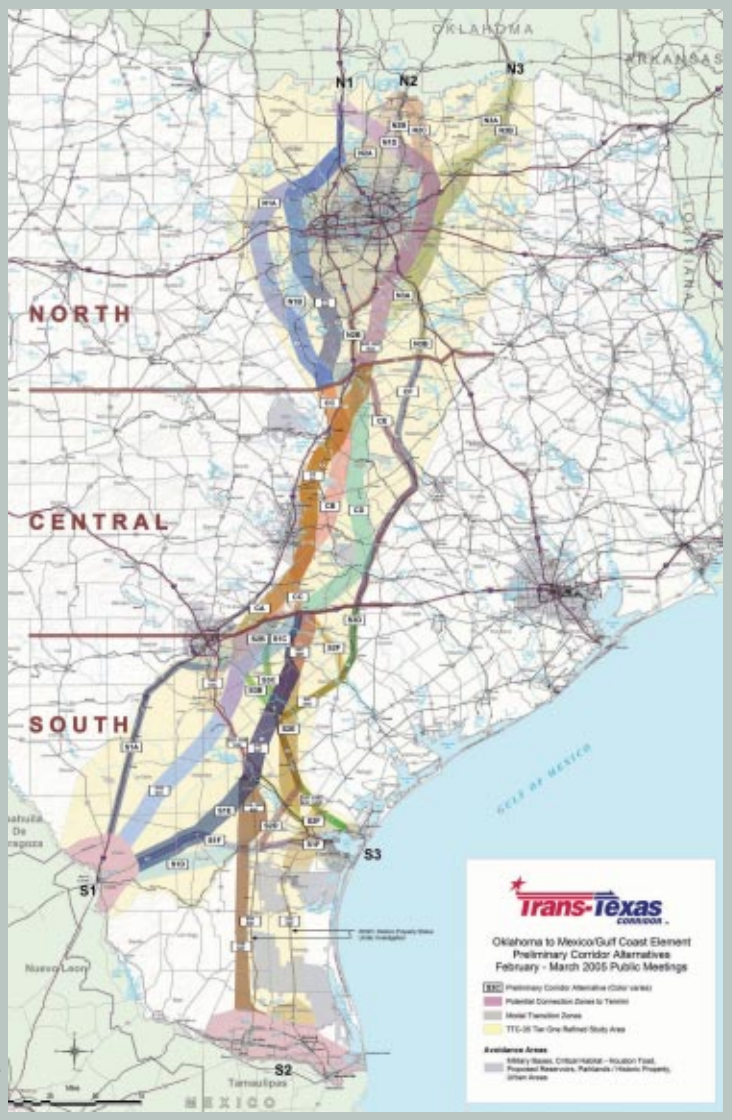
"Finally, successful PPPs must protect the interest of the public. By this, governments need to ensure that pricing systems reflect broader societal objectives, which may influence their decisions about how to buy facilities, or the kind of subsidy they're willing to provide."

How would you define an environment that is attractive to successful public-private partnerships?

FHWA and USDOT want to remove obstacles to the formation of public-private partnerships, and also to create incentives for the promotion of PPPs. How to create an environment that is conducive to successful PPPs was the second topic discussed by the panelists.

D.J. Gribbin (FHWA): "From a big picture perspective, some significant statutory changes are needed at the State level. We have 18 States that have no provisions even allowing the design-build project delivery method. There are a large number of States that also prohibit tolling. This needs to change.

"Another significant change that's needed is for us to allow markets to work in the transportation sector the way they do in every other service. The notion that we should be able to travel unimpeded by tolls seems to be very much a part of the American personae, but that line of thinking—when applied to the current highway system—creates a number of economic price distortions that don't serve American drivers very well in the long run. If we're going to create an environment to attract PPPs, we need prices to create a market to allow the private sector to play a larger role. We're starting to see some changes in this area, with Interstate 15 and the congestion pricing that's been used around the country, like S.R. 91 [State Route 91 Express Lanes in Orange County, CA]. Also, Minnesota is now looking at the whole network of variable price lanes, and Maryland is considering express toll lanes."



The Trans-Texas Corridor (TTC) is one example of a proposed public-private partnership. The Texas Department of Transportation (TxDOT) will use a contract that allows the State to hire a private firm to plan, design, construct, finance, maintain, and operate the TTC. For the proposed Oklahoma-Mexico element (TTC–35), shown on this map, TxDOT has already selected a private-sector partner (Cintra-Zachry).

TxDOT

Allan Rutter (NTTA): "We need to understand what markets are and what they're not. In the marketplace, people make mistakes and pay the price. But people in the public sector, particularly engineers, grow up to be risk averse—because we don't want things to fall apart. Yet, things do fall apart—pavements don't last as long, soil behaves in weird ways—and risks are taken every day. Within the marketplace, the transportation community needs to allow itself to make mistakes, to not fear retribution, and to learn from those mistakes by fixing supply and delivery."

Jim Taylor (Bear Stearns): "State DOTs [departments of transportation] should receive resources from the Federal Government or their legislature to properly pursue PPPs. Additional support staff and access to outside expertise are often needed to level the playing field in negotiations with the private sector."

Geoffrey Yarema (Nossaman): "We have our own internal checklist to determine whether a PPP [would] work in a given case. First, the community needs to want the project and be willing to have it tolled, or accept whatever other financial mechanisms are being used to pay for it. Second, the project needs to be one that can be environmentally cleared in a relatively short period of time. In addition, legal authority and bipartisan political support for PPPs are needed, as is the support of DOT senior management. In terms of the procurement selection process, it must be fair, transparent, and competitive, and carefully designed to ensure that the private partner delivers what the public agency is

seeking. Also, the process must not create public perceptions of conflicts of interest or abuses of the system. Finally, the contract terms also need to be fair, reasonable, and reflect an appropriate balance between public and private concerns."

Bob Prieto (Fluor): "There are four key things we look for in identifying opportunities. The first is political will at the level of the executive office and/or legislature, which is needed for the tough decisions to get made and the project cycle to proceed in a timely manner. Second, there must be good legislation. From my perspective, one key characteristic of good legislation is the ability to submit an unsolicited proposal, because it provides for maximum innovation. Third, the procurement process must be transparent, with objective criteria. Fourth, the agency involved—be it the State DOT or other transportation authority—must embrace change to reap the full benefit of the innovation that the private sector can bring."

TxDOT

The concept for the Trans-Texas Corridor, shown here in an artist's rendering, calls for separate lanes for cars and trucks; rail with separate lines for passenger, high-speed freight, and commuter traffic; and a utility zone.

What is the appropriate role of the Federal Government in encouraging public-private partnerships?

FHWA has already taken a number of steps to promote PPPs. For example, in 2004, FHWA published a report to Congress on PPPs and created a new Special Experimental Project (SEP–15) to explore alternative and innovative approaches to the overall project development process. SEP–15 enables FHWA to identify new PPP approaches to project delivery for trial evaluation, addressing (but not limited to) four major components of project delivery: (1) contracting, (2) compliance with environmental requirements, (3) right-of-way acquisition, and (4) project finance. Also, in 1998, the Transportation Infrastructure Finance and Innovation Act (TIFIA) established a new Federal program under which USDOT may provide credit assistance to major transportation investments. The TIFIA program is designed to fill market gaps and leverage substantial private coinvestment by providing supplemental and subordinate capital and credit rather than grants.

The panelists offered additional ideas on how the Federal Government can foster more PPPs in the transportation sector.

Jim Taylor (Bear Stearns): "Although there may be a role for the Federal Government in pushing PPPs, we need to be careful because some Federal initiatives to promote innovative finance in the past have had unintended consequences. For example, in the late 1980s and early 1990s, a number of successful project development efforts were undertaken by people who recognized that there was not going to be any money coming from Federal or State Governments for some important projects. They found ways to get the projects done without private activity bonds or special legislation. But much of that activity stopped after TEA–21 [Transportation Equity Act for the 21st Century], because it was much easier to use GARVEE bonds [Grant Anticipation Revenue Vehicles—a type of project financing issued by a number of States that uses financing mechanisms involving the payment of future Federal-aid highway funds to retire debt] to fund projects, for example, than to embark on a 2-year development effort for standalone project financing. Likewise, we had a number of contractors who were willing to put money into projects prior to TIFIA, but now project sponsors question why they should accept expensive private investment when they can secure better terms on a TIFIA loan from the Federal government. Although not the intent of GARVEEs or TIFIA, these initiatives did result in a hiccup in private-sector involvement in transportation infrastructure finance."

SANDAG

The San Diego Association of Governments (SANDAG) employs advanced signing to help motorists use the I–15 FasTrak lanes effectively. This sign displays the charge to use the facility.

Orange County Transportation Authority

A sign above the S.R. 91 express (HOT) lanes in Orange County, CA, provides a toll-free telephone number and uses arrows to indicate "3+ Lane" and "Toll Lanes."

Geoffrey Yarema (Nossaman): "I feel strongly that we need Federal tools—such as GARVEE bonds, TIFIA, and private activity bonds—that save money and make deals more efficient. The idea is to line up as many tools as possible and optimize them for your particular project, not to use them just because they're there. You don't use a hammer when you need a screwdriver.

"I think that the role being played by FHWA in providing grants, Federal credits, and environmental assessments to the States is right on. FHWA should continue to remove procurement restrictions and allow the States significant flexibility to experiment, such as through SEP–15. Allowing long-term private operations and warranties, as well as a combination of private equity, tax-exempt debt, and long-term operations, is also critical. Administration support of private activity bonds programs should be continued, and toll credits should be expanded to create additional incentives for toll implementation. Finally, the Federal Government should continue its leadership in articulating the vision of advancing PPPs."

Bob Prieto (Fluor): "I don't think the Federal role is to legislate, regulate, or mandate. Rather, the experimentation that's occurring now is absolutely essential. That said, I do think there is a role to be played by the Federal Government. SEP–15 is a great tool, and moving forward, the Federal Government can help facilitate the sharing of best practices and lessons learned, and help States identify the 'must haves' in a contract. Environmental streamlining for all capital projects—not just PPPs—should also be promoted, and some kind of a risk-weighted facility should be created, such that Federal money can be advanced to the States and repaid with a return following financial close. This type of risk-weighted facility would free the States from worrying about their annual budget cycles and effectively accelerate the process."

Allan Rutter (NTTA): "The USDOT *Report to Congress on Public-Private Partnerships* is important because it provides information about experiences, even if they're not all glowing successes. Many States want to pursue PPPs but are afraid, so they need to see what others are doing in this area. The States that don't have any experience are actually in the best position—they can learn from everybody else's mistakes and cherry-pick all the best and most effective approaches."

D.J. Gribbin (FHWA): "I also think FHWA can help the public-private process through knowledge sharing. Currently, we have a contract to create both draft model legislation for States and a draft contract for an innovative project. This draft contract will address many different issues, including the risks of greater private-sector involvement, which is important given that many CFOs [chief financial officers] have never negotiated these types of contracts." The draft legislation is available online at www.fhwa.dot.gov/ppp.

What areas of expertise do public and/or private sectors need to develop to maximize the potential for successful PPPs?

The procurement, management, and implementation of a PPP require special expertise at various levels, which may be different from the sets of skills and experiences of existing workers in the public and private sectors. The panelists provided insights into the types of expertise that both sectors will need to maximize the potential for successful PPPs.

Allan Rutter (NTTA): "To start, a rudimentary understanding of project finance is needed. For example, many people in transportation agencies are clueless when it comes to what a bond is or how to do project finance. They don't have to become experts, but they do need to understand the terms and know the risk factors. Agencies need to come up with a team [of experts] who know what they're doing, who understand the owner's perspective, and who can negotiate such that both sides can get something out of it."

Jim Taylor (Bear Stearns): "State DOTs need to develop a clear vision before they can figure out how public-private partnerships fit into their long-term strategies. If they focus only on getting a certain

project done without having a vision of where they're going, they'll end up taking detours. I think DOTs need tools to help them articulate their vision to both the legislature and the general populace, so that then they can evaluate any given initiative in the context of getting them closer to their ultimate goal."

Geoffrey Yarema (Nossaman): "State DOTs need someone to run the project or program who is well respected within the DOT senior management and the legislature. Although this role does not need to be filled by a chief engineer, it does require someone with the ability to command the respect of the line engineers so they don't form a wall that the program can't get through. Additionally, the role requires someone who thrives 'outside the box' and is somewhat of a natural leader—because almost by definition, they're going to have a newly formed team.

"On the other hand, the private sector needs to have a very soft touch when it comes to dealing with local stakeholders, public officials, and community concerns. Also, thought needs to be given to organizational conflicts of interest, which have arisen in the past, and there is a need for long-term operations and asset management services. However, it remains to be seen whether U.S. industry is ready to reengineer itself to pursue such services, as this would entail an increase in the ability to predict costs, long-term liability, and balance-sheet risk."

Bob Prieto (Fluor): "The public sector needs to add a set of skills to assess total taxpayer impact. This is not a financial evaluation; it's an economic calculation, which requires a different type of analysis. If PPPs are to have a long-term future at the State level, their economic benefits are going to have to be demonstrated.

"On the private-sector side, you need a strong set of financing skills and a firm understanding of the available tools (such as GARVEE bonds, TIFIA) to determine which will provide the best risk-weighted return for you and your public-sector partner."

D.J. Gribbin (FHWA): "On the private-sector side, [companies] need to do a better job of understanding the risk that the public sector takes in these projects and that public-sector decisions are not made project-by-project, but across the entire program. This can be frustrating because it may render the public sector hesitant to take action on a given project knowing that that decision may affect many other projects in [the] future."

How do you choose partners in a public-private partnership?

Typically the public partner in a transportation PPP is a State DOT, a county or municipal public works department, or a State-chartered toll road, bridge, or transit authority. In addition, certain public-benefit organizations are authorized by States to undertake transportation development projects using PPP approaches.

Private partners include professional service companies, contractors, and financial entities pursuing business with owner-operators. Private-sector participants in PPPs have included businesses that provide services to public agencies for a fee, such as engineering and construction companies and specialized financial and legal advisers.

But on what basis should public-private partners choose one another? This question was the final one posed to the panelists.

Bob Prieto (Fluor): "Both the public and private sectors need partners that clearly understand their obligations and are fully able to stand behind them. Too often a party on one side does not really understand what they've signed up for. In the public sector, this requires a fair and objective evaluation process and true political will. The key for us [the private sector] is the reputation of the public-sector partner."

Jim Taylor (Bear Stearns): "A transparent process is key. I think we need to focus on the process that will lead to a partner, not on defining the category of partners that is ideal."

Geoffrey Yarema (Nossaman): "Defining the kind of competition for a particular project and how to select a partner that has the most likelihood of success is a core part of our business. In doing this we try not only to identify the most proficient partners for a particular project, but also to engender public confidence over the long term—and expediency on a particular project isn't necessarily in the long-term interest. Ultimately, we want to select partners that will contribute to a vibrant PPP future; a single major public controversy could damage not only a particular project or the State program, but the entire national industry. Therefore, robust competitions with transparent, nonbiased selection processes are needed. So it's very important that no one, including unsolicited proposers, be practically guaranteed to win.

"Also, while there are many models of competition, there is no right or wrong model. To decide among options, agencies should ask themselves a series of questions that will allow them to get the most out of the private-sector partner and be clear about needs and expectations upfront."

Allan Rutter (NTTA): "In addition to what's been said, we aim to create a pool of people who can work for us. So we try to design the procurement in such a way that we're not beholden to one provider, and somebody who doesn't get picked still wants to work with us."

The Time Is Now

If the telecommunications sector is any indication of what private-sector involvement can do, PPPs may lead to dramatic improvements in our roadway systems over the coming decades. To mainstream PPPs in the transportation sector, the Federal Government needs to continue removing barriers, sharing experiences, and building expertise.

In the words of former Administrator Peters, "Highways in the United States are traditionally Government-funded, Government-planned, and Government-maintained . . . It's time to let the free markets deliver innovation, deliver cost savings, and deliver quality improvements."

The challenge awaits.

Jim March is leader of the Industry and Economic Analysis Team in FHWA's Office of Policy.

For more information, contact Jim March at jim.march@fhwa.dot.gov or 202-366-9237. The complete transcript of the panel session is available at www.fhwa.dot.gov /ppp/lmd050110.htm.

Formula for Success

by Jim Sorenson

Today's transportation agencies face significant pressures to handle more challenges with fewer resources. Traffic congestion is increasing, as is the need to preserve and enhance an aging infrastructure and address public frustration with travel delays and work zones.

The Federal Highway Administration (FHWA) is pursuing numerous avenues to improve the Nation's surface transportation system. State and local agencies have been traditional partners of FHWA in these efforts, and the newly passed highway legislation—Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU)—institutes a number of new opportunities for partnerships with the private sector. By working together, solutions will be found, and public satisfaction with transportation programs should increase.

Asset management equals oversight plus accountability, sound engineering, and economic decisionmaking.

Whenever public dollars are used, governments are responsible for more than just keeping their constituents satisfied. Governments also must account for the use of the public's money and the resources devoted to the projects and programs under their direction. Agencies at every level of government have a responsibility to be good stewards of the transportation infrastructure and to maintain the public's trust and confidence that constituents do receive value for every tax dollar spent.

"Without public trust and confidence, the resources will not be made available to address the immense challenges that face the transportation community today and that we will continue to face in the future," says Acting Federal Highway Administrator J. Richard Capka.

FHWA plays a key role in protecting the Nation's transportation investments and has an overarching stewardship responsibility for managing federally funded programs efficiently and effectively. The stewardship includes effective management of public funds entrusted to the organization. FHWA accomplishes this stewardship by being a value-added leader, sharing innovations in technology, and providing sound technical advice and support to its State partners and stakeholders.

"Financial stewardship and accountability are embedded in all aspects of the agency's mission, both in headquarters and in field offices," says FHWA Executive Director Frederick G. Wright. "It is imperative that we ensure integrity in the expenditure of public funds through strong financial accountability and oversight."

(Above) Responsible oversight is key to meeting the American public's expectations of quality in transportation construction programs, including building and rehabilitating highways such as the one shown here being paved.

Secretary of Transportation Norman Y. Mineta has confirmed that financial accountability is one of the top priorities of the U.S. Department of Transportation (USDOT). The recently issued Financial Integrity Review and Evaluation (FIRE) program documents how FHWA will take action to improve its financial management role. As indicated by Wright, "It is imperative that FHWA effectively evaluate the systems, controls, and procedures that are in place to protect the funds entrusted to the agency."

The FIRE program directs FHWA division offices to perform a number of reviews in support of the annual certification of financial controls to support the agency's financial statements. FIRE includes a toolkit that provides detailed information for implementation and contains review guides for the various processes to be reviewed. FIRE covers internal controls as well as Federal-aid funds management. Just as FHWA must meet the fiscal controls, it must ensure that the product being purchased with Federal dollars gives the expected performance. Looking at system performance and highlighting areas for further reviews is vital for construction program management.

Oversight, a primary element of stewardship, is key to meeting the public's expectations of quality in transportation projects. FHWA's oversight responsibility involves ensuring that the Federal-Aid Highway Program is delivered in accordance with applicable laws, regulations, and policies. This responsibility incorporates minimizing the potential for waste, fraud, and abuse, as well as advocating the national values expressed in environmental laws, public participation requirements, and safety design standards.

FHWA's oversight methods have changed over the years as the emphasis has shifted from building new highways to preserving and enhancing the existing infrastructure. During that time, FHWA has developed resources and tools that State and local government partners can use to enhance their own oversight efforts. (See "Evolution of FHWA Oversight" at right.)

FHWA's focus remains unchanged: working with its partners to ensure that Federal dollars achieve defined national goals and maintain the public's trust that its money is well spent.

Evolution of FHWA Oversight

The FHWA oversight role has changed over the years, but the agency's responsibility as the guardian of the national transportation system remains the same.

"Much of our oversight and approval for eligibility has been delegated to our State partners," said Christine Johnson, FHWA's director of field services-west, at the FHWA 2005 Western Area Engineer's Conference. "However, our accountability has not been delegated. We have a responsibility to verify that the processes and safeguards that a State is supposed to have in place are in place and are being followed."

From the early 1900s to the 1950s, FHWA's predecessor, the Bureau of Public Roads (BPR), used a partnership approach in which States administered Federal-aid highway projects and BPR made the checks necessary to protect the Federal interest. BPR was the main technical source for State and local agencies, and BPR field engineers stepped in frequently to solve complicated design and construction problems.

In 1956, the Federal-aid program expanded to build the national interstate system. From 1956 to 1974, authorizations under the Federal-Aid Highway Program increased more than 900 percent, while FHWA staff increased to an agency maximum of about 5,200 employees.

When a U.S. House of Representatives special investigative committee raised concerns in 1959 about a lack of construction quality and waste, fraud, and abuse in highway construction, BPR changed its oversight role and stepped up the level of project inspections. The focus of the division offices changed from providing advice to providing project-level actions that included detailed reviews and approvals. As the interstate construction program continued its rapid growth, and the State highway agencies gained experience and technical expertise, BPR began delegating some oversight responsibilities to the States.

By the early 1970s, FHWA (created when the U.S. Department of Transportation was formed in 1967) faced the dilemma of not being able to maintain its previous level of project reviews, despite its larger workforce. Meanwhile, FHWA was gaining confidence in the States' technical competence and ability to manage their own construction projects.

In 1973, Congress reduced the scope of Federal monitoring of Federal-aid highway projects on all but the interstate system. A 1974 FHWA study recommended a transition from project reviews to process and program reviews. Then-FHWA Executive Director R.D. Morgan initiated a stepped-up program of training in core areas and renewed emphasis on both program and project reviews, and division office program reviews and annual reporting was required.

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) changed the Federal oversight role by giving States more authority to ensure that projects are constructed to expected quality levels and shifting the Federal role primarily to program-level oversight.

The Transportation Equity Act for the 21st Century (TEA-21) further delegated authority to the States by releasing oversight functions under agreement between FHWA and States. At the same time, TEA-21 increased Federal oversight for megaprojects, major construction projects with budgets that total more than $1 billion each.

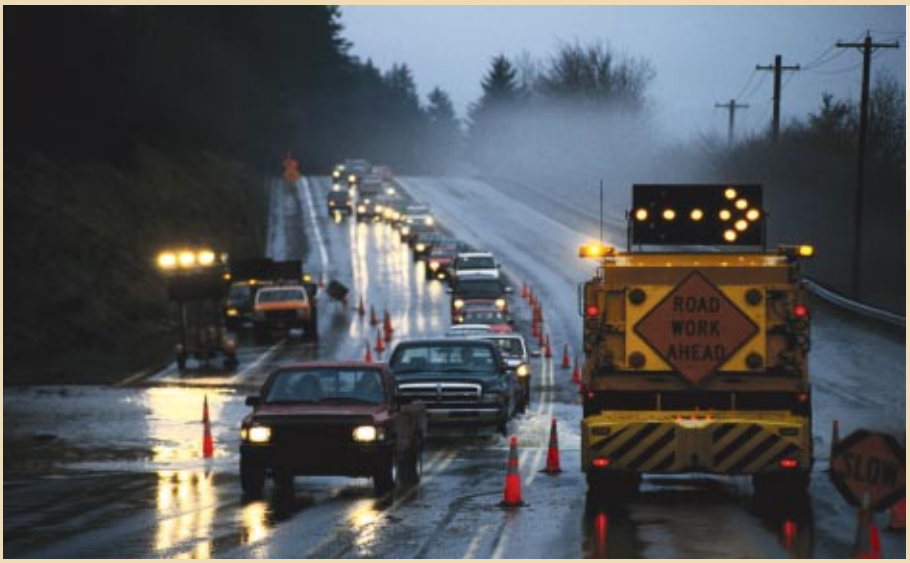
A 2001 FHWA policy statement reaffirmed that, regardless of the project responsibilities delegated to States, FHWA is ultimately responsible for Federal highway programs. The policy emphasizes stewardship and oversight initiatives that focus on broad program and process reviews with project-specific verification.

"Our roles and responsibilities in the administration of the Federal-Aid and the Federal Lands Highway Programs have evolved in past authorizing legislation; however, the expectation that we maintain an appropriate level of oversight and accountability in those programs has been constant," Wright says.

Challenges for Today

Today's transportation agencies work in an era of increasing demands on budgets and staff resources. The transportation professionals responsible for oversight face a number of challenges in their day-to-day operations. One of the greatest challenges is meeting customers' expectations. In addition, Federal, State, and local departments of transportation (DOTs) all face similar staff reductions and budget challenges.

Contributing to the staffing challenge is the attrition of seasoned transportation and construction personnel. Many field engineers who were on the front lines during the major highway construction projects of the 1960s and early 1970s have retired, and many of today's transportation professionals have not had the opportunity to acquire as much experience in construction project management and oversight. As in the past, these field engineers are the



Among the challenges faced by today's transportation agencies is addressing the public's frustration with this kind of growing traffic congestion resulting from highway construction delays.

eyes and ears for transportation agencies.

Despite the staffing challenge, the level of highway construction and hence oversight are not expected to decline. More roads than ever are operating near capacity, and an increasing percentage of highways have outlived their original design lives and now face needed rehabilitation or reconstruction. Yet there are fewer personnel to provide oversight on existing infrastructure enhancements and operational needs in addition to the oversight needed for development of new or reconstructed roads.

Requirements to preserve and enhance the aging infrastructure within budget parameters make it necessary for agencies to set priorities as to which of many critical projects to undertake now and which to postpone until another budget cycle. Although construction and rehabilitation projects are generally higher profile and, in the past, have received priority, today States are finding that a minimum (5 to 10 percent) investment in a dedicated preservation program is both improving the condition of roads and bridges in their jurisdictions and freeing up their budgets for the capital improvements desired.

In addition, the public continues to raise the bar on its expectations of the highway system. Although in the early days of highway construction, the priority was simply to have paved roads to get from farm to market, today the public demands a safe, efficient, long-lasting national highway system. Many industries depend on just-in-time delivery to minimize overhead costs and move products throughout the Nation and overseas. Given the new global economy, the ability of the United States to compete internationally is directly related to its capacity to move goods from the plains to the ports.

Along with the public's high expectations comes increasing frustration with growing traffic congestion and highway construction delays. FHWA's 2000 traveler satisfaction surveys found that 43 percent of respondents expressed dissatisfaction with traffic flow on major highways, up from 23 percent 5 years earlier. Thirty-two percent expressed frustration with work zones.

Overall, the Nation's highway program has become increasingly complex, with environmental commitments, urban planning needs, operational requirements, and budget and political pressures all vying for the limited time of transportation agency personnel and tight financial resources. Juggling construction, maintenance, public safety, and financing presents a definite challenge to every transportation organization.

Moving Forward On Oversight

In this challenging environment, FHWA's primary focus continues to be on stewardship and oversight to meet the public's expectations for quality—including safety characteristics, operational efficiency, and durability—and accountability as guardians of the Nation's transportation system.

The focus involves working in partnership with State and local transportation agencies, which have similar stewardship responsibilities to the public for the transportation infrastructure under their management and the Federal tax dollars entrusted to them to operate their programs.

Today, FHWA's emphasis is on initiatives that concentrate on broad program areas because these focuses are more likely to yield systemic improvements and result in higher payoffs for the effort invested. FHWA conducts its oversight through a wide range of mechanisms, including process reviews, program evaluations, program management activities, and project involvement activities.

In years past, when FHWA's staffing level was nearly twice that of the 2005 level, engineers were actively involved in the oversight of numerous individual highway construction projects. Although there has been a shift from project oversight to program oversight, FHWA's responsibility to assure the proper use of Federal resources remains unchanged.

FHWA's evaluation of State and local transportation agencies' construction programs, for example, involves an assessment of State procedures and controls for assuring that transportation improvements are constructed in accordance with approved standards and contracting methods.

"We will be far more efficient if we focus on ensuring that the processes that produce project decisions are right, rather than trying to track each individual decision," FHWA's Director of Field Services-West Christine Johnson told attendees at the FHWA 2005 Western Area Engineer's Conference. "However, to be good program managers, we must not lose sight of the core skills needed to understand project decisions." Every process review requires a sampling of the projects to assure that the process is being followed and that it is effective at producing the product or activity desired.

Effective evaluation of management and financial issues is also key to oversight. An example that Johnson cited was focusing on

getting the right materials for the roadway's asphalt mix, but losing the value of having the right materials because the construction project bid was off or the construction schedule was delayed because the funding was estimated incorrectly. "Those tend to be management issues rather than technical issues. Nevertheless, they are just as important," she said.

FHWA provides technical assistance in solving problems, recommends improvements to ensure high-quality construction, and shares information on innovations in materials, equipment, construction practices, and contracting methods. The recent success in carrying out the Accelerated Construction Technology Transfer program is an example of the leadership and technical support that FHWA can provide.

Inspections at the program level and on carefully selected projects are the primary methods that FHWA uses to fulfill its construction program oversight responsibilities. FHWA's objectives in conducting inspections include defining the progress and quality of work, identifying problem areas and innovations, documenting resolution of those problems, and sharing innovations and new technologies. The number and type of reviews conducted annually are determined by the FHWA division administrator's periodic risk assessment. This assessment takes into account the staffing and skills of the State DOT, program size and complexity, contractor and supplier availability, as well as FHWA division staffing and other factors.

FHWA conducts various types of inspections. Process reviews and product evaluations, for example, assure that State processes, procedures, and controls conform to Federal requirements. Indepth inspections are detailed reviews to track the processes necessary to correct problems or promote processes that produce high-quality products on a project, district, or statewide basis.

The FHWA reviews generally confirm that the work is in reasonably close conformity to the plans and specifications or that certain areas might need future attention.

Reviewing Processes And Programs

Each FHWA division office is responsible for developing a construction management program that defines the types and frequencies of inspections needed to maintain a reasonable level of confidence in the construction program it oversees.

To help carry out its oversight responsibilities, the FHWA Illinois Division developed guidelines for conducting annual process reviews. Under the guidelines, available at www.fhwa.dot.gov/construction/cpmi04c2.htm, FHWA and the Illinois Department of Transportation (IDOT) jointly select five or six topics a year for review, establish review teams, and develop a purpose and scope for each review.

Topics of reviews conducted in 2005 included bridge expansion joints, construction program estimates, roadside safety assessments, environmental documentation, and the Chicago Department of Transportation's authorization process and construction documentation.

"Process reviews are part of our continuous improvement process," says Eric Harm, IDOT deputy director and assistant chief engineer. "Working with FHWA on reviews gives us an extra set of eyes to take a look at our processes to see where we can improve them."

Joint coordinators from FHWA and IDOT head each review team, which can include representatives from other State and local transportation agencies affected by the review topic. Each team interviews staff in each IDOT district and reviews construction projects related to the topic. After the team completes the review, it holds a meeting with district staff to discuss what it observed and develops a report on its observations and recommendations for each district.

In addition, the team develops a statewide report that summarizes the results of the process review, documents observations that apply to the entire State, and outlines action items with specific deadlines to resolve or improve any problems it observed.

"What the Illinois process shows is that you can establish good partnerships with a State agency and make mutually beneficial progress," says Dean Mentjes, an FHWA Illinois Division mobility engineer who has participated on several review teams.

The Illinois reviews have resulted in a number of process improvements and specification changes over the years. Using cost and performance data collected during a review of bonded concrete bridge deck overlays a few years ago, the team produced guidelines and rewrote specifications on when to use different types of overlays and preoverlay treatments.

As a result, IDOT adopted new policies and is now obtaining better performance from bridge decks. "Anytime we can improve performance on something like a bridge deck, we ultimately save money by not having to rehabilitate it as often," says Harm.

FHWA's Washington Division develops annual performance reports on its construction project inspections, program evaluations, systematic reviews, and financial audits of the Washington State Department of

What Is Asset Management?

FHWA and AASHTO define asset management as "a strategic approach to managing transportation infrastructure. It focuses on . . . business processes for resource allocation and utilization with the objective of better decisionmaking based on quality information and well-defined objectives."

Asset management involves combining engineering principles with sound business practices and economic analysis to provide tools that facilitate an organized and logical approach to informed decisionmaking. Asset management provides a framework for both short- and long-term planning. It is about having a systematic process for maintaining, upgrading, and operating assets in a cost-effective way.

Implementation of asset management processes helps an organization use its available resources, human as well as financial, to provide customers with the most efficient and effective transportation system possible. The principles of asset management apply to all aspects of the program, from planning through project development, construction, operation, preservation, and maintenance.

Managing assets from a stewardship perspective requires carefully evaluating the critical areas needing oversight and committing the resources necessary to ensure that risks are addressed adequately.

FHWA works closely with State agencies to confirm that they have mechanisms in place to assure that construction projects like this one in Colorado are carried out according to laws, regulations, and policies, and meet taxpayers' expectations.

Transportation (WSDOT). The reports describe the reviews conducted during the fiscal year and provide a synopsis of FHWA's findings. WSDOT, in turn, posts the FHWA reports on its "Accountability" Web site at www.wsdot.wa.gov/accountability/performance/default.htm and prepares media releases to demonstrate the accountability of its construction program to the public.

In addition, WSDOT State Construction Engineer Kevin Dayton cites FHWA's independent reviews of State projects as useful in providing feedback to the Washington State Joint Legislative Audit and Review Committee, which conducts performance audits of State programs. In one instance, when a committee member commented that she believed WSDOT did not have an adequate number of field staff, WSDOT officials replied that FHWA inspection reports indicated that the agency was doing a satisfactory job.

FHWA's California Division developed a program review/product evaluation (PR/PE) initiative, which it used during the 1990s and is now reviving. Program guidelines are available at www.fhwa.dot.gov/construction/cpmi04c1.htm. The program calls for annual evaluations of the adequacy of processes, procedures, and products used by the California Department of Transportation (Caltrans) in project development and construction activities.

These reviews can be broad in scope, covering a major activity or program such as conceptual studies or preliminary plan development for construction projects, or more specific, covering products or elements such as pavement design, safety features, materials quality control, or construction management. Based on the reviews, FHWA can determine whether a process is being implemented as intended and is producing the desired result.

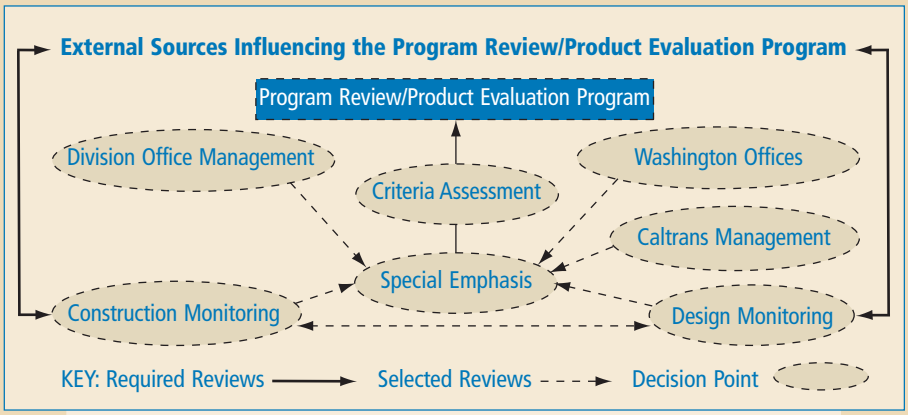
Under the guidelines, the PR/PE team develops an annual schedule of reviews based on input from several sources, including the State DOT, FHWA headquarters, and trends found in other division offices. The effort is to identify national and statewide policy concerns, and to obtain Caltrans management input on high-risk or problem areas. The team also looks at data from past design reviews, construction inspection reports, and related activities.

In addition, the team reviews a list of special emphasis areas, which are potential major review elements for the PR/PE program. The list covers a multitude of phases in the development, design, and construction of Federal-aid projects—from seismic analysis and bridge design to project staffing and supervision.

The team uses a criteria assessment model to evaluate each potential topic to determine the need for a PR/PE review. Topic selection criteria include the level of Federal interest, technical complexity, the degree of concern, and the statutory requirements related to it.

Guide to Better Inspections

The guidelines developed in Illinois and California for process and program reviews and the positive



As the diagram shows, several sources influence the choice of annual review topics in California's program review/product evaluation (PR/PE) initiative. They include input from Caltrans management and FHWA division and headquarters offices, data from past reviews of design and construction, and selections from the list of special emphasis areas, which are potential major review elements for the PR/PE program. *Source: FHWA.*

working relationship found in Washington State and many of the FHWA division offices are just some of the many tools available for local and State transportation personnel to adopt and use in carrying out oversight activities.

The guidelines are included in FHWA's *Construction Program Management and Inspection Guide* (FHWA-IF-04-013), available online at www.fhwa.dot.gov/construction/cpmi04tc.htm. To help engineers improve their technical knowledge and select a balanced program of construction management techniques, the guide highlights proven techniques for construction inspections.

"The guide can familiarize newer staff members with the construction management and oversight process, as well as serve as a refresher for veteran engineers," says Jeffrey Lewis, field operations engineering team leader in the FHWA California Division and a member of the FHWA Construction Quality Improvement Team, which developed the publication.

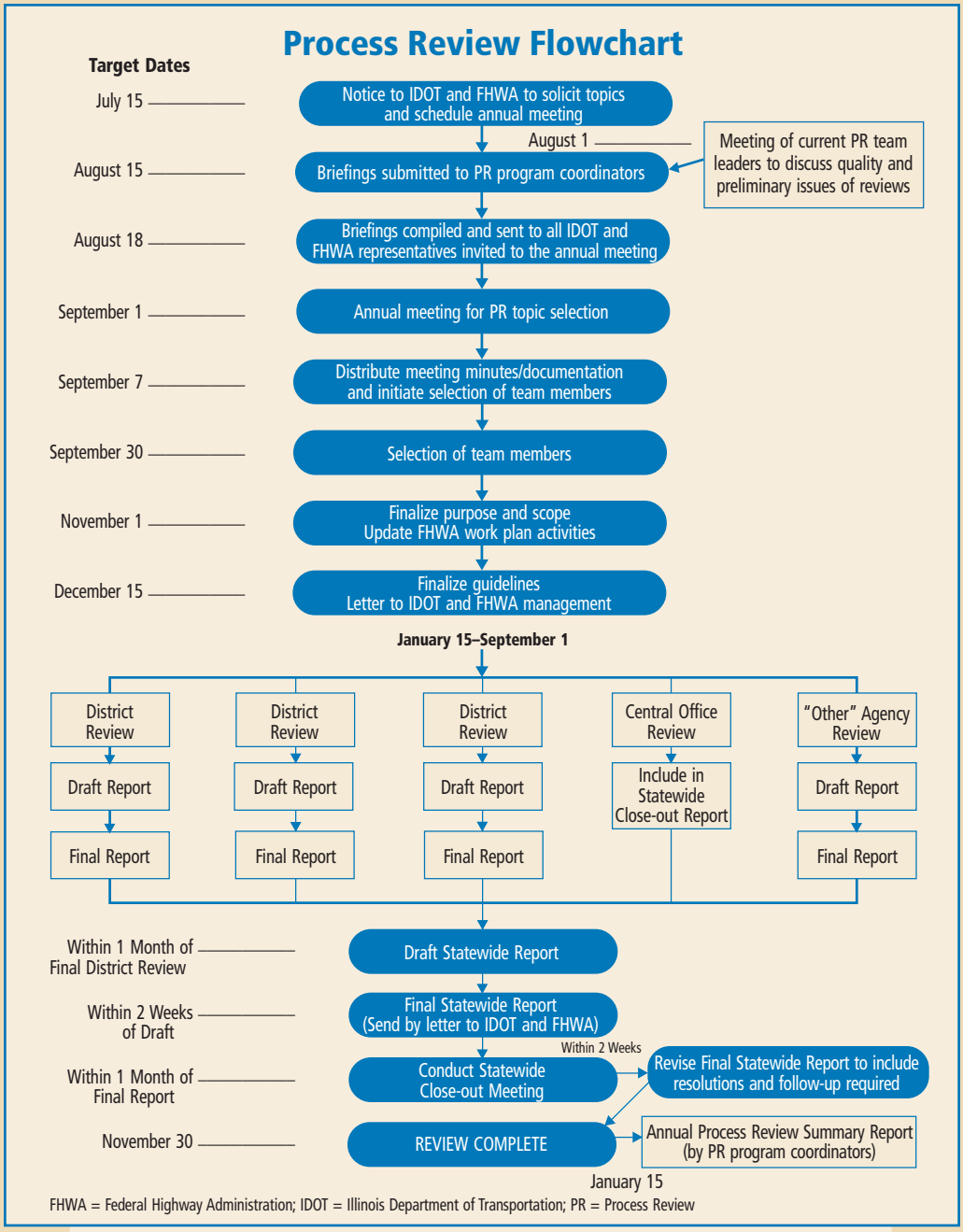
In addition to being a resource for FHWA staff, the guide is useful for State and local staffs as they plan, construct, and monitor projects using Federal-aid funds, Lewis says. "They need to understand the FHWA philosophy and intent when they act on FHWA's behalf," he says. "The guide helps explain what that encompasses."

The guide discusses the steps necessary to implement an effective construction management program. The steps include defining the types and frequencies of inspections needed to assure a quality construction program, performing inspections and reviews, preparing and distributing reports, and following up on findings.

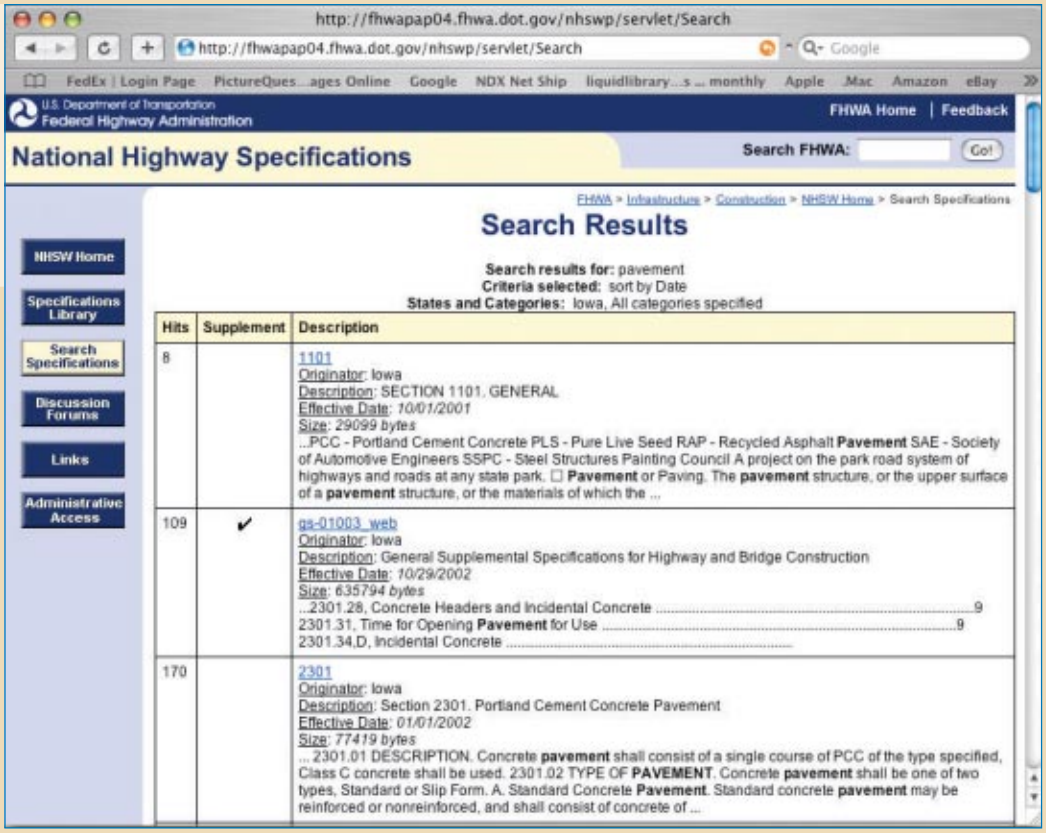
Among the tools in the guide is a checklist of items to consider when conducting an inspection, such as progress and quality of work, construction operations and features, project records, changes, and time extensions. The guide also contains an outline of the contents that a construction management report should incorporate, including details on observations, findings, resolutions, and quality management initiatives.

In addition, the guide has sample inspection report forms, such as bid review and design project checklists. Engineers can use the forms to streamline the writing process for reports and make them easy to follow.

The online version of the guide will be updated as new products, processes, guidelines, and sample



A detailed flowchart outlines 15 steps that FHWA and IDOT use to select topics for annual process reviews and to plan and carry out those reviews. The process starts with a solicitation of potential review topics and development of topic briefings. IDOT and FHWA managers meet to choose review topics for the year and assign a team to each topic. Teams conduct reviews, write reports on their findings, and meet with staff in each IDOT district. Finally, teams develop statewide reports on their topics that include action items with deadlines and present them at statewide meetings. *Source: FHWA.*

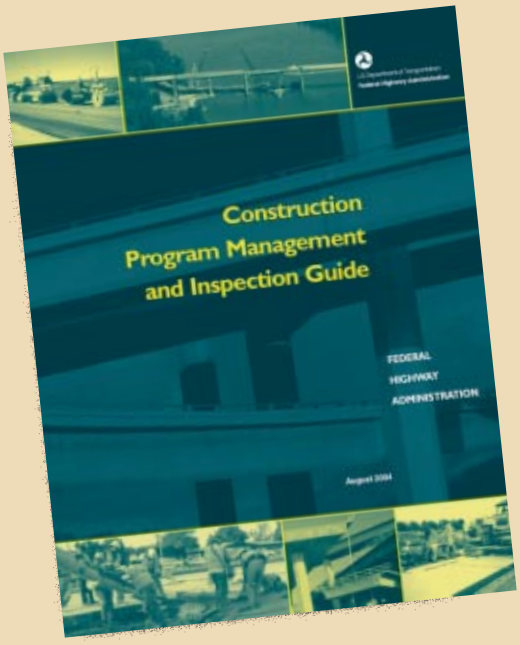


A search for "pavement" and "Iowa" on the "National Highway Specifications" Web site yields a variety of entries on pavement specifications used in the State.

reports become available that would benefit engineers carrying out oversight responsibilities. "It's designed to be an evolving document," says Lewis. "This is just one of the tools we have made available to assist our younger engineers and midcareer employees."

More Tools to Use

In addition to the *Construction Program Management and Inspection Guide*, FHWA has developed several workshops and maintains a number of Web sites that provide valuable information and tools for transportation professionals involved in construction management and oversight.



FHWA's *Construction Program Management and Inspection Guide* helps engineers improve their technical knowledge of inspections and set up a balanced construction management program.

A National Highway Institute (NHI) workshop based on the *Construction Program Management and Inspection Guide* provides engineers and transportation specialists with proven methods and tools for performing effective construction oversight. The workshop covers the changing roles of FHWA's field staff and provides participants with an understanding of construction stewardship with an emphasis on construction inspection techniques. Another NHI workshop on Conducting Reviews That Get Results covers methods for planning construction reviews, collecting and analyzing data, presenting review results, and formulating recommendations that can be implemented successfully. Information on scheduling these workshops can be found at the following Web sites:

- www.fhwa.dot.gov/construction/072904.htm
- www.nhi.fhwa.dot.gov/coursedesc.asp?coursenum=1146

"One of the beauties of these workshops is that the instructors are a blend of FHWA staff from the Resource Center, division offices, and headquarters, so participants benefit from that interaction," says Lewis, a workshop facilitator and Construction Quality Improvement Team coleader. "By the time participants walk out of the class, they're ready to go to a project and be comfortable doing a review. We can't make up for years of experience [that] we as an agency have been losing the past 10 years, but with this workshop and the tools provided, we do add confidence to our newer employees."

Workshop facilitators encourage local, State, and Federal teams to attend sessions together and bring examples from upcoming reviews to discuss. "If we can include our State and local partners in a workshop, then when we perform reviews with them on the team we can all use the same tools and the same terminology and get the most out of the process review," says the FHWA Illinois Division's Dean Mentjes, who helps deliver the workshop.

NHI offers several other courses related to construction program management, including Drilled Shaft Foundation Inspection (13207A), Driven Pile Foundation Inspection (132069A), Safety Inspection of In-Service Bridges (130055A), Shallow Foundations (132037A), and Use of Critical Path Method (CPM) for

Estimating, Scheduling, and Timely Completion (134049A). The NHI course catalog is available at www.nhi.fhwa.dot.gov/coursec.asp.

"What we get out of training workshops is the latest available information on a specific topic and any developments going on nationwide or even internationally that can help us do things better in Illinois," says IDOT's Harm.

The "Construction and Maintenance" Web site, maintained by FHWA's Office of Asset Management at www.fhwa.dot.gov/construction, provides an overview of resources and links, including highway construction specifications, Federal-aid construction program regulations, accelerated construction technologies, the latest memoranda and publications on construction and maintenance topics, and related research.

The "National Highway Specifications" Web site at www.specs.fhwa.dot.gov consists of a searchable library of highway specifications from across the country. This publicly available site is the result of a partnership between FHWA and the American Association of State Highway and Transportation Officials (AASHTO) Subcommittee on Construction. The site also features discussion forums on the development and use of various types of construction specifications.

The "Generic Construction Related Review Guidelines" site at www.fhwa.dot.gov/construction/reviews.htm provides engineers with examples of reviews undertaken by FHWA field offices on topics such as asphalt pavements, bridge decks, right-of-way appraisal, and traffic control in work zones. These generic samples can be modified to meet specific program needs.

The "Construction Program Guide" site at www.fhwa.dot.gov/construction/cqit/index.htm features a list of links on construction topics such as advertising for bids, design-build contracting, quality assurance, safety, and warranties. The links, in turn, provide information on laws, regulations, policies, guidelines, and training on each topic.

Public Trust and Confidence

Just as the transportation community of 50 years ago faced the challenge of building a national interstate system, today's transportation community is looking at how to best use resources, protect the environment, reduce congestion, enhance safety, and increase the longevity of the infrastructure.

Connecticut DOT

Today's construction oversight emphasizes ensuring that the processes that produce project decisions are effective, rather than tracking individual decisions. Here, a construction crew prepares to place a steel truss on a bridge in New Haven, CT.

FHWA plays a major role in addressing these issues by promoting innovative practices and working with State agencies to find new solutions to highway problems. In addition, FHWA conducts oversight activities that assure the best use of taxpayers' dollars in meeting the needs of the traveling public. FHWA has an important role working with its State partners to manage public investment in the Nation's highway assets.

This renewed recognition of the need for construction oversight does not mean turning back the clock to more Federal oversight. Instead, today's emphasis is on working with State partners to ensure that the processes that produce project decisions are effective, rather than trying to track each individual decision.

FHWA's focus is on being proactive in meeting public expectations for quality and accountability and earning the public's trust and confidence as the guardian of the national transportation system.

"Agencies are charged with ensuring that the programs they oversee are conducted in a manner that best meets the public interest," says Acting FHWA Administrator Capka. "The public expects agencies to maintain the highest standards of integrity, demonstrate competence, make wise decisions, communicate openly and clearly, and meet commitments. By meeting those expectations, the agency earns the public's trust and confidence."

Jim Sorenson, senior construction and system preservation engineer in FHWA's Office of Asset Management, is responsible for technical assistance, policy development, and research guidance in the areas of construction and maintenance, operations, transportation system preservation, asset management, and quality management. During his three-decade career, Sorenson has worked in a variety of assignments in FHWA field and headquarters offices and participated in a number of FHWA initiatives, including the Superpave Technology Delivery Team, the Strategic Highway Research Program's Highway Operations Technical Working Group, and the Integrated Mobility and Safety Team. He has a bachelor's degree in civil engineering from Montana State University.

For more information, visit www.fhwa.dot.gov/construction.

THE "TIMED" IS NOW

by Dana Newsome and Buddy Porta

Innovative contracting promises to expedite completion of major transportation projects in Louisiana by 2010.

(Above) Earthwork is a major component of many TIMED roadway projects. Here, workers are using heavy equipment to move 443,400 cubic meters (580,000 cubic yards) of embankment for the 10-kilometer (6.3-mile) expansion project between Noble and Converse. *Photo: Dana Newsome, LTM.*

The year 2004 brought big changes to Louisiana. Newly elected Governor Kathleen Babineaux Blanco took office as the first female Governor of Louisiana. Governor Blanco appointed Johnny B. Bradberry as the new secretary of the Louisiana Department of Transportation and Development (LA DOTD). And the new administration committed to accelerating the single largest transportation program in the State's history, the Transportation Infrastructure Model for Economic Development (TIMED) Program.

The TIMED Program, which was created in 1989, directs $4.0 billion to enhance economic development in Louisiana through investments in transportation projects. The program includes widening 867 kilometers (539 miles) of State highways to 4 lanes along 11 corridors, widening existing bridges or constructing new ones, and improving both the Port of New Orleans and Louis Armstrong New Orleans International Airport.

For more than a decade, the TIMED Program has generated economic growth and provided job opportunities. But with recent commitments of additional resources and support, the new administration accelerated the program with the goal of providing all of the anticipated benefits by December 31, 2010, cutting 20 years off the original timeline.

"Governor Blanco and Secretary Bradberry understand the vital role that transportation plays in enhancing economic development, and both recognize Louisiana's need for continued growth," says Ron Hartje, who serves as program manager for the TIMED Program. "Together they refocused the TIMED Program to expedite completion."

A Brief History

In the late 1980s, the Louisiana economy was in a downward spiral. According to statistics from the U.S. Department of Commerce's Bureau

of Economic Analysis, per capita income for Louisiana residents was down and progressively dropping below the national average. State officials were searching for a solution and found inspiration in an economic development initiative underway in Mississippi known as the Advocating Highways for Economic Advancement and Development (AHEAD) program. Mississippi created AHEAD in 1987 to help build 1,733 kilometers (1,077 miles) of four-lane highways over a 14-year period, using dedicated funding generated through a motor fuel tax.

On March 7, 1989, the Louisiana legislature passed House Bill No. 17, which introduced the TIMED Program to stimulate economic growth in the State by investing in 16 specific transportation projects, with a completion date of 2005. With a vote of 30 to 7, the bill passed in the Senate and was signed into law as Act 16 of the 1989 First Extraordinary Session of the Legislature, effective January 1, 1990. The act imposed an additional motor fuel tax of 4 cents per gallon to fund the entire TIMED Program, including preconstruction, construction, and administrative costs. The tax was initially scheduled to be in place until 2005, the target completion date for the program.

Act 16 included specific language pertaining to the types of projects that would be funded and how the funding would be collected and allocated. To kick off the program, the State held a bond sale in 1990 to finance the then-estimated $1.4 billion program. The initial $264 million provided funding to begin design and environmental clearance on some projects and initiate funding for the Port of New Orleans and the Louis Armstrong New Orleans International Airport—two designated TIMED projects. Once the initial bond funding was spent, the program continued on a pay-as-you-go basis, and work progressed as the State collected gas tax revenues. LA DOTD was responsible for oversight, management, and execution of the TIMED Program, reporting annually to the legislature on progress and expenditures.

The TIMED Program is mostly funded by gas tax revenues, bond sale proceeds, and interest earnings, with some support from Federal funding. Until the mid-1980s, Louisiana was listed among "donee" States in terms of Federal transportation funding, meaning that it received more than it paid into the Highway Trust Fund. But by 1990, Louisiana had become a donor State, paying more into the Highway Trust Fund than it received. The TIMED Program offered an alternative to relying on Federal funding to provide for transportation projects.

"Although collecting gas tax revenues is a slower form of income, it is steady, consistent, and dedicated," says Sherri LeBas, assistant TIMED program manager with LA DOTD.

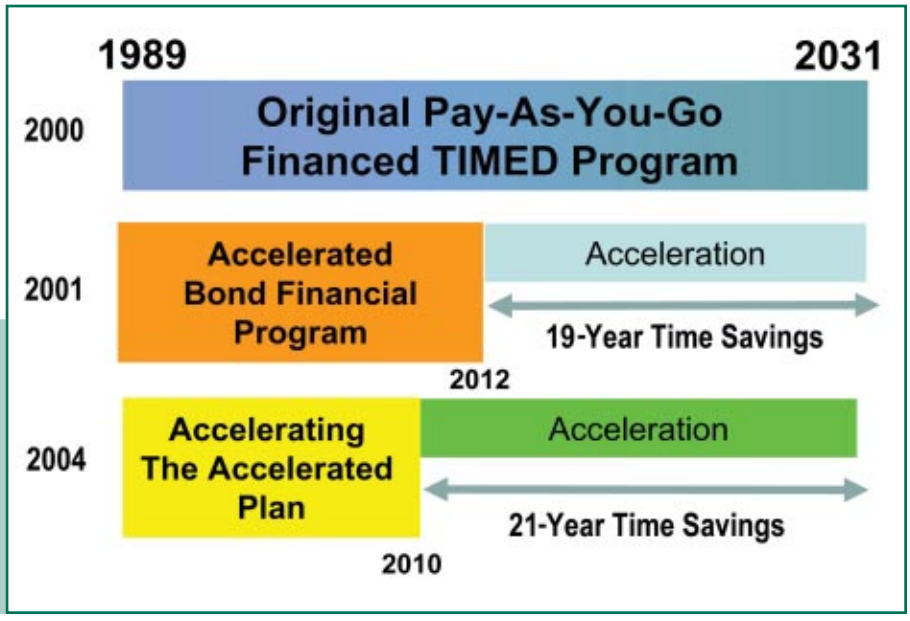
Progress, however, proved slower than anticipated. The airport and port improvements required $175 million in funding, as designated by Act 16 legislation, from the initial $264 million bond sale. The remaining $100 million in revenues from the bond sale, combined with annual gas tax revenues of approximately $100 million, could not maintain

Author's Note

Louisiana and other Gulf Coast States were devastated by Hurricanes Katrina and Rita earlier this year. Transportation facilities were vital to the evacuation and recovery efforts, yet some facilities took a hard hit from the storms. Louisiana will recover, and transportation rebuilding will play a large part in the process. There were many lessons learned during the aftermath of the hurricanes, and these lessons will benefit others in the future. But an immediate lesson was the need for strong State and Federal transportation infrastructure.

Louisiana is committed to rebuilding a stronger, safer State, but existing priorities will not be discarded during the recovery process, specifically State transportation priorities. Now more than ever it is vital for Louisiana to build better roads and bridges, to open up more multilane facilities for evacuation routes, and to ensure residents can travel within the State in the event of an emergency.

Therefore, Louisiana is committed to programs, including the TIMED Program, that already were helping meet these goals and objectives. The dedicated funding and commitment to the TIMED Program outlined in this article will not be overshadowed or compromised during Louisiana's recovery efforts. In addition to the new focus on rebuilding and strengthening the transportation systems affected by the storms, Louisiana will maintain progress on its priority projects and programs already in place.



This figure shows how the schedule for the TIMED Program has evolved since 2000. According to the original timetable, the program would not be complete until 2031. But thanks to the accelerated schedule, LA DOTD expects that all TIMED projects will be completed by 2010. *Source: LTM.*

Public-Private Partnerships

LA DOTD is executing the TIMED Program through an innovative public-private partnership known as LTM.

Public-private partnerships refer to contractual agreements formed between a public agency and private-sector entity that allow for greater private-sector participation in the delivery of transportation projects. Traditionally, private-sector participation has been limited to separate planning, design, or construction contracts on a fee-for-service basis, based on an agency's specifications.

Expanding the role of the private sector enables an agency to achieve objectives such as greater certainty in cost and schedule by accessing private capital, innovative technology applications, and specialized expertise. The private partner can expand its business opportunities in return for assuming the new or expanded responsibilities and risks.

"Public-private partnerships represent win-win situations for both parties," says LTM Program Manager Ron Hartje. "Using a private manager, clients are able to provide additional staff to complete specific projects or programs without needing to add employees to their permanent workforce. These partnerships increase resources available to a program and can allow for delivery in timeframes that would not be feasible under other circumstances."

For more information, visit www.fhwa.dot.gov/ppp.

adequate funding for the construction schedule. The TIMED Program, therefore, fell off target in meeting the original completion date. In fact, the new estimated completion date as of 2000 was 2031.

Time for a Change

In 2000, with only 4 of the program's 16 projects complete, then-Governor Mike Foster and his administration, including Lieutenant Governor Kathleen Blanco, called for measures to expedite completion of the TIMED Program. Recognizing a need to overhaul the program, LA DOTD began exploring ways to meet the Governor's challenge. In 2002 LA DOTD took two major steps to accelerate the TIMED Program.

First, the department hired a private program manager, dubbed Louisiana TIMED Managers (LTM), which is a joint venture composed of private consulting and engineering firms. LA DOTD selected LTM to manage the process of accelerating the remaining construction on 12 projects and to provide support staff in program controls, financial management, public outreach, and engineering. In addition, LTM would perform extended work on 55 of the project segments, including design oversight, environmental permitting, real estate acquisition and relocation, utility relocation, and construction engineering and inspection services. LTM and LA DOTD administration fees are paid through the dedicated gas tax.

"LTM is serving as an extension of LA DOTD," says LTM Program Manager Hartje, who oversees the TIMED Program. "By having a dedicated staff working exclusively on the program, LTM is able to provide significant resources toward completing the TIMED Program ahead of schedule and on budget."

The second major step was to change the program's financing strategy. The TIMED Program initially started with bond-financed seed money and then converted to a pay-as-you-go strategy financed through gas tax revenues. Then, in 2002, LA DOTD converted the TIMED Program to a bond-financed program, which allows construction projects to be funded with bond sales in addition to pay-as-you-go funding and interest earnings. "This financing strategy facilitated an estimated 19-year acceleration in the schedule," says LA DOTD's LeBas.

The decision to pursue bond sales, subsequently approved by the Louisiana State Bond Commission, will enable LA DOTD to complete the remaining projects in less than 10 years. A series of bond sales will occur over the next 4 years, supported by the voter-approved motor fuel tax. The tax is scheduled to be in place until the TIMED debt is repaid in 2039, per the 1998 legislation.

"The 2002 bond issuance of $275 million provided enough funding to accelerate project lettings from $30 million in fiscal year 2001–2002 to $172 million in 2002–2003," LeBas says. "The current accelerated schedule has TIMED projects letting almost every month for the next 2 years to meet our new completion date."

Together, these steps ultimately helped reduce the timeline for completion by 21 years.

LTM

These utility workers are completing their work prior to the start of a construction project. Early communication and coordination with utility stakeholders during the preconstruction process saves time and helps accelerate project schedules.

LTM

Workers are using heavy equipment to widen a section of Earhart Boulevard in New Orleans. TIMED funding provided $20 million for this expansion project, and construction is scheduled for completion in 2006.

Financing Approach

Act 16 laid the groundwork for accelerating construction by authorizing the use of bond sales to increase funding options. Since that time, Louisiana adopted new legislation to further ensure that the program's financing needs are met. House Bill No. 286, which became Act 64 of 1998, extended the original 4-cent per gallon tax until the TIMED debt was repaid. And Senate Bill No. 74, Act 1 of 2000, extended the opportunity to issue bonds through January 1, 2010, and extended the allowable bond maturity term from 20 to 30 years. These additional pieces of legislation further supported the use of various financing techniques to ensure that the TIMED Program could be completed on an accelerated schedule.

To ensure its continuation, the TIMED Program needs to remain financially feasible, meaning that enough projected revenue must be available to complete all 16 legislatively mandated TIMED projects in their entirety. The LTM financial team manages all aspects of funding and financial reporting for the program. One of the most significant responsibilities is the annual feasibility update. To maintain feasibility, LTM needs to forecast revenues, manage and forecast program costs, and administer the bond issuance program effectively. Therefore, the financial team actively manages the projected cost curve to align the sizing and timing of the bond issues with the program's cash needs. Since the majority of costs are funded using bond proceeds, the team needs to analyze the financing structure continuously in the context of current market conditions to manage borrowing costs properly.

"Our team has extensive knowledge of various debt structures and financial derivative instruments that are critical in managing the risks of a volatile interest rate environment," says Frank Smith, LTM finance director. "Expert financial management facilitates cost-effective and timely delivery of a complex construction program, such as the TIMED Program."

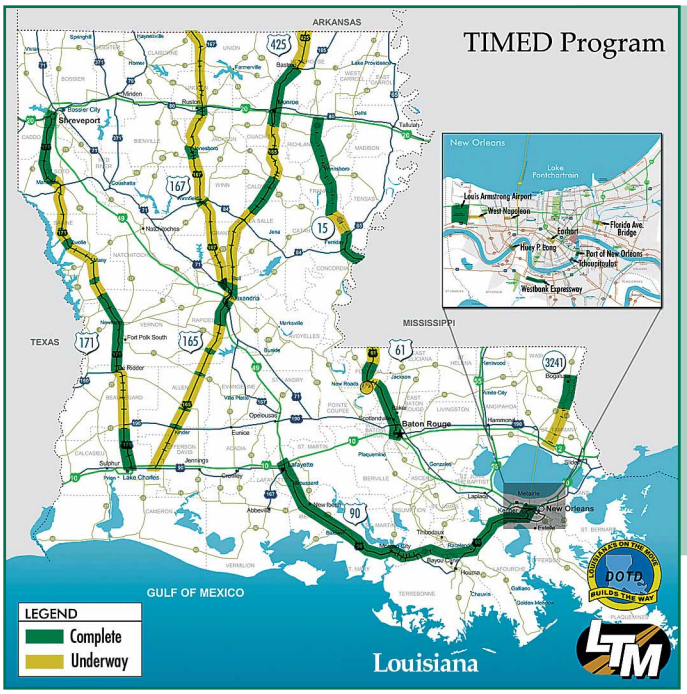
Four primary factors affect the feasibility of the program: revenues, borrowing costs, policy, and program costs. LA DOTD and LTM have varying degrees of control over these factors but are aware of the impact that changes can have on the program. Working with an in-house staff of schedulers and planners, LTM monitors and manages program changes and works to minimize scope creep.

"For the past 3 years, the TIMED Program has proven to be financially feasible," Smith says. "And LTM will continue to adapt the program's financing structure to meet the challenges presented by current market conditions."

LTM schedules bond issuances with the goal of maintaining funding through the completion of the program. For the 2005 bond sale, the team selected an investment banker and bond counsel in January 2005 and delivered rating agency presentations in April 2005. Standard & Poor's and Moody's upgraded the TIMED Program's gas and fuel tax revenue bonds to AA- and Aa3,

Jeff DeGraff, LTM

The TIMED Program includes widening 867 kilometers (539 miles) of Louisiana highways to four-lane corridors. Traffic is shown here driving on a recently completed section of highway.



This map of Louisiana shows the status of construction projects funded under the TIMED Program. Sections of highway highlighted in green were complete, and those in yellow were underway, as of February 2005. *Source: LTM.*

respectively. The upgrade allows for less expensive bond insurance premiums and lower borrowing costs, which should save the program a significant amount of money in the future. The 2005 interest rate was 4.688 percent. TIMED bonds were priced on April 18 and April 19, 2005, and produced proceeds of more than $548 million. Additional bond sales currently are scheduled in 2007, 2008, and 2009.

Three Bridge Projects

When LA DOTD executed the initial program management contract in 2002, three major bridge projects were still assigned to LA DOTD management: the new St. Francisville Mississippi River Bridge, the widening of the Huey P. Long Bridge over the Mississippi River in New Orleans, and the new Florida Avenue Bridge over the Industrial Canal in New Orleans.

In 2004 LA DOTD transferred management of the bridge projects to LTM, with a challenge from Secretary Bradberry to complete the entire TIMED Program by December 31, 2010. The original schedule called for completing the bridge projects by the end of 2012, but LTM reevaluated the schedule and developed strategies to meet the secretary's challenge.

One of the strategies for acceleration includes using design-build procurement on the St. Francisville Bridge project. In 2004 the State passed legislation allowing construction to proceed using the design-build process, which is a project delivery method that combines both architectural-engineering services and construction into one contract. With the new delivery method in place, LTM officials estimated that they could reduce the scheduled completion date by 15 months.

"With the procurement schedule for the St. Francisville Bridge project, we are on target to make final selections of the design-build team in December 2005," says Chuck Duggar, LTM St. Francisville project manager. "LTM is proud to have been a part of LA DOTD's first experience with design-build delivery on a project of this size and scope, and we are eager to finalize the procurement process and see bridge construction begin."

The second major bridge project involves widening the existing Huey P. Long Bridge in New Orleans. The structure's importance as a nexus for automobile and rail traffic, as well as vessels passing beneath it on the Mississippi River, poses a significant challenge to LTM and the TIMED Program, as they will need to maintain all traffic with minimal impacts throughout the duration of the project.

Completed in 1935 and named after the Louisiana Governor who was shot and killed the same year, the bridge is one of three major Mississippi River crossings serving the New Orleans area. Nearly 50,000 vehicles a day travel across the bridge, and river traffic averages more than 6,000 vessels each year. In addition, the bridge services six Class 1 railroads on the New Orleans Public Belt Railroad tracks.

The bridge currently consists of two 2.74-meter (9-foot) vehicle travel lanes in each direction, with no inside or outside shoulders. The roadway portion is cantilevered from a high-level railroad bridge approximately 61 meters (200 feet) above the river. The bridge continues to support both vehicle and rail traffic in the same configuration as when it opened in 1935.

Engineering investigations revealed that the existing structure could support additional widening, so LTM will widen the current bridge to include three 3.35-meter (11-foot) travel lanes in each direction, with the addition of inside and outside shoulders. The current construction plans call for no additional pier foundations for the main river bridge but rather widening of the pier shafts above the existing caisson foundations and the addition of two new parallel trusses to accommodate the widened roadway along the main bridge. For the approaches, new parallel structures

Progress of TIMED Program

	June 2002	June 2003	June 2004	June 2005
Miles Completed	74	103	119	126
Miles Under Construction	68	94	113	153
Miles in Design	375	320	285	238
Miles in Planning	19	19	19	19
Funds Encumbered	$1.1 Billion	$1.2 Billion	$1.5 Billion	$1.9 Billion

Source: LTM.

LA DOTD

This photo shows the original Huey P. Long Bridge under construction in the early 1930s.

LTM

This rendering shows how the Huey P. Long Bridge might look after a proposed $340 million widening project.

will be built to accommodate the new roadways.

Further, LA DOTD and LTM have committed to maintaining all traffic, including rail, roadway, and river, throughout the project. "The project itself is an engineering feat," says Juan Murillo, who serves as the LTM project manager for the Huey P. Long Bridge project, "but the true marvel will be maintaining traffic during construction. Lane closures and traffic slowing will be necessary, but there is no option for closing the bridge."

Intense communication and coordination will be vital to maintaining this commitment to the people who rely on the Huey P. Long Bridge and the Mississippi River. Until the TIMED Program came along, a lack of dedicated funding hindered making improvements to the bridge. However, now this $340 million construction project is scheduled to let its first contract for widening the main bridge piers by late 2005.

The third major bridge project is construction of the Florida Avenue Bridge in New Orleans, which will provide the only stationary bridge over the Inner Harbor Navigation Canal, or Industrial Canal, with the exception of an interstate crossing to the north. Currently, three low-level, movable bridges carry vehicular traffic over the canal but need to be lifted as vessel traffic demands.

The Industrial Canal is 8.9 kilometers (5.5 miles) long, connecting the Mississippi River to the Gulf Intracoastal Waterway and Lake Pontchartrain. The canal is home to terminals that service ships and barges transporting freight between the United States and the Caribbean, Central America, and other domestic ports. Opened in 1923, the canal today averages more than 14.5 million metric tons (16 million tons) of shipping activity annually.

"The new Florida Avenue Bridge will have a [47.5-meter] 156-foot vertical clearance over the Industrial Canal and will provide a crossing that will not be impeded by marine traffic," says Wayne Aymond, who serves as the LTM project manager for the Florida Avenue Bridge project. "Construction is scheduled to begin in 2007, and the bridge will be built in three segments—all to be completed by December 2010."

LTM

This image shows the proposed $213 million St. Francisville Bridge over the Mississippi River.

LTM

This artist's rendering shows the proposed $180 million Florida Avenue Bridge over the Industrial Canal in New Orleans. One of the existing moveable railroad bridges is visible in the background.

LTM

Public outreach to communities, residents, and the media is an important element in the execution of the TIMED Program. Public Outreach Manager Dana Newsome (left) points to a TIMED project segment on a wall-size map of Louisiana while discussing the program with a resident.

Reaching Out

Program management responsibilities for the TIMED Program also include developing and executing public outreach. LTM planned, designed, executed, and now maintains a Web site, www.timedla.com. The public outreach office provides media relations, public interaction, dissemination of program information, and legislative monitoring. The public outreach manager creates opportunities to increase the visibility of LA DOTD and the TIMED Program through public speaking, participation in professional conferences, and media pitching in local, State, and national media outlets.

Regaining public support has been a key challenge. With a program that was years behind schedule, the residents of Louisiana had lost sight of the economic growth the TIMED Program has the capability to provide, according to LA DODT Communications Director Mark Lambert. "Many areas forgot where their 4-cent tax was going and lost the faith that they would see the benefits," he says.

By dedicating resources to improving public opinion, LTM's efforts have proven highly effective in increasing awareness of the program. The Web site, for example, received more than 20,000 visitors in fiscal year 2004, and media coverage was 95-percent positive. The positive media response garnered headlines that included the following:

- "TIMED Breathes Life Into Declining Highway Construction Revenues," *Louisiana Contractor*, January 2004
- "Louisiana TIMED Program Advances Project Designs," *The Weekly Press*, Baton Rouge, February 2004
- "Many Businesses Opening, Expanding," *Many Sabine Index*, June 2004
- "Four-Laning at Half-Way Point . . . Mayor Sees Needed Growth Coming," *The Town Talk*, Alexandria, February 2005
- "Florida Avenue Bridge to Boost Home Values," *New Orleans CityBusiness*, February 2005

According to LeBas of LA DOTD, the greatest accomplishment of the public outreach program is achieving client satisfaction. Requests for information from residents, media representatives, and elected officials are all directed to the LTM Public Outreach Office. This process enables program personnel to focus on their areas of expertise and not be distracted by answering general program questions. And it

Dana Newsome, LTM

Public information meetings enable residents to stay up to date on TIMED projects. Wayne Aymond (right), LTM project manager for the Florida Avenue Bridge, discusses a tabletop model of the alignment with interested citizens.

LTM

Signs like this one remind motorists of the specific highway projects that are being funded through their 4-cent gas tax.

allows for a single source of information, which is a key factor in maintaining credibility and ensuring the accuracy of information. Having one person disseminate information and present the image of the TIMED Program ensures continuity and reliability in the communication efforts.

In recognition of its efforts, the TIMED Program earned a 2005 "PRIDE Award" from the American Road & Transportation Builders Association. The PRIDE Award recognizes extraordinary programs dedicated to enhancing the image of the transportation industry.

TIMED for Progress

The TIMED Program is building economic development in Louisiana, and thanks to the efforts of LA DOTD, Louisiana residents will experience those benefits even sooner than expected.

Just as the legislators planned back in 1989, the TIMED Program is bringing more jobs to Louisiana. With more than $140 million in construction lettings in fiscal year 2004 and another $160 million projected for fiscal year 2005, Louisiana contractors have the work they need for their current employees and to provide new opportunities for skilled workers.

The 4.5 million Louisiana residents are reaping the benefits of the $4 billion TIMED Program as well. Improved transportation routes, intrastate connectivity, and economic growth are the key benefits, and they are already starting to emerge. Five projects are complete, and all projects are either in design, preconstruction, or construction phases. By 2010, three improved north-south routes will be open in Louisiana, encouraging shipping, commuter and tourist travel, and business development throughout the State.

"In these days of ever-increasing congestion, the public is demanding that we as an industry deliver highway programs and projects much faster than before and on budget," says FHWA Louisiana Division Administrator William A. Sussman. "LA DOTD's accelerated TIMED Program exemplifies what we can do with focused resources and innovative funding. The FHWA Louisiana Division is pleased that this effort, along with early Federal-aid projects costing $78 million and completing [16 kilometers] 10 miles of the U.S. 90 project, will complete the TIMED Program much sooner."

For making progress on Louisiana's transportation projects, now is the "TIMED."

LTM

The TIMED Program logo, shown here, helps create an identity for the program. LTM uses the logo on all printed materials, the program Web site, and signage posted near construction projects.

Dana Newsome is the public outreach manager for LTM. She has 7 years experience in transportation public relations. She joined Parsons Brinckerhoff Construction Services, Inc., in October 2002 to work on the TIMED Program. Newsome holds a degree in public relations from the University of Florida. She can be contacted at 866–846–3352 or dana.newsome@latimedmgrs.com.

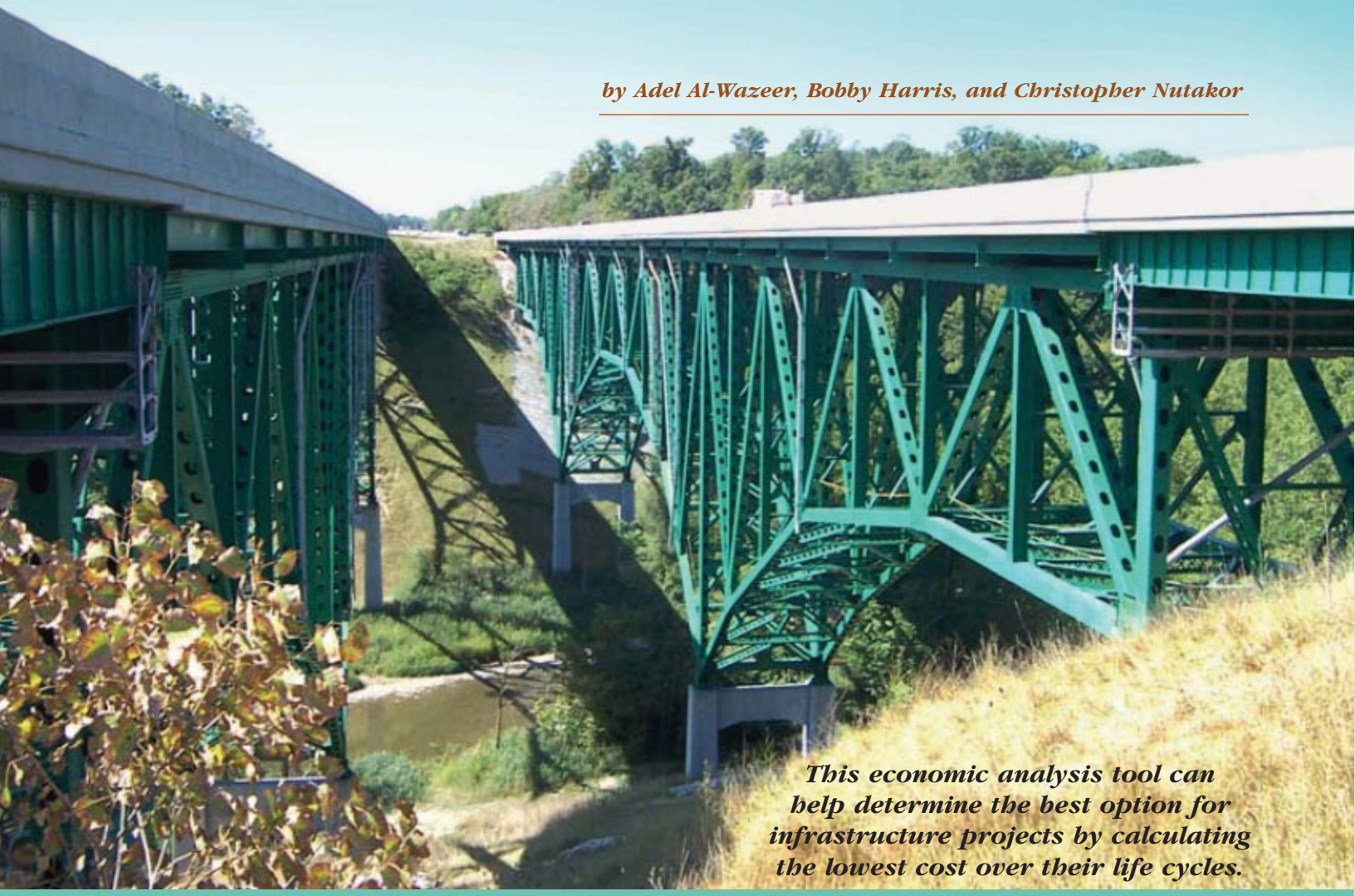
Buddy Porta is the LA DOTD TIMED program manager. He has managed the program's operation since 2001, overseeing the scope, budget, and schedule. Porta has worked at LA DOTD for 30 years and has served as design leader for roadway design and program manager for off-system bridges, the urban system program, and the overlay program. He is a certified public manager in Louisiana and received his B.S. in civil engineering from Louisiana State University.

For more information, please visit www.timedla.com or contact the TIMED Public Outreach Office at 866–TIMED–LA or 866–846–3352.

Dana Newsome, LTM

Pile driving progresses on a section of U.S. 171 between the Converse and DeSoto Parish line in northwestern Louisiana. Minor bridges are a common component of the majority of TIMED projects.

by Adel Al-Wazeer, Bobby Harris, and Christopher Nutakor



This economic analysis tool can help determine the best option for infrastructure projects by calculating the lowest cost over their life cycles.

Applying LCCA to Bridges

In the face of growing public scrutiny, officials at transportation agencies are under increasing obligation to demonstrate their stewardship of taxpayer investments in the construction and maintenance of highway infrastructure, including bridges. Many agencies are investigating economic tools such as life-cycle cost analysis (LCCA) that will help them choose the most cost-effective alternatives and communicate the value of those choices to the public.

Any transportation agency can use LCCA to determine the design alternative that will accomplish a project's objectives at the lowest overall cost. By factoring in all costs over a project's total multiyear life cycle, not just the initial construction investment, LCCA helps to ensure that an agency can avoid selecting an alternative based solely on the lowest initial cost. Agencies typically use LCCA to choose among design alternatives that would deliver the same level of performance during normal operations over the project's life cycle.

Many Federal, State, and local agencies have successfully applied LCCA to analyze options for investments in highway infrastructure, particularly for decisions concerning the reconstruction, rehabilitation, preservation, and maintenance of pavements. LCCA concepts are even built into some pavement management systems, and the Federal Highway Administration (FHWA) recently developed a software tool called RealCost to support the application of LCCA in pavement design. RealCost incorporates probabilistic evaluation of multiple variable inputs including costs, service lives, and economic factors to estimate the likelihood of net present value (NPV).

Various States and organizations also have established their own

(Above) When the appraisal and sufficiency ratings for this bridge with two spans carrying I–90 over the Grand River in Lake County, OH, indicated that it was structurally deficient because of the poor condition of the superstructure and should be rehabilitated, the Ohio Department of Transportation (ODOT) conducted an LCCA study to determine which potential rehabilitation strategy would be the most cost effective. *Photo: Barr Engineering Company.*

procedures for analyzing life-cycle costs. Published and unpublished surveys of State practices indicate that many States currently use LCCA methods for making at least some pavement design and maintenance decisions, according to Eric Gabler, an economist in the Office of Asset Management at FHWA.

The use of LCCA is not widespread, however, for decisions about bridge projects. "States have been much less likely to apply LCCA to bridge design and maintenance decisions," Gabler says. "There is, however, a growing recognition of the importance of life-cycle concepts within the bridge community."

In addition, on August 10, 2005, the President signed into law the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). "Section 1904 of this law requires the application of value engineering methods," says Gabler, "including the analysis of life-cycle costs, to bridge projects with an estimated total cost of $20 million or more. Therefore, State applications of LCCA to bridge projects are likely to grow in the future."

Need for LCCA of Bridge Projects

The projects evaluated using LCCA may include maintenance, deck replacement and widening, strengthening, superstructure replacement, or bridge replacement.

Steve Chase, the research program manager and acting director of the Office of Infrastructure Research and Development at the FHWA Turner-Fairbank Highway Research Center (TFHRC) in McLean, VA, emphasizes the importance of developing life-cycle cost models for future bridge design and management. "The development of rational, realistic, accurate, and usable life-cycle cost methodologies and models is an important element of FHWA's research and development programs for highway infrastructure," he says. "Life-cycle cost models are essential for FHWA's Bridges of the Future initiative because they provide the objective function—the method for finding the best solution—for system optimization. They also are essential for FHWA's stewardship and management initiative because they are the underpinning of asset management systems."

Application of LCCA to Bridges

Life-cycle cost analysis can support bridge design and management decisions by helping engineers evaluate the economic effectiveness of proposed construction or rehabilitation projects, using all costs incurred related to the bridge during its multiyear life cycle. All agency costs involved in each alternative over the planning period are factored into the analysis, potentially including costs for the following:

- Design
- New construction
- Contingency and administration
- Right-of-way
- Inspection and routine maintenance
- Painting and repair
- Rehabilitation and strengthening
- Deck widening, demolition, and replacement
- Superstructure demolition and replacement
- Total bridge demolition and replacement

The analysis should include those costs borne indirectly by users of the bridge and other parties, in addition to costs paid directly by the agency that owns the bridge. User costs include those caused by traffic control and detours due to bridge construction and maintenance, in the form of vehicle operating costs and costs from delays and crashes. The indirect user costs from delay and detours may be due to inadequate horizontal and vertical clearances, inadequate load capacity, environmental damage, congestion, or work zone impacts during construction.

Agencies use the costs incurred on the bridge and their timing in computing an NPV of life-cycle costs for each alternative. The alternative with the lowest NPV of costs is the most cost-efficient alternative. In addition to the NPV of costs, political and environmental factors should be considered in deciding which alternative to implement.

Cost estimation could be based on historical data for contract awards and in-house activities, expert elicitation, or prediction. State agencies that use the Pontis bridge management system already have some form of historical data as part of their Pontis database so they do not have to search through hard-copy documents. Some State agencies have used their Pontis databases, which contain element-level data on the cost values and timing for many maintenance, rehabilitation, and replacement (MR&R) actions, to support bridge LCCA.

Tools Available for Bridges

In recent years, the National Cooperative Highway Research Program (NCHRP) and the National Institute of Standards and Technology (NIST) have produced tools to help State departments of transportation (DOTs) calculate the life-cycle costs of project alternatives for highway bridges.

Bridge Life-Cycle Cost Analysis (BLCCA), developed under NCHRP Project 12-43, is an analysis tool with an engineering-oriented approach that uses models to estimate cost data, traffic growth, bridge condition, and load capacity, both under normal conditions and

Colorado Department of Transportation

For this I–76 reconstruction project in northeastern Colorado in 2001 and 2002, alternative pavement designs were developed and evaluated using deterministic LCCA during design of the four-lane rural interstate section.

during construction activities. The cost models include agency, user, and vulnerability costs. Vulnerability costs may include potential costs of damage due to earthquakes, scour, flooding, collision, overload, or fatigue. They are calculated by multiplying the potential cost of a particular type of damage, such as seismic displacement or scour, by the likelihood of that damage occurring.

Developed by NIST, Bridge Life-Cycle Cost (BridgeLCC) is software with an easy-to-use interface that enables designers to view the life-cycle costs for project alternatives from different perspectives, such as that of cost holders (the person or agency that pays the cost directly or indirectly), bridge components, application of new technologies, and cost timeline.

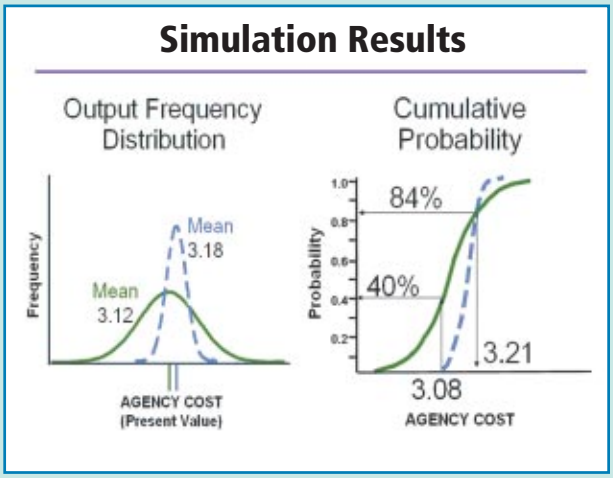
Performing a life-cycle cost analysis, whether using an off-the-shelf tool or a solution developed by a State DOT, can enhance an agency's ability to select cost-efficient solutions for bridge improvement projects. LCCA tools help engineers and designers focus on the long-term implications of their decisions, boosting their engineering and experience judgment. Just as important, this type of analysis helps decision-makers understand future maintenance requirements and costs, enabling them to make more informed decisions from the standpoint of conserving scarce public resources.

"The future challenge for bridge owners is to build economical, longer lasting, and low-maintenance bridges with minimal disruption to traffic," says Thomas Everett, team leader for bridge programs in the FHWA Office of Bridge Technology. "Bridges that incorporate the latest advances in materials, design methodologies, and construction techniques will help address this challenge."

Current Practices

Successfully applying life-cycle cost analysis to bridge management depends to a large extent on the availability and quality of relevant data, such as types, costs, and frequency of bridge maintenance and related activities. Over the past year, the Bridge Management Information Systems Lab (BMISL) at TFHRC undertook a pilot study of current practices in 10 States regarding the application of LCCA to bridge management. In particular, the study focused on efforts involving bridges with concrete decks.

A survey was sent to the 10 States, and 6 responded. Analysis of the survey results revealed that the States generally perform similar types of maintenance activities: deck overlays, sealing, and patching; wearing surface replacement; joint repair and replacement; deck widening; and deck replacement, including removal and disposal. Though their activities are similar, the States differ in their methods of collecting and maintaining data, the level of detail, and their confidence in the quality of the cost data and the cycles or frequency of activities. In general, the responding States rely on expert opinion rather than cost data as the main source for predicting repair cycles. A few States, however, have developed models to predict the life cycle of the bridge deck, for example, by using a repair matrix based on the condition rating and the actions taken.



Simulation results for a pavement design showing variation and magnitude of possible outcomes. The charts were developed using the RealCost software and show identical information in both frequency distribution and cumulative probability curves to aid in identifying critical factors. *Source: FHWA.*

An Example from Ohio

The Ohio DOT (ODOT) is among the State agencies that participated in the FHWA study. In March 2001, ODOT studied the I–90 bridge over the Grand River. The 265-meter (870-foot)-long bridge was built in 1960 as twin steel truss structures. Each structure carries two lanes on a 12.2-meter (40-foot)-wide deck.

At the time that ODOT conducted the LCCA study of the I–90 bridge over the Grand River, the bridge had a superstructure appraisal rating of 4 and sufficiency ratings of 61.4 for the left span and 67.1 for the right span. An appraisal rating is indicative of the superstructure condition of a bridge and is done on a scale of discrete values from 0 through 9, with 9 being an excellent condition. A rating of 4 and below shows that the superstructure is in a deficient condition. The sufficiency rating is a numerical value that gives an indication of a bridge's eligibility for rehabilitation or replacement and is based on structural adequacy, safety, serviceability, functional obsolescence, and essentiality for public use. Sufficiency is measured on a scale of 0 for the worst possible state to 100 for the best possible state. The appraisal and sufficiency ratings for the Grand River bridge indicated that it was structurally deficient because of the poor condition of the superstructure and should be rehabilitated.

ODOT selected an analysis period of 50 years, starting in 2005 and ending in 2054. Engineers identified 12 alternative strategies to improve the bridge, all with the same benefit of keeping Ohio I–90 in service.

The life cycle of each alternative included five construction or maintenance "projects" with a set of actions to be applied on the bridge. Projects 1, 2, 3, 4, and 5 consisted of actions to be scheduled in the years 2005, 2015, 2025, 2035, and 2045, respectively. Cost components during the 50-year analysis period were discounted to the base year (2005) to compare the NPV of the costs for the alternatives. ODOT used a real discount rate of 4.2 percent in the analysis.

Four of the 12 alternatives (A, B, C, and D) used the existing structure in the improvement projects. Alternative A included minimum maintenance only, Alternative B included repair and strengthening in addition to maintenance, and Alternative C

included deck replacement and maintenance. Alternatives A, B, and C kept the existing deck width at 12.2 meters (40 feet). Alternative D included maintenance, repair, strengthening, and deck replacement with a wider deck of 15.25 meters (50 feet).

Eight improvement alternatives (E, F, G, H, I, J, K, L) included construction of a new superstructure or a new bridge with a 17-meter (56-foot)-wide deck. Additional roadway width is accounted for by eliminating user costs for delays during construction in the future after a deck-widening project. Crash occurrences and ride ability were not expected to change among the alternatives because the deck will be maintained in fair to good condition.

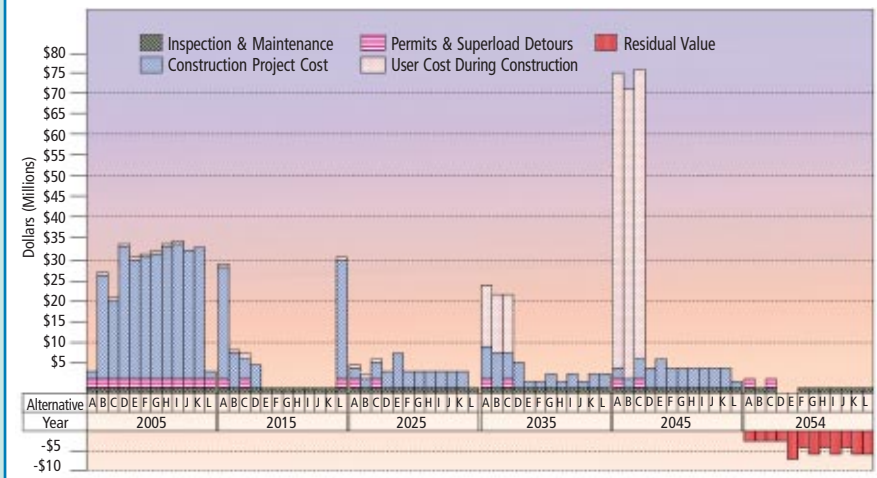
Alternative E proposed a new steel superstructure to replace the existing one. Alternatives F, H, and J planned for a new concrete structure to replace the existing structure, while Alternatives G, I, and K planned for a new steel replacement structure. (Alternative E has a new steel superstructure only, while Alternatives G-K have a new steel structure that necessitates replacing the entire bridge.) Alternatives F and G considered using the existing curved alignment of the bridge. Alternatives H and I proposed using a bridge alignment tangent to the existing curved alignment. Alternatives J and K planned for using a new tangent alignment for the bridge. Alternative L was a deferred start of Alternative F, in which the construction of a new concrete structure was scheduled for 2015 instead of 2005.

The LCC of the alternatives was composed of agency costs, user costs, industry costs, right-of-way costs, and remaining service life values. Agency costs include those related to inspection, routine maintenance, repair and rehabilitation, and construction project costs based on data in the ODOT summary of contract awards. User costs during construction result from lane closings on the structure, detours, and other impacts created by traffic management. Industry costs—a subset of user costs—result from detours due to size and weight restrictions, creating delays and increased mileage.

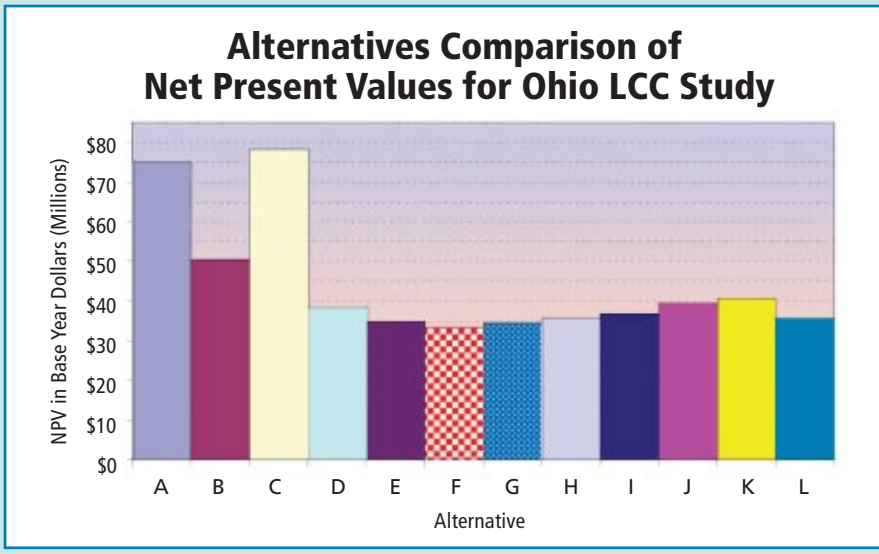
The ODOT engineers then estimated residual values at the end of the 50-year study period for each alternative. They assumed that existing superstructures and new concrete superstructures would have no residual values. They also assumed new steel superstructures and existing substructures would have residual values equal to half of the construction value. New substructures were assumed to have three-quarters of the construction values as their residual values.

The LCC study for improving the Ohio I–90 bridge revealed that, for this specific example, alternatives with new construction projects were more cost efficient than alternatives that keep the existing structure over the analysis period.

Among the options using the existing structure, deck replacement Alternative C for this specific example was the most expensive in terms of NPV of costs. The strengthening Alternative B was 33 percent less than the maintenance Alternative A in terms of NPV of costs. Alternative D, with strengthening and deck replacement and widening, was 50 percent less than Alternative A in terms of NPV of costs. In other words, for the existing bridge options (A to D) for this



The cashflow timeline of the cost components for the different alternatives identified in the LCCA of the Grand River bridge is shown here.
Source: Adel Al-Wazeer.



This figure shows the comparison of the NPV of costs for the different alternatives identified in the LCCA of the Grand River bridge.
Source: Adel Al-Wazeer.

specific example, the analysis led to the conclusion that the strengthening and deck widening alternative was the most cost efficient, followed by deck strengthening only, then maintenance only, and finally deck replacement.

Among the new construction alternatives, the ones that use the existing alignment were more cost efficient than those using a new alignment because of additional roadway and right-of-way costs needed for a new alignment. The ODOT engineers noticed a slight difference in NPV of costs between new concrete and steel alternatives for improving the bridge, with concrete being lower in NPV of costs. Finally, the study demonstrated that delaying the start of a new construction project for the bridge was not cost efficient.

The ranking of alternatives in descending order of NPV of life-cycle costs was C, A, B, K, J, D, I, H, L, E, G, F. Alternative F, new curved concrete structure on the existing alignment, had the lowest LCC and therefore was the best and most cost-efficient alternative. However, Alternative G, new curved steel structure on the existing alignment, was only 3 percent higher than Alternative F in NPV of life-cycle costs, a value likely to be less than the uncertainty in estimating several cost parameters. Thus, Alternative G could also be considered in the decisionmaking process.

In conclusion, the study recommended a new construction project to completely replace the existing structure with a concrete (or steel) beam type structure on the existing alignment of the bridge starting in 2005. The LCC approach used in the ODOT study helped the decisionmakers not only to consider the initial costs for the alternative projects, but also to compare the total costs throughout a longer analysis period. ODOT decisionmakers were able to find the most economical alternative by comparing the NPV of life-cycle costs in base-year dollars for all cost components of the alternatives during a long analysis period.

Matt Shamis, bridge engineer for the FHWA Ohio Division, explains

Life-Cycle Cost Calculation and Selection of Alternatives

LIFE-CYCLE COST CALCULATION FOR EACH ALTERNATIVE

PROJECT TITLE _____

ALTERNATIVE _____

BASE YEAR (Y_0) _____

DISCOUNT RATE (i) _____

(1) TYPE OF COST	(2)	(3)	(4) $t = (3) - Y_0$	(5) $(5) = (1 + i)^{-t}$	(6) (6)=(2)X(5)
AGENCY COST	$ AMOUNT	TIME OF OCCURRENCE, YEAR	TIME FROM BASE YEAR	DISCOUNT FACTOR	PRESENT VALUE OF COST
TOTAL DISCOUNTED AGENCY COST (7)					
USER COST	$ AMOUNT	TIME OF OCCURRENCE, YEAR	TIME FROM BASE YEAR	DISCOUNT FACTOR	PRESENT VALUE OF COST
TOTAL DISCOUNTED USER COST (8)					
USER COST WEIGHT (9)*					
TOTAL WEIGHTED USER COST (10) = (8) X (9)					
OTHER COSTS	$ AMOUNT	TIME OF OCCURRENCE, YEAR	TIME FROM BASE YEAR	DISCOUNT FACTOR	PRESENT VALUE OF COST
TOTAL DISCOUNTED OTHER COSTS (11)					
OTHER COSTS WEIGHT (12)*					
TOTAL WEIGHTED OTHER COSTS (13) = (11) X (12)					
NET PRESENT VALUE OF LIFE-CYCLE COSTS (14) = (7) + (10) + (13)					

* USE 1.0 IF COSTS HAVE SAME WEIGHT AS AGENCY COST; OTHERWISE, USE THE WEIGHT CONVENIENT TO THE AGENCY.

Source: Adapted and modified from the "Worksheets for LCC Analysis" used in Fuller, S.K. and S.R. Petersen, Life-Cycle Costing Manual for the Federal Energy Management Program, NIST Handbook, U.S. Department of Commerce, Technology Administration, National Institute of Standards and Technology, 1995, www.bfrl.nist.gov/oae/publications/handbooks/135.pdf.

Richland Engineering Limited

A "before" view of the I–90 bridge over the Grand River.

SELECTION OF ALTERNATIVES IN LIFE-CYCLE COST ANALYSIS

PROJECT TITLE _____

Step 1. Comparison of life-cycle costs
- — List all alternatives analyzed, their present value costs, and LCCs
- — Compare the LCCs
- — Rank the alternatives in ascending order of their LCCs

Step 2. Sensitivity analysis
- — Check for uncertainty about the input values
- — Perform sensitivity analysis, if needed, and enter results
- — Correct ranking of alternatives, if appropriate

Step 3. Selection of preferred alternative
- — Enter the top-ranked alternative and document reasons
- — If LCCs are identical, consider nonquantifiable benefits or costs for ranking

ALTERNATIVE	TITLE/DESCRIPTION
A1	
A2	
. . .	
An	

1. ALTERNATIVES ANALYZED

ALTERNATIVE	A1	A2	. . .	An
LIFE-CYCLE COST				
TOTAL LCC				
RANK				
2. SENSITIVITY ANALYSIS				
NEW RANK				

3. SELECTION BY LCC

ALTERNATIVE	RANK	TITLE/DESCRIPTION

COMMENTS:

how the LCC tool helps in the selection of bridge improvement projects: "Although most projects involve only informal LCC investigations within the preliminary design process, certain projects are strong candidates for a formal LCC study. When various project alternatives involve complex issues such as differing maintenance costs, differing life spans, large financial investments, and large user costs, a formal LCC is an excellent tool to quantify the pros and cons and help select the proper alternative."

Moving Forward

Some States have recognized the need to look beyond initial costs and have taken the practical step of initiating or implementing LCCA in the management of their bridges. Although this is encouraging, some challenges still need to be overcome in order to improve the process. Experts in many States have identified the lack of complete and good quality data as an obstacle to applications of LCCA.

Technical guidance for estimating the cost data needed for bridge LCCA and timing of the actions could prove useful in promoting more applications of this tool to bridge management. The guidance should address all significant agency costs, user costs, vulnerability costs, and other costs borne by affected parties or businesses. Agency costs would need to be estimated as part of an LCCA provided they vary between the alternatives being evaluated. States will likely vary in the importance that they assign to user costs and other nonagency costs relative to agency costs.

Finally, LCCA in bridges could be significantly enhanced over time by treating every bridge as an object and maintaining in a database all activities associated with the bridge throughout its history. The database can include agency costs in contract awards, cycles of maintenance, in-house activities, costs for bridge users, and other costs borne by affected businesses and neighborhoods. Contract and maintenance management systems can be used as potential sources for some of these cost data.

In summary, the application of LCCA to bridges is valuable for developing cost-efficient, long-term, comprehensive plans for optimal design and management that make the most of available resources.

Adel Al-Wazeer is a senior research engineer with bd Systems, Inc., working at the FHWA Bridge Management Information Systems Laboratory at TFHRC.

Bobby Harris is senior manager at bd Systems, Inc., and serves as the contractor's project manager at the FHWA Bridge Management Information Systems Laboratory. He has 18 years of experience in transportation information technology design and implementation, with more than 8 years supporting bridge management research.

Christopher Nutakor, Ph.D., P.E., P.M.P., is a senior analyst and research engineer with bd Systems, Inc., also working at the FHWA Bridge Management Information Systems Laboratory.

For more information, contact Adel Al-Wazeer at 202-493-3202. For more information about the Ohio example, contact Matt Shamis at 614-280-6847.

Along the Road

Along the Road is the place to look for information about current and upcoming activities, developments, trends, and items of general interest to the highway community. This information comes from U.S. Department of Transportation (USDOT) sources unless otherwise indicated. Your suggestions and input are welcome. Let's meet along the road.

Management and Administration

Peters Departs from FHWA

The 15th Federal Highway Administrator, Mary E. Peters, recently stepped down after serving nearly 4 years as the Nation's top highway official to return to Phoenix, AZ, to be with family. During her tenure at the Federal Highway Administration (FHWA), Peters moved the agency forward by finding new and more effective methods of financing highway and bridge projects, primarily through greater private-sector investment. She encouraged the use of new technologies that reduce construction time and expense and that result in safer, longer lasting highways, led a national campaign to improve safety in highway work zones, and worked to streamline the decisionmaking process for major transportation projects.

"Mary has left a lasting impression on the history of surface transportation," U.S Transportation Secretary Norman Y. Mineta said. "She has made us all think about the future of surface transportation in ways we might not have otherwise."

Peters was director of the Arizona Department of Transportation (ADOT) when nominated by President George W. Bush 4 years ago, and she was sworn in on October 2, 2001. She received the 2004 National Woman of the Year Award from the Women's Transportation Seminar, a national organization of transportation professionals. She is a fourth-generation Arizonan with a bachelor's degree from the University of Phoenix. FHWA Deputy Administrator J. Richard Capka is serving as acting administrator.

For more information, contact Brian C. Keeter at 202-366-0660.

Secretary Mineta Announces Public Opportunity To Discuss USDOT Regulations

In an effort to make Government more accessible and to reduce unnecessary costs associated with Federal regulations, U.S. Secretary of Transportation Norman Y. Mineta recently announced an innovative public review of USDOT's regulations and its current regulatory agenda. As part of the evaluation, the department hosted two public meetings in spring 2005, where senior officials—including General Counsel Jeffrey A. Rosen—listened to public opinions on past, present, and future regulations. USDOT required potential participants to submit their initial comments by February 2005 and to indicate their desire to speak at the meeting, but also accepted written comments through April.

"Improving, eliminating, and prioritizing regulations all are important tasks for the Department," Secretary Mineta says. "Making regulations simpler, more effective, and less burdensome is a challenge that can be met only if the public participates." After the information has been evaluated, USDOT will publish a report that responds to comments received, including items that will be put under consideration.

To view the Federal Register *notice, visit www.gpoaccess.gov/fr/index.html. The docket number is OST-2005-20112. USDOT's current regulatory agenda can be found at www.info.gov.*

Public Information and Information Exchange

Peters and Guinn Spearhead U.S. 95 Settlement in Nevada

Former Federal Highway Administrator Mary E. Peters and Nevada Governor Kenny Guinn recently announced an agreement to settle a Sierra Club lawsuit that should clear the way to resume widening U.S. 95 in northwest Las Vegas, NV, as early as fall 2005.

The agreement allows for the addition of new lanes, including high-occupancy vehicle lanes in each direction, and installation of technologies designed to reduce congestion and improve safety. To strike a compromise between the demands of both parties involved in the suit, the settlement also includes environmental measures that will involve testing air-filtration systems in nearby schools, retrofitting Clark County schoolbuses to make them run cleaner, and gathering information on local and national vehicle emissions. As a result of the agreement, FHWA will monitor emissions at up to five major highway locations across the Nation.

Peters said that FHWA worked closely with Guinn and the Nevada Department of Transportation (NDOT) to reach the settlement as quickly as possible. The Sierra Club lawsuit, which stalled construction on the additional

At a press conference, former FHWA Administrator Mary E. Peters and Nevada Governor Kenny Guinn announced a settlement with the Sierra Club that will facilitate future widening projects on U.S. 95 near Las Vegas.

lanes in August 2004, ended with the U.S. District Court of Nevada's acceptance of the settlement.

U.S. 95 is frequently congested, with nearly 12,000 vehicles on the six-lane highway traveling less than half the speed allowed during peak commuting hours, according to Peters. Estimates indicate that even a slight increase in vehicle speed would save the public more than $8.5 million per year in delay costs. Each day, 190,000 vehicles travel the corridor, a number expected to increase significantly as southern Nevada continues to be one of the Nation's fastest growing regions.

For more information, contact Brian C. Keeter at 202–366–0660.

Operation Green Light Helps Coordinate Kansas City Traffic Signals

Operation Green Light (OGL), a recently launched project involving about 20 jurisdictions in the Kansas City, MO, area, is seeking to improve traffic flow and reduce vehicle emissions in the region. The $13.1 million initiative will coordinate signals through numerous high-priority corridors during both morning and evening rush hours. Selective signal controller upgrades currently are underway, and a new wireless communications backbone—which will download signal timing plans to individual controllers—may be installed as early as fall 2005. For OGL's initial phase, 600 signals are expected to be under control by 2007.

According to OGL Project Manager Ron Achelpohl, the operation's sponsoring organization—the Mid-America Regional Council (MARC)—became interested in traffic signal operations through its local work in air quality planning in the mid- to late 1990s. After securing funding to study the potential environmental impacts of improved regional signal coordination and becoming aware that both Kansas City and the Missouri Department of Transportation (MoDOT) were performing similar studies, MARC combined efforts with the other agencies and invited other local jurisdictions to participate.

MARC

Operation Green Light, an initiative to retime traffic signals in Kansas City, MO, could significantly reduce congestion at intersections like this one.

Using the results of its research, OGL will update and coordinate the timing plans currently installed at 600 intersections across seven counties and two States. In a recent test on Barry Road in Kansas City, MARC and its partners retimed and coordinated 10 signals along a 1.6-kilometer (1-mile)-long stretch of the road, reducing the number of stops and improving travel times significantly. After finishing some design work on the communications system and controller upgrades, OGL will begin constructing its wireless communications backbone for the Kansas City Scout—a congestion-management and traveler-information system managed by MoDOT and the Kansas Department of Transportation (KDOT).

For more information, visit www.marc.org/transportation/ogl or contact Reggie Chandra at 816–474–4240 or rchandra@marc.org.

MARC

I–93 Widening on Fast Track Due To Priority Designation

U.S. Transportation Secretary Norman Y. Mineta recently confirmed that plans to expand a 32-kilometer (20-mile) stretch of Interstate 93 (I–93) between Salem, MA, and Manchester, NH, are back on track after Federal transportation officials expedited an environmental review process that had been underway since May 2000. The project, which will expand I–93 from four to eight lanes, was placed on the Bush Administration's priority list for accelerated decisionmaking because of its importance to the local and regional economies, according to Secretary Mineta. After Federal officials approved the environmental review, the project now advances to the design phase and should be completed by 2012.

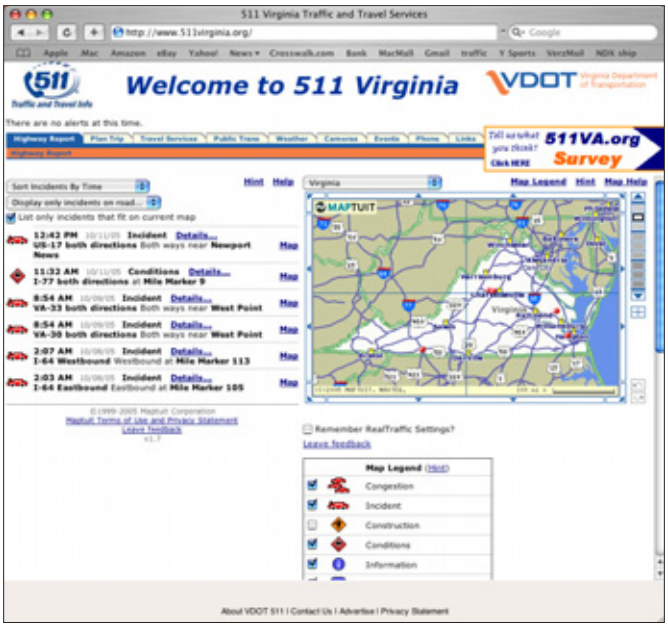
The I–93 project is one of 15 across the Nation designated by Secretary Mineta for priority status. The priority designation invokes authority granted by President George W. Bush under which Federal officials with responsibility for reviewing, permitting, and deciding to approve transportation projects can commit to a faster, higher level review process. More efficient reviews can lead to swifter project completion and lower costs for planning, construction, and labor.

The expedited decisionmaking process, however, must still comply with all environmental laws. Consequently, the I–93 project also will include construction of three park-and-ride lots, several variable message signs to reduce congestion, and other technologies and procedures to maximize traffic flow. When completed, the expanded section of I–93 will help reduce chronic congestion in heavily traveled southern New Hampshire. Parts of I–93 carry more than 104,000 vehicles per day, a number expected to swell to more than 143,000 per day by 2020.

For more information, contact Brian C. Keeter at 202–366–0660.

VDOT Launches Statewide 511 System

Motorists may now obtain traffic updates and travel information for all Virginia interstates by simply dialing 511. The Virginia Department of Transportation (VDOT) recently launched the State's new system so that motorists



VDOT

Virginia's 511 Web site.

can make more informed travel decisions by accessing round-the-clock information on traffic incidents, road and weather conditions, work zones, and other potential traffic difficulties. In addition to real-time road and traffic reports provided by VDOT and the Virginia State Police, 511 also will provide information on gas, food, lodging, and transit connections.

"511 Virginia is unique because it uses information received directly from the source," says Constance Sorrell, VDOT chief of systems operations. "When the Virginia State Police respond to [a crash], or when a VDOT representative updates construction information or information about how weather is affecting travel conditions, within minutes this information is available on 511 Virginia."

The service, which has been available for I–81 for the past 3 years and now covers all Virginia interstates, will soon become available for some primary routes as well. Along with the expansion of the information service, VDOT also upgraded the Web site, www.511Virginia.org, which formerly offered information only for travelers on the I–81 corridor. VDOT is upgrading the site to include statewide traffic and traveler information, as well as driving directions, a trip-planning function, and a link to the Virginia Tourism Corporation. Virginia is one of 22 States to offer a 511 service.

For more information, please contact Scott Cowherd, VDOT 511 travel information program manager, at 804–786–2451 or scott.cowherd@virginiadot.org.

VDOT

USDOT Provides Innovative Loan to Help Launch Central Texas Turnpike

To relieve congestion in one of the fastest growing regions of the country, the Federal Government is closing on a $66 million loan that will help launch construction of the 183A Turnpike near Austin, TX. The USDOT funds, loaned to the Central Texas Regional Mobility Authority, are expected to lower overall costs and accelerate completion of the turnpike project. U.S. Secretary of Transportation Norman Y. Mineta indicated that the loan will not only give the project the extra push needed for success, but also will help attract private funding.

CTRMA

This map shows the proposed route of the new U.S. 183A roadway in Texas.

The loan, announced on March 2, 2005, will help finance design and construction of an 18.7-kilometer (11.6-mile), four-lane toll highway that will run roughly parallel to an existing stretch of U.S. 183. The heavily traveled highway now carries approximately 44,000 vehicles per day, a figure expected to climb to 58,500 vehicles per day in 15 years.

USDOT provided the funding using an innovative financing program established by the Transportation Infrastructure Finance and Innovation Act. With a credit-assistance component to help State and local governments add private-source transportation funding to available public sources, the program potentially could advance large, capital-intensive transportation projects that otherwise might be delayed or not completed at all.

For more information about innovative financing, visit www.fhwa.dot.gov/innovativefinance. To learn more about the turnpike project, visit www.183a.com.

Georgia Helps Teens Commit to Safe Driving

To promote safe driving habits among newly licensed drivers, the Governor's Office of Highway Safety in Georgia recently issued a Teen Driver/Parent Agreement—a short-term safe driving contract to be used during the intermediate licensing phase (Class D) and to be periodically revised as a teen increases his or her driving experience and maturity. The agreement is designed to be a signed safety contract between teens and parents during the most dangerous time for a new driver—the first year of independent driving, when young people lack mileage exposure but are no longer required to have a parent or an adult driver who is 21 years or older accompanying them.

Because teens between the ages of 15 and 18 years are more likely to be injured or killed as a result of

motor vehicle crashes than by any other cause, special attention to their safety is warranted. The agreement sets out the expectations that parents should have for teens who are developing safe driving and decisionmaking skills. During that critical year, the agreement may be modified as frequently as needed while the teen gains experience and driving judgment.

The agreement includes several stipulations under the categories, "Be Safe and Obey the Law" and "Be Responsible," for each teen and parent to initial. Safety agreements include: "Never use alcohol or drugs," "never drive aggressively (follow too closely or cut others off)," and "always check blind spots before passing and changing lanes." In addition, parents and teens agree to time periods for potential revocations of driver privileges according to the severity of the infractions.

To view the agreement, visit www.gahighwaysafety.org/teendriverparent.html.

Georgia Governor's Office of Highway Safety

Mississippi and Michigan Crack Down On Roadside Litter

The departments of transportation (DOTs) in Mississippi and Michigan recently expanded their programs to combat roadside litter. The Mississippi Department of Transportation (MDOT), with help from its Myrtle the Turtle character mascot, recently partnered with the city of Natchez to bring the agency's message, "I'm not your Mama—Pick it up Mississippi," to Natchez schoolchildren in kindergarten through the third grade. The MDOT District 7 Antilitter Coordinator Barbara Mercier used a Myrtle the Turtle video, puppet, and other reinforcement materials during the 30-minute presentations. The "I'm not your Mama" message was made famous by Mississippi's former First Lady Pat Fordice in public service announcements.

MDOT originally developed the "I'm not your Mama" campaign to reduce litter, avoid expensive cleanups, and save tax dollars. In addition to the award-winning message, which emphasizes personal responsibility and teamwork, the department's antilitter coordinators in various Mississippi cities have used the Myrtle the Turtle video, along with a Litter Patrol Pledge and an MDOT Litter Patrol badge, to elicit an enthusiastic response from student participants.

The Michigan Department of Transportation (also called MDOT) also recently strengthened its campaign to keep roadways in the Detroit metropolitan area free of litter by using an expanded Youth Corps program. In 2005, the department added a spring program to the region's successful summer program to ensure that grassy slopes and medians along the freeway system do not become roadside garbage collectors.

"The spring program will give us a jump-start on controlling the litter issue while providing area youth the opportunity to learn working skills and earn a paycheck," says Greg Johnson, the MDOT metro region engineer.

The 2005 spring session began in mid-March with two crews of five workers each, patrolling freeways for eight consecutive weekends, focusing on those areas most cluttered with litter after the winter months. The summer program, which began in mid-June 2005, also offered enrichment opportunities where participants interacted with transportation professionals, area universities, and business leaders to learn about careers available in the transportation industry.

For more information about Mississippi's Antilitter Program, contact Amy Land, MDOT public affairs, at 601-359-7017 or visit www.gomdot.com/antilitter/educational_components/educational_main.htm. For more information on the Michigan Youth Corps program, contact Rob Morosi with MDOT at 248-483-5127.

Mississippi and Michigan DOTs

Personnel

Kaveeshwar Named Head of New DOT Agency

The U.S. Senate recently voted unanimously to approve Dr. Ashok G. Kaveeshwar as the first administrator of the Research and Innovative Technology Administration (RITA), a newly created agency within USDOT. Kaveeshwar was nominated to the position in May 2005 by President George W. Bush.

RITA was created under the Norman Y. Mineta Research and Special Programs Improvement Act to coordinate and manage the agency's research portfolio more effectively and to expedite the implementation of cross-modal, innovative technologies.

"The goal in creating RITA is to have a focused research agency, which is part Silicon Valley entrepreneurial company and part university research lab," Secretary Mineta says. "By forming innovative partnerships with transportation-related industries, government agencies, and other public and private stakeholders, RITA will be more effective in coordinating research to more efficiently address the transportation needs of the 21st century. Dr. Kaveeshwar's diverse experience, from managing successful high-technology companies to performing cutting-edge scientific research, makes him uniquely suited to carry out this vision."

Kaveeshwar has 35 years of experience in providing research and technology development to a wide range of Federal agencies. He most recently served as president of Orange Technologies, Inc., a small business that provides information technology to government and commercial customers. From 1998 to 2002, Kaveeshwar served as senior vice president of Raytheon Technical Services Company, where he was responsible for leading more than 4,000 employees worldwide.

Kaveeshwar moved to the United States from his hometown of Indore, India, in 1961. He received his bachelor's degree from Holkar Science College in Indore and his Ph.D. in physics from the State University of New York at Buffalo.

For more information, contact Roger Lotz at 202-366-2246.

NATIONAL HIGHWAY INSTITUTE

Training Update

New NHI Course Bridges Gaps In Bridge Specifications

Community Transportation Solutions

A new NHI course on LRFD specifications will help engineers produce more reliable designs for bridges like these three over the Ohio River near Louisville, KY.

With the goal of ensuring a more uniform level of safety and reliability for highway structures, the Federal Highway Administration (FHWA) and the American Association of State Highway and Transportation Officials (AASHTO) established an October 2007 deadline for States to transition to using load and resistance factor design (LRFD) specifications for highway bridges.

LRFD incorporates state-of-the-art analysis and design methodologies with load and resistance factors based on the known variability of applied loads and material properties. The load and resistance factors are calibrated from actual bridge statistics to ensure a uniform level of safety. Because LRFD specifications are probability-based and incorporate working stress design and load factor design (LFD), while accounting for extreme events like ship collisions with bridges and earthquake damage, they can help produce more reliable structures.

To help States obtain the practical hands-on technical training necessary to transition to the LRFD platform, the FHWA Office of Bridge Technology and the National Highway Institute (NHI) are introducing a new course, LRFD for Highway Bridge Substructures and Earth Retaining Structures (#130082A).

To date, some States have adopted the new LRFD specifications to varying degrees, while others are designing bridges in relatively close accordance with traditional specifications.

Traditionally, States either followed the allowable stress or LFD platform, and AASHTO maintained two sets of national specifications: *Standard Specifications for Highway Bridges*, 17th Edition, and *Load and Resistance Factor Bridge Design Specifications*, 3rd Edition. NHI's course strives to unify the Nation's design approach by presenting the most up-to-date guidance, including a proposed specification rewrite for structural foundations. Because of LRFD's applicability across disciplines, this comprehensive set of specifications also can help improve communication between structural and geotechnical specialists.

The new course replaces the former NHI course, LRFD for Highway Bridge Substructures (#13068), and covers current national practices and procedures for structural design, along with geotechnical design and foundation engineering. To improve delivery of the content, instructors emphasize hands-on exercises and sample problems.

Upon completing the course, participants will be able to do the following:

- Define LRFD limit states and compute structural and geotechnical design loads
- Integrate the LRFD specifications into their local practices
- Apply LRFD criteria for design
- Integrate the geotechnical aspects of LRFD foundation design into LRFD structural design

The LRFD course targets a variety of infrastructure specialists, including mid-level bridge and geotechnical journeymen and mid-level design engineers. The course also can accommodate entry-level designers with LRFD experience and experienced designers who have worked with allowable stress design or LFD but not LRFD.

"The transition to LRFD is simply a language translation," says Jerry A. DiMaggio, principal bridge engineer at FHWA. The new course will help dispel concerns that the transition to LRFD could be complex, difficult, and costly, or result in designs that are too conservative or not conservative enough.

Each course installment is delivered by two experienced instructors—a structural engineer and a geotechnical specialist—in an onsite classroom format using a comprehensive participant's manual and a reference manual as teaching tools. The course is available in four formats, with timeframes ranging from 1 to 5 days.

For more information on this course, contact Jerry A. DiMaggio at 202-366-1569 or jerry.dimaggio@fhwa.dot.gov. To schedule a course, contact the NHI Training Coordinator at 703-235-0500 or nhitraining@fhwa.dot.gov. To obtain information about NHI courses, access the course catalog at www.nhi.fhwa.dot.gov or contact NHI at 4600 N. Fairfax Drive, Suite 800, Arlington, VA, 22203; 703-235-0500 (phone); or 703-235-0593 (fax).

Internet Watch

by Keri A. Funderburg

NTOC Site "Talks" Operations And Management

While some transportation agencies are building new roads and bridges, nearly every agency is focused on keeping the Nation's existing roads and bridges up and running. Across the country, the management and operation of existing transportation infrastructure has become a priority, with numerous transportation specialists working to improve the performance and efficiency of the system.

To help institutionalize management and operations within the transportation industry, the Federal Highway Administration (FHWA) recently provided funding to establish the National Transportation Operations Coalition (NTOC) as an alliance of national associations, transportation practitioners, and private-sector groups. Recently, the coalition developed a new Web site, "NTOC Talks" (www.ntoctalks.com), to provide a central location for current news and information on transportation management and operations and intelligent transportation systems (ITS).

"FHWA supports NTOC because it helps educate transportation stakeholders at the Federal, State and local levels on strategies to improve the performance of the highway system," says Zia Burleigh, the FHWA program manager responsible for oversight and management of NTOC activities. "To help with this task, NTOC created the Web site as a tool to help elected and appointed officials and transportation practitioners make more informed decisions about operations and management, the deployment of ITS technologies, and resource allocations over the long term."

Something to Talk About

Divided into several content-based sections, the Web site provides users with various types of information. By clicking on the forums link from the homepage, for example, users can access two online message boards that serve as a common area for discussing current issues and sharing information with peers.

The Talking Operations forum serves as a place for practitioners and managers to share their thoughts and views on how to improve the collective maintenance and operation of the transportation system. Topics recently discussed in the forum include traffic management for special events and the cost effectiveness of operations strategies.

The objective of the ITS Technology forum is to support a dialogue among transportation organizations and professionals involved in planning, researching, deploying, and operating ITS technologies. Recent topics have included loop detectors, pedestrian safety technologies, and dynamic message signs.

In addition to the forums, the NTOC Web site provides users with access to the Talking Operations Web casts. Conducted via the Internet and telephone, these monthly seminars are designed to educate transportation professionals on trends, tools, and noteworthy practices in management, operations, and ITS technologies. Recent Web casts topics have included transportation performance measures and traffic signal optimization.

"The Web casts are useful because they provide an easy and free way for transportation decisionmakers and practitioners to learn about a variety of operations and ITS topics from the comfort of their own offices," says Burleigh.

Newsworthy and Resourceful

In the newsletter section of the site, users can access the latest edition of the NTOC newsletter, which is published twice every month. Articles cover a range of topics, from information on the latest transportation research to announcements about upcoming conferences and meetings. Several NTOC member organizations contribute articles to the newsletter, including the American Association of State Highway and Transportation Officials and the Transportation Research Board.

The newsletter section also includes a search engine that enables users to access articles from previous issues, either by entering a keyword or choosing an appropriate category, such as training or market research. Users also can peruse the contents of past issues and sign up to have specific issues sent directly to their e-mail accounts. This feature can benefit both new practitioners in the field of transportation operations and management and also seasoned veterans who want to catch up on recent news and events.

From the homepage, users also can access the resources section of the site, which features links to reports, Web sites, and other publications. Using drop-down menus, users can select information by resource type or objective, such as improving freight operations or enhancing emergency transportation.

"This part of the site provides information on a variety of subjects related to operations and ITS," Burleigh says. "If a user cannot find the information he or she is looking for in the resources section, another option is to contact FHWA or one of NTOC's member associations for assistance."

While the "NTOC Talks" Web site provides a wealth of technical information for transportation professionals, it also enables users to learn more about NTOC and its mission and objectives. By including information on both technical issues and the coalition's activities, the site is helping to ensure that the transportation professionals responsible for keeping the Nation's transportation system up and running are educated and involved.

The "NTOC Talks" Web site.

Keri A. Funderburg is a contributing editor for PUBLIC ROADS.

Communication Product Updates

Compiled by Zac Ellis of FHWA's Office of Research and Technology Services

Below are brief descriptions of products recently published online by the Federal Highway Administration's (FHWA) Office of Research, Development, and Technology. Some of the publications also may be available from the National Technical Information Service (NTIS). In some cases, limited copies are available from the Research and Technology (R&T) Product Distribution Center.

When ordering from NTIS, include the NTIS publication number (PB number) and the publication title. You also may visit the NTIS Web site at www.ntis.gov to order publications online. Call NTIS for current prices. For customers outside the United States, Canada, and Mexico, the cost is usually double the listed price. Address requests to:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703–605–6000
Toll-free number: 800–553–NTIS (6847)

Address requests for items available from the R&T Product Distribution Center to:

R&T Product Distribution Center, HRTS-03
Federal Highway Administration
9701 Philadelphia Court, Unit Q
Lanham, MD 20706
Telephone: 301–577–0818
Fax: 301–577–1421

For more information on research and technology publications from FHWA, visit the Turner-Fairbank Highway Research Center's (TFHRC) Web site at www.tfhrc.gov, FHWA's Web site at www.fhwa.dot.gov, the National Transportation Library's Web site at http://ntl.bts.gov, or the OneDOT information network at http://dotlibrary.dot.gov.

Safety Evaluation of Red-Light Cameras
Publication No. FHWA-HRT-05-048

The objective of this final study was to determine the effectiveness of red-light-camera (RLC) systems in reducing crashes. RLC systems enhance accountability and enforcement for red-light running violations. Using the empirical Bayes (EB) research method, the study compared statistics drawn from test sites both before and after the implementation of RLC technology. Drawing from tests conducted in seven jurisdictions across the United States and from 132 sites, the study estimated the crash-reducing effects and associated economic effects of RLC systems and specifically derived costs for rear-end and right-angle crashes for various crash severity levels.

The crash effects detected were consistent with those found in many previous RLC studies. Specifically, the RLC systems decreased right-angle crashes and increased rear-end ones. But further economic analysis, which examined the extent to which increased rear-end crashes might negate the benefit of fewer right-angle crashes, showed an aggregate *benefit* from RLC systems in terms of crash costs. A disaggregate analysis found that the greatest economic benefits can be attained at intersections with the following characteristics: high levels of average annual daily traffic, more right-angle than rear-end crashes, and the presence of protected left-turn phases.

The NTIS publication order number for this report is PB2005106539. To view this publication online, visit www.tfhrc.gov/safety/pubs/05048/05048.pdf.

Covered Bridge Manual
Publication No. FHWA-HRT-04-098

FHWA's *Covered Bridge Manual* provides guidance to transportation specialists involved with any aspect of maintaining covered bridges, from initial inspections and evaluations through engineering, rehabilitation, and construction. To provide users with introductory background information, the publication also contains general terminology for covered bridges as well as brief historical information. The manual covers loading, structural analysis, connections, and design issues. The last six chapters contain discussions of evaluation, maintenance, strengthening, and preservation of existing covered bridges; historic considerations; and a state-of-the-art guide on wood preservatives for covered bridges, including historic preservation requirements as directed by the U.S. Department of the Interior.

The appendices include an extensive series of case studies that highlight engineering problems and solutions for several covered bridges in the United States. A unique feature of the *Covered Bridge Manual* is that it focuses on nuances of how covered bridges are engineered, including some issues not addressed currently by national bridge specifications. The chapter on timber connections in particular provides a comprehensive discussion of joinery and represents an important contribution to covered bridge engineering.

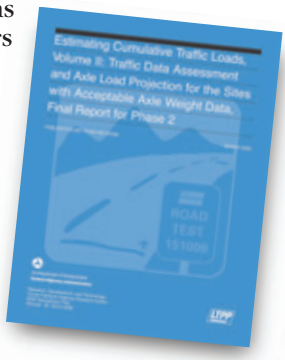
To learn about the preservation of U.S. covered bridges, visit the Web site for the National Historic Covered Bridge Preservation Program at www.fhwa.dot.gov/bridge/covered.htm.

Estimating Cumulative Traffic Loads, Volume II: Traffic Data Assessment and Axle Load Projection for the Sites with Acceptable Axle Weight Data, Final Report for Phase 2
Publication No. FHWA-RD-03-094

This report contains findings of the second phase of a study to estimate traffic loads on long-term pavement performance (LTPP) sites. The first phase, which encompassed the development of an estimation methodology with numerical examples, now is documented in *Estimating Cumulative Traffic Loads, Final Report for Phase 1* (FHWA-RD-00-054), first issued in July 2000. Phase 2

includes the assessment of the overall quality of traffic data for all 890 LTPP traffic sites surveyed and the projection of axle loads for each site that provided adequate traffic data. The Phase 2 report also includes the distribution of comprehensive traffic data reports to participating agencies and the incorporation of each agency's comments regarding the study's traffic projections.

The study developed projections for axle loads for all inservice years up to 1998 for LTPP traffic sites that had adequate traffic monitoring data in FHWA's Information Management System (IMS) database. The researchers expressed the projections as annual axle load spectra for single, tandem, and triple axles and placed the data into IMS-computed parameter tables. Appendix A summarizes projection results for all LTPP sites.



To overcome the difficulty of estimating traffic loads for the 332 LTPP sites without adequate data, researchers proposed developing an LTPP Pavement Loading Guide (PLG). Therefore, the report contains a description of the purpose, design parameters, and functionality of the PLG; a blueprint for the guide's development; and two examples of using the PLG to obtain traffic load projections for LTPP sites without site-specific data on truck class or axle load.

The recommended traffic analysis activities include the development of the PLG, completion of traffic load projections for all LTPP sites, and the development of a comprehensive action plan to better utilize existing traffic data. Recommended components of the action plan include a comprehensive quality assurance process, use of monthly traffic data for estimating traffic loads, and regional modeling using both LTPP and other traffic data.

The NTIS publication order number for this report is PB2005103114. To view the publication online, visit www.fhwa.dot.gov/pavement/ltpp/03094/03094.pdf.

Reporting Changes of Address

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Conferences/Special Events Calendar

Date	Conference	Sponsor	Location	Contact
Jan 22–26, 2006	TRB 85th Annual Meeting	Transportation Research Board (TRB)	Washington, DC	Linda Karson 202-334-2362 lkarson@nas.edu www.trb.org
Mar 5–8, 2006	Earth & Space 2006	American Society of Civil Engineers (ASCE)	Houston, TX	Ramesh B. Malla 860-486-3683 mallar@engr.uconn.edu www.asce.org/conferences/space06
Mar 13–16, 2006	World of Asphalt 2006 Show & Conference	Asphalt Pavement Alliance, Asphalt Institute, National Asphalt Pavement Association, State Asphalt Pavement Associations	Orlando, FL	Megan Tanel 800-867-6060 mtanel@aem.com www.worldofasphalt.com
Mar 19–22, 2006	ITE 2006 Technical Conference and Exhibit	Institute of Transportation Engineers (ITE)	San Antonio, TX	Donna Ford 202-289-0222, ext. 140 dford@ite.org Christina Denekas 202-289-0222, ext. 128 cdenekas@ite.org
Mar 29–30, 2006	TED 2006 Conference on Transportation & Economic Development	TRB	Little Rock, AR	Vincent W. Yao 501-569-8453 wxyao@ualr.edu www.ted2006-littlerock.org
May 7–10, 2006	The 63rd IEEE Vehicular Technology Conference	Institute of Electrical and Electronics Engineers, Vehicular Technology Society	Melbourne, Victoria, Australia	Sarah Craze 61-3-9925-5382 sarah@atcrc.com www.vtc2006spring.org
Jun 4–7, 2006	North American Travel Monitoring Exhibition & Conference	TRB	Minneapolis, MN	Tom Palmerlee 202-334-2907 tpalmerlee@nas.edu Brian Canepa 202-334-2966 bcanepa@nas.edu www.trb.org/conferences/natmec
July 16–20, 2006	11th Maintenance Management Conference	TRB, American Association of State Highway and Transportation Officials	Charleston, SC	Sue McNeil 312-996-9818 mcneil@uic.edu http://gulliver.trb.org/conferences/MMC_CALL-FOR-ABSTRACTS.pdf
July 23–26, 2006	13th International Conference on Cold Regions Engineering	ASCE	Orono, ME	Phil Dunn 207-581-2326 Philip_Dunn@umit.maine.edu Steven W. Cole 207-848-5714 scole@bangor.swcole.com www.asce.org/conferences/coldregions2006
Aug 13–16, 2006	Applications of Advanced Technology in Transportation	ASCE	Chicago, IL	Kelvin Wang 479-575-8425 kcw@engr.uark.edu www.asce.org/conferences/AATT06

For the latest on the updated Work Zone Safety and Mobility Rule . . .

Go to www.ops.fhwa.dot.gov/wz/resources/final_rule.htm for guidance, examples, best practices, tools, and resources to help implement the provisions in the updated Work Zone Safety and Mobility Rule (23 CFR 630 Subpart J), published in the *Federal Register* on September 9, 2004.

An overall Rule implementation guide is available on the Web site. Companion guidance documents also are available on specific aspects of the Rule: impacts assessment, transportation management plans, and public information and outreach strategies.

U.S. Department of Transportation
Federal Highway Administration

For more information, contact Tracy Scriba at 202–366–0855 or tracy.scriba@fhwa.dot.gov.

RULE on WORK ZONE Safety and Mobility

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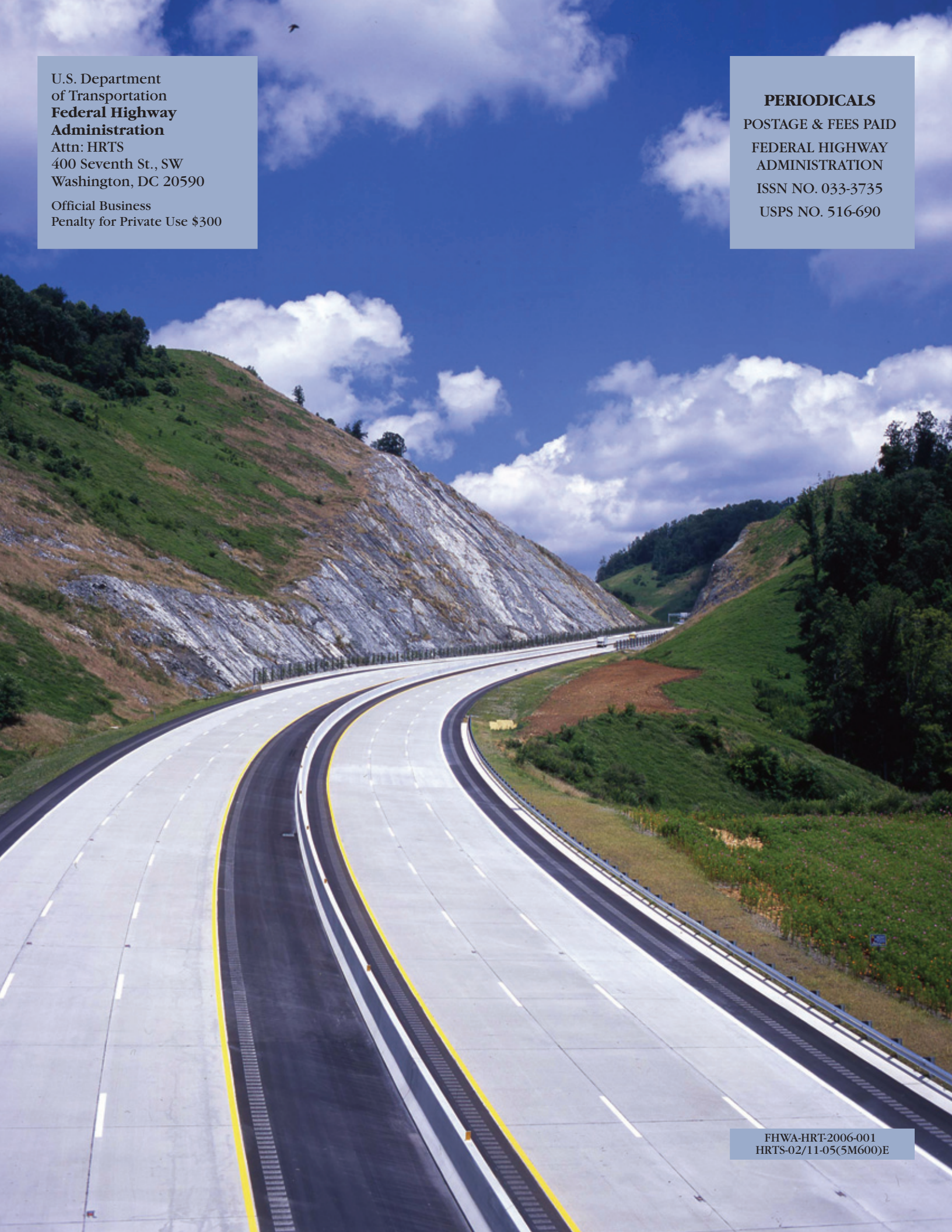

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