



TR News January-February 2015: Preparing for a New Panama Canal

DETAILS

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COVER: In 2016, a major expansion of the Panama Canal will facilitate passage of vessels up to 15,000 TEUs and with drafts of 50 feet. The large vessels will require super-post-Panamax crane and draft equipment, shown here at the Port of Oakland. (Photo: Eddie Codel, Port of Oakland)

TR NEWS

features articles on innovative and timely research and development activities in all modes of transportation. Brief news items of interest to the transportation community are also included, along with profiles of transportation professionals, meeting announcements, summaries of new publications, and news of Transportation Research Board activities.

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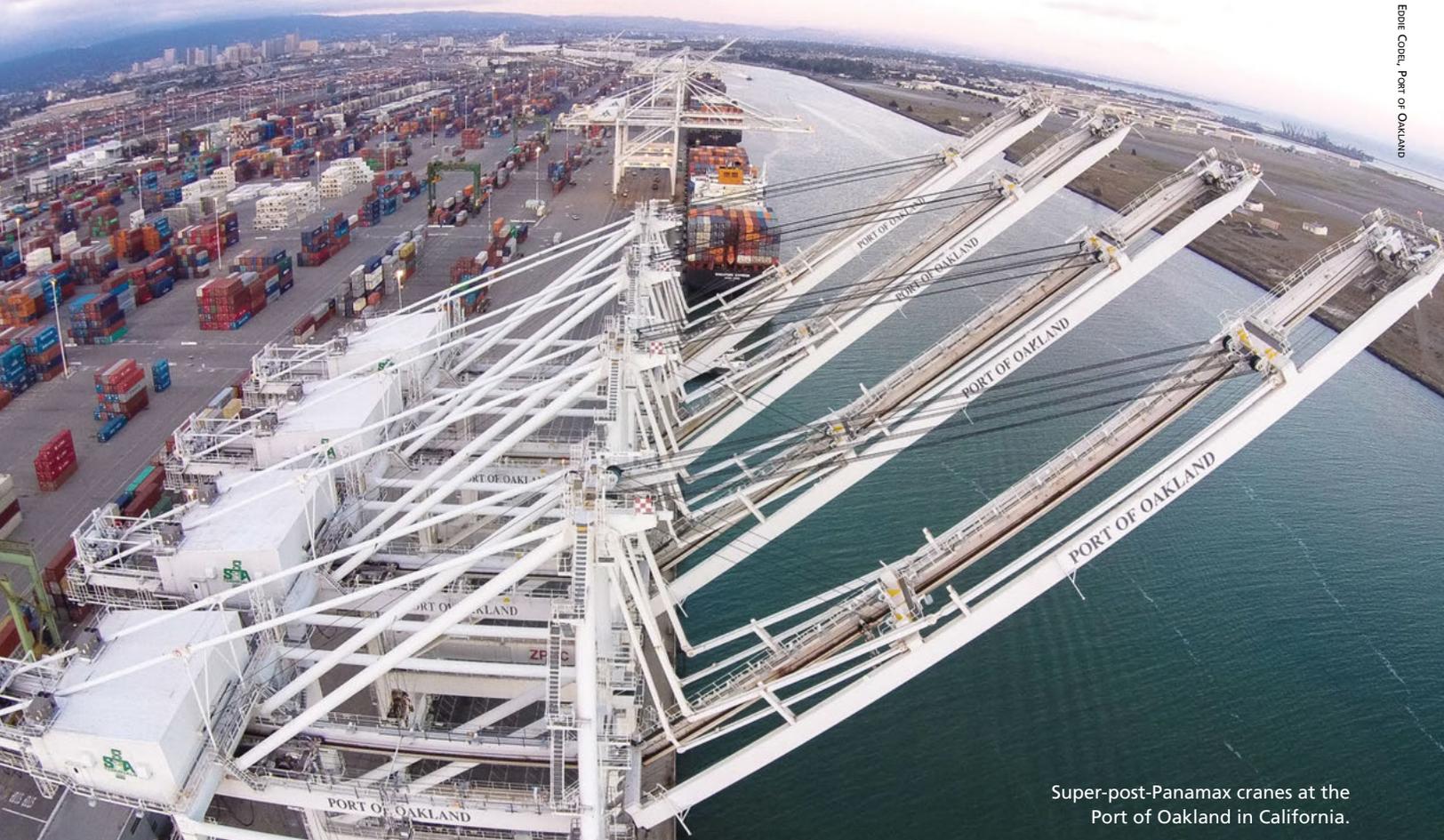
COMING NEXT ISSUE

Photographic highlights capture the high energy and many successes of TRB's 94th Annual Meeting, which featured U.S. Secretary of Transportation Anthony J. Foxx,



U.S. Transportation Secretary Anthony J. Foxx (*left*) participates in a question-and-answer session with *Washington Post* reporter Ashley Halsey III (*right*) at the 2015 TRB Annual Meeting. Foxx outlined priorities for the coming year as well as long-term transportation needs.

more than 3,500 research papers, major professional awards, committee meetings, an active exhibit hall, and more—achieving record-breaking attendance at a new and more capacious venue. Also featured are the valedictory address by Robert E. Skinner Jr., who retired as Executive Director at the end of January, and a statement of vision for the Board's future by new Executive Director Neil Pedersen. Other features review the history of TRB's *Critical Issues in Transportation* series and examine the logistics and transportation innovations of traveling circuses.



Super-post-Panamax cranes at the Port of Oakland in California.

The Legacy and Future of the Panama Canal

From Point of Transit to Transshipment Hub

JEAN-PAUL RODRIGUE AND THEO NOTTEBOOM

Rodrigue is Professor, Department of Global Studies and Geography, Hofstra University, Hempstead, New York. Notteboom is Foreign Expert Professor, Dalian Maritime University, Dalian, China; part-time Professor, University of Antwerp and Antwerp Maritime Academy, Belgium; and a visiting Professor in Shanghai and Singapore.

In 2014, the Panama Canal celebrated its centennial—spotlighting its legacy as an important gateway of international trade but also raising questions about its future in an increasingly integrated global economy. The Panama Canal expansion project will open a new set of locks and will complete several ancillary projects, such as dredging and widening, in early 2016 at an estimated cost of \$6.2 billion. As is common with megaprojects, however, unforeseen events and cost overruns are likely to increase the final price tag.

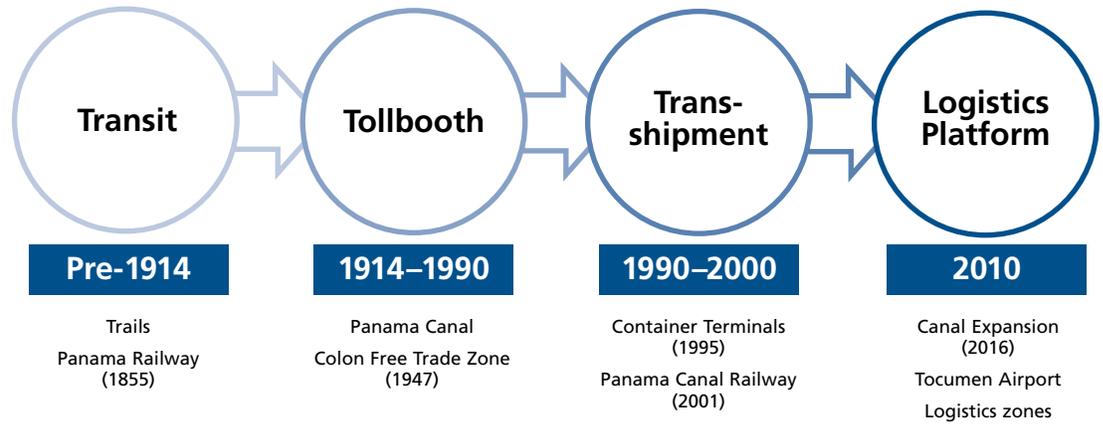
The expansion is timely and necessary and will accommodate containerships in the range of 12,000 to 15,000 20-foot equivalent units (TEUs) with a draft of 50 feet. Before the expansion, the canal could handle containerships of up to 4,500 TEUs with a draft of 42 feet.



The Panama Canal formally opened in August 1914 with the passage of the cargo ship *SS Ancon*.

PHOTO COURTESY OF THE PANAMA CANAL AUTHORITY

FIGURE 1 Evolution of Panama's role in global transport.



This limitation on vessel size had threatened the relevance of the Panama Canal—the number of containership transits grew only minimally, despite a surge in the amount of transit tonnage and transshipment traffic at Panama's ports. This is the latest stage in the canal's evolution from a simple point of transit into a logistics platform with a growing role in maritime transshipment and regional economic development (Figure 1, above).

Transit Point to Tollbooth

During the colonial era, Panama was a transit country, connecting Pacific and Atlantic trade routes through trails across the isthmus. Panama City served as a transit hub as early as the 17th century, functioning as a trade platform for the Spanish Empire, particularly for the west coast of South America.

In the 19th century, commerce and the growing

influence of the United States replaced the patterns of colonial trade. The completion of the Panama Railroad in 1855 reinforced the transit function and established the ports of Balboa and Colon as the maritime terminals on each side of the isthmus.

The growth of global and intra-American trade and the development of steamships provided a rationale for the construction of the Panama Canal, completed in 1914. Panama became a tollbooth country, deriving revenue from canal crossings. Within decades, the nation was recognized as an important connector for the global maritime transport system.

The Panamax ship class that fits exactly into the locks became the de facto standard in maritime shipping. Nevertheless, investments in this connectivity were limited—Panama remained a location for cargo in transit. Although established in 1947, the Colon Free Trade Zone did not experience significant growth until the 1990s.

Flags of convenience, bunkering, and other service functions emerged. Panama today is the world's leading country in ship registry.

Transshipment Hub

In the 1990s, a series of events encouraged the transformation of Panama from its conventional role as a transit country, culminating with the Panama Canal Authority assuming control of the canal in 1999. Before 1995, the Panamanian container ports of Cristobal and Balboa had handled limited amounts of container cargo—approximately 100,000 to 150,000 TEUs—to support domestic trade.

The port privatization reforms of 1995 attracted significant investments in port infrastructure and the entry of major global terminal operators, such as Hutchison Port Holdings Limited, SSA Marine, and PSA International. The container traffic at the ports grew rapidly.

The arrival of the larger post-Panamax ship services and the growth of Transpacific trade introduced

This 1855 engraving shows the Culebra station on the Panama Railroad. The railroad connected ports at Balboa and Colon, expanding their functions as trade terminals.

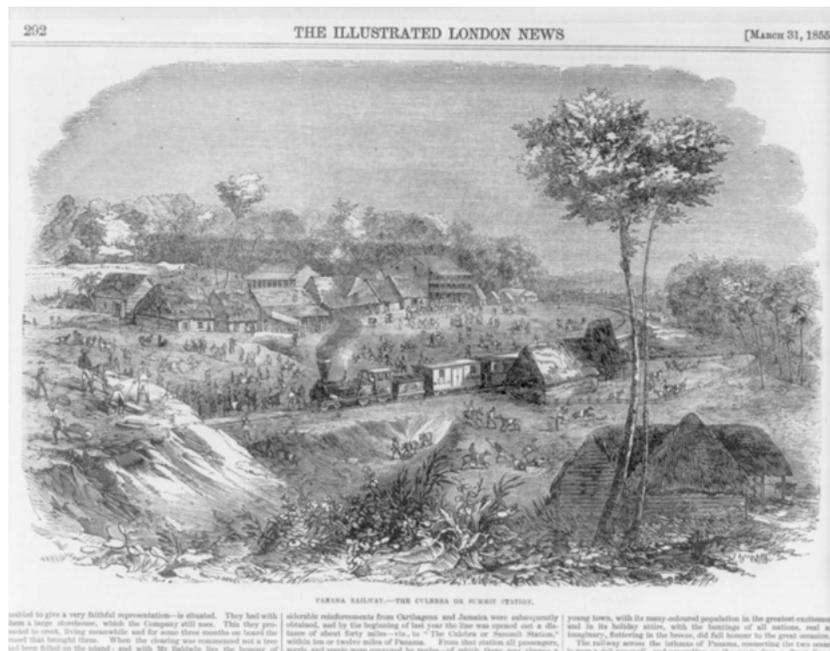


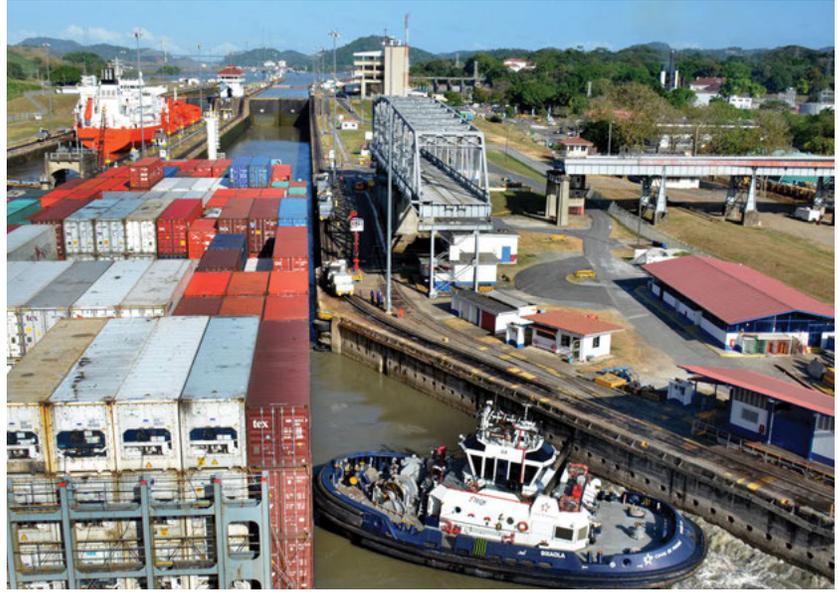
PHOTO: LIBRARY OF CONGRESS PRINTS AND PHOTOGRAPHS DIVISION

a new dynamic. Panama quickly became a transshipment hub, helping reconcile long-haul and feeder maritime services on both the Atlantic and Pacific sides of the canal.

In 2012, Panamanian ports handled 6.8 million TEUs; 95 percent of these involved transshipment activities. For instance, before 2001, the Port of Balboa on the Pacific coast handled almost no traffic, but by 2012, the volume exceeded 3.2 million TEUs—a spectacular growth.

The Panama Canal railway reopened in 2001 with double-stack rail service to support the growing container flows between the Atlantic and Pacific container ports. As a result, Panama expanded its intermediary role—transshipments required the temporary storage of growing quantities of containers at the port terminals, as well as the repositioning of containers throughout the isthmus. This has placed pressure on the road and rail infrastructures.

PHOTO COURTESY OF THE PANAMA CANAL AUTHORITY



Logistics Platform

In the first decade of the 21st century, a new trend emerged, reinforcing Panama's role as a global trade platform. The growth in transshipment volumes, the central position of Panama within the Americas, the growth of the finance sector, and Panama's emergence as an air transportation hub stimulated logistics activities. The developing scenario raised the potential for Panama to become a logistics platform, servicing global and regional supply chains by providing added-value activities for the region.

This transition is still in progress, and Panama must address several challenges to develop world-class logistics capabilities. In particular, additional port capacity is needed, particularly on the Pacific side, as well as port-centric logistics zones and a more extensive road system to support the new interactions. Economic development and the expansion of trade relations throughout Latin America also will benefit Panama directly, through transshipments and freight distribution, and indirectly, with more canal transits.

With post-Panamax ships carrying nearly 50 percent of cargo traffic, the Panama Canal has become a transshipment hub.

PHOTO COURTESY OF THE PANAMA CANAL AUTHORITY



The Panama Railway reopened in 2001 to support the canal's growing transshipment operations.

The 6,600-TEU *Yang Ming Milestone*—a post-Panamax vessel—arrives at the Port of Jacksonville in Florida. Vessels that cannot fit through the canal have shifted to new routes.



Photo: JAXPORT, Jeff Price

Expansion and Global Trade

The Scale Driver

Maritime shipping offers improved economies of scale—this was a key reason for expanding the Panama Canal; larger ships lower the transport costs per unit. Starting in the 1990s, an increasing share of the world's post-Panamax container fleet was unable to use the Panama Canal; new configurations arose for maritime services.

By 2014, post-Panamax vessels comprised approximately 48 percent of the capacity of the global container fleet. At the same time, maritime shipping companies also substantially expanded ship designs that fit the Panamax specifications.

Panamax remains an important standard, not only because of the capability to transit the Panama Canal, but also because the draft and the crane equipment at many ports around the world are designed to Panamax specifications. Changing the standards is a costly and risky endeavor; and the lock size of the expansion project most likely will set the new standard for global maritime shipping.

Shifting Trade Rationale

The Panama Canal initially was built to serve shipping between the East and West Coasts of the United States; the expansion now under way is predominantly to accommodate trade between Asia and the U.S. East Coast. This trade accounted for 39 percent of canal cargo in 2012, followed by cargo traffic on the route between the West Coast of South America and the U.S. East Coast, at 13 percent (see Figure 2, page 7).

The expansion project, however, takes place in an economic environment prone to uncertainties; the financial crisis of 2008 has occasioned a reassessment of the prospects for trade growth. Although East Asia—notably Japan, South Korea, Taiwan, and Hong Kong—has been a driver for global economic growth for decades, the Chinese economy has had the greatest impact on the global structure of production and trade, evidenced by a surge in the transpacific trade and cargo handled by U.S. West Coast ports.

The Panama Canal benefited from the growth pattern as well, particularly for the all-water route between East Asia and the U.S. East Coast. For a variety of reasons, China's comparative advantages are being eroded, particularly for labor-intensive activities, which imply a redistribution of elements of the manufacturing base to other locations, probably in Southeast Asia, South Asia, and South America.

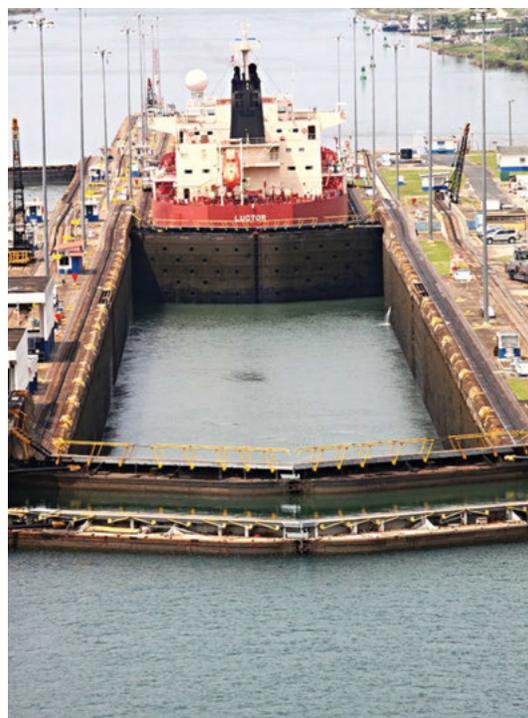


Photo: JASFRENO, Flickr

A vessel in the Gatun locks. The Panamax standard extends beyond the infrastructure of the canal itself; many ports follow the standard for their own draft and crane equipment.

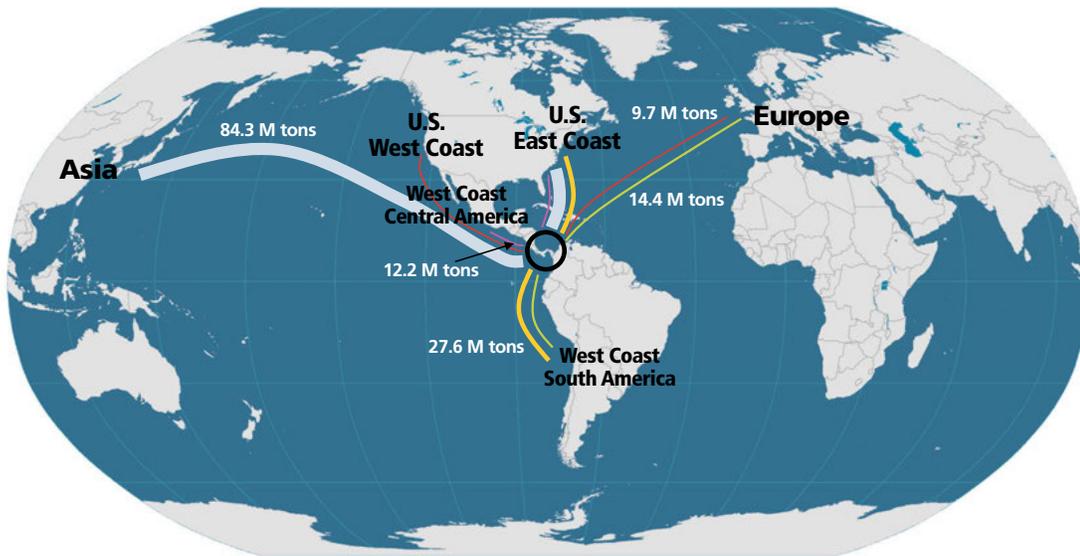


FIGURE 2 Main trade routes via the Panama Canal, 2012. (M = million. Source: Panama Canal Authority)

Expectations for trade growth are focusing on different locations from those prominent in the transpacific patterns of the past two decades. For example, growth levels in markets that previously were dominant drivers—such as the United States and Western Europe—may decline, while the growth rates in markets previously more marginal—such as South America, South Asia, and Africa—may increase.

The extent to which the emerging Latin American markets can offset the prospects of limited growth in the conventional market of the Panama Canal is unclear but positive. Economic and trade growth on both of the South American coasts will result in a proportionate growth in Panama Canal traffic, because alternative shipping options are limited—although the Cape Route option for trade between Asia and South American countries such as Brazil and Argentina is growing.

Competitive Changes

Coastal Balancing Act

Asian imports can enter the North American market either through West Coast ports with an intermodal rail leg or through the Panama Canal by an all-water route to East or Gulf Coast ports (Figure 3, page 8). The all-water route must balance lower transport costs with greater transit time compared with the intermodal option. The Suez Canal and the Mediterranean also can serve the U.S. East Coast—this option is growing.

The choice of route depends on the final destination, the transport costs, and the travel time. The all-water route from Shanghai to New York, for example, takes approximately 26 days, the intermodal option takes 22 days, and the Suez Canal route takes 28

days. The Panama Canal expansion is likely to change several elements of the transport cost structure and alter the comparative advantages of each of the routing options.

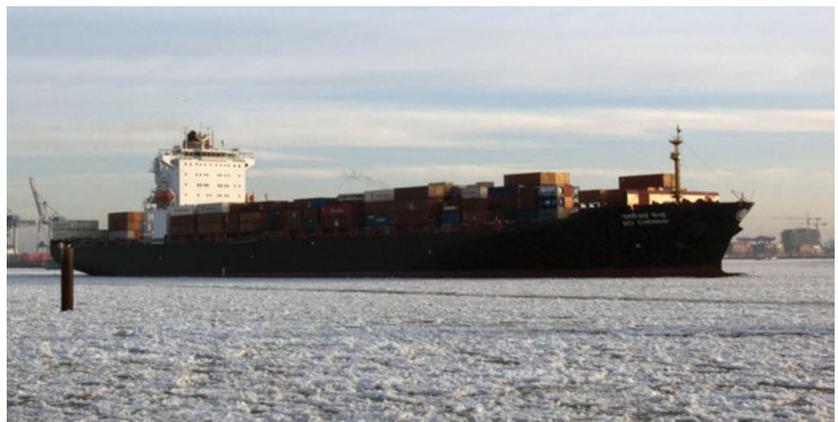
Cost Structure

The tolls that are set after the expansion also will affect the Panama Canal’s competitiveness as a routing option. The cost structure for the shipment of containers between East Asia—for example, Shanghai—and North American ports is revealing (see Figure 3). The pattern for inbound traffic is straightforward and relates to shipping distance; the shipments with the lowest cost in the sample are to Vancouver and the highest are to Montreal, at the opposite end of the all-water route.

The container shipping rates for outbound traffic differ, because shipping distance plays a much less evident role. The rates more closely reflect trade patterns, particularly the export opportunities in the port’s hinterland.

The marine vessel *SCI Chennai*, based in South Asia, where burgeoning markets are driving trade growth.

PHOTO: PAWEŁ BYT, FLICKR



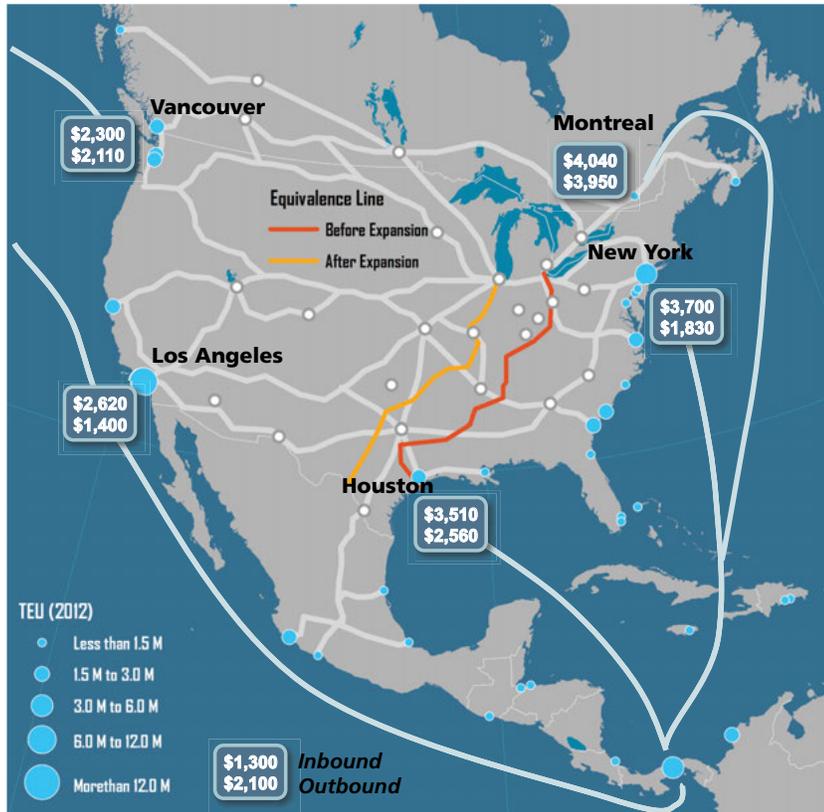


FIGURE 3 Shipping rate in U.S. dollars for a 40-foot container from Shanghai to selected port pairs, mid-2012. (Note: The rate benchmarks are for full container loads and include the base ocean rate, the terminal handling charge at origin and destination, the fuel surcharge, and all other surcharges; inland transport costs are not included. Sources: Drewry Container Benchmarks; equivalence lines: WorleyParsons and Princeton Consultants, Inc.)

When inbound flows are significant, and return cargo is proportionally scarcer, the outbound rates are much lower, because the shipping companies offer discounts to attract backhaul cargo. The greatest paradox is that the inbound rate per TEU is 60 percent higher for New York than for Vancouver, at the opposite end of the all-water route from Asia, yet the outbound rate for New York is 15 percent cheaper.

For the inland cost structure, achieving cost equivalence for shipping to Asia from either the West or East Coast is a possibility, as the East Coast ports handle additional cargo via the Panama Canal. The expected gains, however, are subject to the uncertainties of comparative pricing and the reliability of routing options, as well as to the capacity of the inland rail corridors. Nonetheless, the inland shift of the line of cost equivalence remains a reasonable assumption.

The stakeholders of the North American land-bridge—mostly the rail companies—have been gearing up for the competition by making infrastructure

investments, such as building inland terminals, and by developing high-capacity corridors, which could significantly influence the routing options. Many infrastructure expansion projects along the East and Gulf Coasts are planned or are in progress, with the express purpose of accommodating increased shipments after the Panama Canal expansion (see sidebar, page 10).

Differing Perspectives

The expected benefits or drawbacks of the Panama Canal expansion depend on geography. For the East and Gulf Coast ports, the expansion of the Panama Canal is an opportunity to increase cargo volumes and attract a greater share of the transpacific trade, the dominant factor in the growth of container transportation.

From the perspective of the West Coast ports, the expansion of the Panama Canal may threaten the hinterland market share, particularly to the Midwest. How much of the cargo handled by the West Coast may be divertible to other maritime ranges is uncertain; some estimate that 25 percent of the intermodal cargo could change routes.

Nevertheless, Pacific Asia remains the fundamental market of the West Coast; the cost structure would have to change significantly to have an impact. Therefore, the expectations that East Coast ports will gain significant new market opportunities after the Panama Canal expansion may be exaggerated.

The Transshipment Question

In recent years, an active transshipment market has emerged in Panama and the Caribbean. After the expansion, large container ships passing through the Panama Canal carrying cargo between Asia and East Coast ports may proceed directly to the East Coast ports or may transship the containers at a hub in Panama or in other Caribbean ports.

Caribbean ports are gearing up for a bigger transshipment market and are investing to accommodate 10,000- to 15,000-TEU vessels. The growth in the Caribbean transshipment activities will affect economic growth throughout Latin America, because the ports are located at an intersection of transatlantic and north-south trade flows; shippers will see an opportunity to reconcile the inbound and outbound trade flows within their shipping networks. The advantages of network interconnectivity and improved use of ship assets will outweigh the additional handling costs of transshipments.

Contrary to the expectations at most North American ports, the Panama Canal expansion is likely to have a greater impact on the transshipment of con-

tainerized cargo. At the global level, only 17 percent of commerce involves direct connections between ports; transshipment is fundamental to maritime shipping networks and is likely to increase in scale and scope after the expansion.

New Panama, New Panamax

The expansion of the Panama Canal comes amid unique developments and uncertainties in world trade—the major drivers of trade, such as American import-based consumption, are being questioned, and new trade relations are not firmly established. Nevertheless, South America offers the potential for additional volumes and for transshipments, which previously had played only a limited role in canal activities.

The expansion presents Panama with the opportunity to position itself as a hub at the interface of longitudinal and latitudinal trade flows and to gain international significance and influence in the process. This positioning may stimulate increases in transshipments and may introduce some diseconomies through congestion at ports and on roads and railways.

New Panamax ships of 12,500 TEUs transiting the expanded canal and calling on Panama's ports are likely to establish different service configurations and different forms of freight distribution within the region. The scale, nature, and function of the logistics platform remain to be seen. Clearly, Panama is no longer a location through which ships are transiting but is transforming into a hub of the global transport system.



PHOTO COURTESY OF THE PANAMA CANAL AUTHORITY

Work under way on the Panama Canal expansion, with the goal of opening in 2016.

A Major Change or a Necessary Adjustment?

SCOTT BROTEMARKLE

In January 2014, to commemorate the 100th anniversary of the Panama Canal, the Transportation Research Board (TRB) conducted a day-long workshop, One Hundred Years of the Panama Canal: Legacy and Future. The workshop reviewed the canal's historic influence and examined the potential effects of the pending expansion on world trade. Speakers discussed the logistical, commercial, financial, and economic influences and impacts of the canal.

In the opening session on History and Legacy, Joseph L. Schofer of Northwestern University presented a keynote address covering the history of the canal in terms of the four main problem areas encountered in the megaproject's management and engineering: the health environment and conditions; the design decisions; the tools and technology; and the methods for solving the transportation problems.

The session then turned to remarks by Joe R. Reeder and Jorge E. Ritter, both of whom were instrumental in the canal's 1999 transition of ownership. Reeder chaired the U.S. Panama Canal Commission and Ritter served as Panama's Minister for Canal Affairs.

The remainder of the workshop focused on the projected impacts of the canal's expansion on global economics, trade route competition, infrastructure, and supply chains. Officials from the Panama Canal Authority, the U.S. Maritime Administration, and public- and private-sector organizations, along with distinguished academicians, presented perspectives on how the expansion already is influencing multimodal infrastructure investments, public policy decisions, and the business plans of supply chain stakeholders. Some saw the expansion as a game-changer for global goods movement, and others maintained that the expansion was only a matter of keeping pace with world shipping trends in the 21st century.

Panelists from all sectors raised more questions than answers. Representatives from rail and ocean carriers emphasized total logistics costs, toll rates, fuel costs, and speed as factors influencing a shift to all-water service via the expanded Panama Canal to the U.S. East and Gulf Coasts.

Public-sector stewards and policy decision makers discussed U.S. sea-port and hinterland infrastructure needs and examined the degree to which federal, state, and regional governments should invest in freight capacity to realize the direct and indirect economic benefits of the potential trade opportunities from the canal's expansion.

The final panel noted that the routing decisions of shippers will depend on the cost and logistics factors to be revealed when the new locks open in 2016. The shippers' response ultimately will determine the degree of the shift in world trade patterns.

Presentations from the workshop are available on the TRB Annual Meeting Online website, <http://amonline.trb.org/>.

The author is TRB Marine and Intermodal Freight Specialist and Staff Director of the Marine Board.



Photo: Reson Photography

U.S. Maritime Administrator Paul (Chip) Jaenichen delivered a keynote address at a 2014 workshop dedicated to the history of the Panama Canal, "One Hundred Years of the Panama Canal: Legacy and Future."

Impacts of the Panama Canal Expansion on U.S. Infrastructure

JEAN-PAUL RODRIGUE AND THEO NOTTEBOOM

When the expansion of the Panama Canal was announced in 2007, decision makers at most of the U.S. East and Gulf Coast ports started to consider their facilities' readiness to accommodate the expected larger ships. Many concluded that their current infrastructure capacity and performance would place them at a competitive disadvantage.

These assessments have spurred the design, planning, and implementation of a variety of projects to improve port infrastructure. The projects fall into three main categories; channel clearance, port infrastructure, and hinterland access (see Table 1, page 11).

Channel Clearance

Channel and harbor clearance mostly involve dredging projects to accommodate larger ships with wider and deeper channels. Wherever possible, the dredging aims to reach a reference depth of 50 feet, to match the draft of the expanded Panama Canal. Dredging is the infrastructure project most directly associated with the canal expansion, because most East and Gulf Coast ports are Panamax ports and accommodate drafts of approximately 42 feet.

The U.S. Army Corps of Engineers is responsible for dredging; as a result, ports have engaged in intense competition and lobbying to secure the funding for dredging projects. Several of the largest port authorities were able to secure sufficient funding, but many have had to raise additional sums. Nevertheless, many of the dredging projects have no specific timeline, reflecting the uncertainty of public funding. In other nations, the port author-

ities assume responsibility for the task and risks of dredging; having a federal agency in charge creates controversy.

Port Infrastructure

The projects to upgrade port infrastructure include installation of super-post-Panamax cranes, improved piers, and yard equipment for larger containerships of 10,000 TEU. Ports with a 50-foot draft have invested in new cranes to service the ships.

The expected growth in the cargo to be handled, as well as in container volumes per port call, has incited terminal improvement projects, including purchase of new yard equipment, expansion of storage space, investment in information technologies, and improvements in gate operations.

Some piers were expanded and strengthened to accommodate the longer ships. Nevertheless, attributing port infrastructure projects to the Panama Canal expansion is not always straightforward—many of the projects may be standard improvements or planned maintenance that would have occurred without the expansion.

Hinterland Access

Infrastructure improvements for hinterland access include better road and rail connections, as well as new or improved intermodal yards. The two Class 1 rail operators on the East Coast have launched the most salient rail corridor initiatives—the CSX National Gateway Project and Norfolk Southern's Heartland Corridor project are direct improvements to the hinterland access of the East and Gulf Coast ports, offering more efficient double-stacking services and intermodal yards.

These projects, however, represent market-servicing strategies that are justifiable without the Panama Canal expansion. Nevertheless, the expansion has provided a context for presenting and justifying many of these infrastructure projects.

Driving the Investments

Since 2009, the Transportation Investments Generating Economic Recovery—or TIGER—program has funded port infrastructure developments, such as pier upgrades and the construction of intermodal rail facilities. Between 2009 and 2014, the federal government allocated approximately \$320 million for port-related projects along the East and Gulf Coasts.

For most of these port-related infrastructure investments, whether planned, under way, or completed, the Panama Canal expansion was part of the discourse. The expansion clearly has served as a driver for many East and Gulf Coast ports to improve their infrastructure to a post-Panamax standard for port access and operations. Which of these investments will prove speculative depends on the canal expansion's impact on port calls and traffic volumes.



PHOTO: VINCE ELIAS, U.S. ARMY CORPS OF ENGINEERS

The dredge New York on the Port Jersey Channel in New Jersey. The U.S. Army Corps of Engineers' New York District is dredging shipping channels at the New York–New Jersey Harbor to accommodate larger post-Panamax vessels.

TABLE 1 Main East and Gulf Coast Port Infrastructure Developments Associated with Expansion of the Panama Canal

Port	Channel Clearance	Port Infrastructure	Hinterland Access
Boston, Massachusetts	Plans to dredge the channel depth from 40 to 48 feet under study (no specific timeline)		
New York	Harbor channels dredged to 50 feet (completed in 2014); clearance improvements to the Bayonne Bridge (to be completed in 2017)	Expansion of Global Terminal (completed in 2014)	ExpressRail improvements (South Hudson Intermodal Facility); Crescent Corridor (CSX)
Philadelphia, Pennsylvania	Plans to dredge the Delaware River channel from 40 to 45 feet (to be completed in 2017)		
Baltimore, Maryland	No plans (currently at 50 feet)	Four super-post-Panamax cranes installed at Seagirt Marine Terminal (completed in 2013)	National Gateway Project (CSX)
Hampton Roads, Virginia	Discussions to dredge from the current draft of 50 feet to 55 feet (no specific timeline)	Craney Island Eastward Expansion project	National Gateway Project (CSX); Heartland Corridor (Norfolk Southern)
Wilmington, North Carolina	Plans to dredge the port channel from 42 to 44 feet (to start in 2019).		National Gateway Project (CSX)
Charleston, South Carolina	Plans to dredge the port channel from 45 to 52 feet (to be completed in 2018 or 2019)		
Savannah, Georgia	Plans to dredge the port channel from 42 to 47 feet (to be completed in 2016)		
Jacksonville, Florida	Plans to dredge from the current draft of 40 to 47 feet (expected to start in 2016, subject to funding)	New container facility at Dames Point (opened in 2009)	Intermodal Container Transfer Facility (CSX; to be completed in 2015)
Miami, Florida	Harbor channel dredged from 42 to 50 feet (completed in 2014)	Seven super-post-Panamax cranes (installed in 2013)	PortMiami Tunnel (completed in 2014); PortMiami–Florida East Coast Railway connection (completed in 2014)
Mobile, Alabama	Plans to dredge harbor channel from 45 to 50 feet (no timeline specified)		Plans for intermodal rail terminal adjacent to port (no specific timeline)
New Orleans, Louisiana	Plans to dredge harbor channel from 45 to 50 feet (no timeline specified)	New Louisiana International Gulf Transfer Terminal (no specific timeline)	Crescent Corridor (CSX)
Houston, Texas	Plans to dredge access channels to main container terminals from 40 to 45 feet (to be completed in 2016)	Bayport and Barbour Cuts terminal improvements	

SOURCE: Websites and press releases of port authorities.

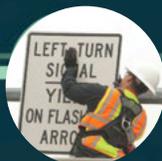
PHOTO: PORTMIAMI TUNNEL



Entrance to the PortMiami Tunnel, which connects Miami's MacArthur Causeway to Dodge Island.

Findings from the Transportation Research Board's
2014 State Partnership Visits Program

TRENDSETTERS IN TRANSPORTATION TECHNOLOGIES



Specialists in the Transportation Research Board's (TRB's) Technical Activities Division identify current issues, collect and generate information on the issues, and disseminate the information throughout the transportation community. The TRB Annual Meeting, TRB-sponsored conferences and workshops, webinars, standing committee meetings and communications, publications, and contact with hundreds of organizations and thousands of individuals provide TRB staff with information from the public and private sectors on all modes of transportation.

A major source of this information is the TRB annual state partnership visits program. Transportation professionals on the TRB staff meet on site with representatives of state departments of transportation (DOTs) and with representatives of universities, transit and other transportation agencies, and industry. In addition, TRB staff is involved with planning and delivering conferences, workshops, webinars, and meetings. This report summarizes what the TRB staff learned from visits and activities during the past year.

PHOTO: SEATTLE DEPARTMENT OF TRANSPORTATION



The lobby of the Municipal Tower in Seattle, Washington, contains the TransitScreen display, a real-time schedule of nearby transit options.

U.S. transportation agencies are accelerating the deployment of new and advanced technologies to improve operations and services to customers. These deployments cover a range of responsibilities and modes. Examples include the following:

- ◆ Enhancing performance management and asset management with innovative data collection and management tools to achieve strategic goals;
- ◆ Tapping the Global Positioning System (GPS)

and other technologies to test the feasibility of new financing options such as mileage-based user fees;

- ◆ Merging key databases to build knowledge and information management systems;
- ◆ Increasing the use of recycled materials for highway construction and maintenance;
- ◆ Applying remote sensing to improve imagery and to reduce response time to natural disasters;
- ◆ Deploying innovative data collection technologies to integrate data across all modes;
- ◆ Preparing for connected-automated vehicles, shared ride services, and unmanned aerial systems—including development of new laws and regulations;
- ◆ Harnessing new technologies to improve and manage truck parking;
- ◆ Providing long-life pavement with continuously reinforced concrete, roller-compacted concrete, and other advances in concrete technologies to accommodate heavy traffic loadings, such as those related to the domestic energy boom;
- ◆ Collecting information for rock slope evaluations with remote sensing technologies;
- ◆ Improving highway safety by implementing the data-driven tools specified in the *Highway Safety Manual*; and
- ◆ Supplying applications for customers to view the real-time performance of transportation modes and services.

As the following reports show, state DOTs and other transportation organizations are working to ensure a high return on investment from limited resources by deploying advanced technologies and implementing innovative solutions to transportation problems.

PHOTO: U.S. GEOLOGICAL SURVEY



The U.S. Geological Survey's Spider tool uses remote sensing technology to survey rock slopes safely.

PHOTO: SCOTT L. FICKER



Taxi drivers protest the city of Chicago, Illinois, granting a license in May 2014 to ridesharing company Uber, which relies on smartphone apps.

Institutional Issues

Policy, Management, and Leadership

State transportation agencies increasingly are applying technology to achieve strategic and policy goals in a variety of areas—asset management and performance measures are common themes. North Dakota DOT, for example, is implementing a new strategic plan that provides detailed objectives, goals, and baseline performance targets at the department and division levels.

California DOT (Caltrans) is approaching the challenge of data needs from several perspectives. The agency's Division of Research, Innovation, and System Information developed a strategic plan through 2016 for information and knowledge management, now in implementation. Caltrans is working to develop the information technology architecture for such tasks as merging key databases and recording assets via light detection and ranging (lidar) technology, to achieve the accurate transfer of data from design to construction to maintenance. Caltrans also is working to implement a pilot program to evaluate mileage-based user fees within the state's road network.

Planning

Planning agencies are working to leverage a range of technologies to improve transportation infrastructure, traveler information, and data collection. For example, the Vermont Agency of Transportation is gathering and centralizing information about transit service across the state. The database will augment the Google transit trip planning service offered by three transit agencies.



PHOTO: CALTRANS

The California Department of Transportation deploys its Mobile Terrestrial Laser Scanning Vehicle to gather surface data to support its information and knowledge management strategic plan.



PHOTO: CALEB KENNA PHOTOGRAPHY

The website for Addison County Transit Resources in Vermont offers Google transit trip planning capability for users.

The Vermont Agency of Transportation also is working with other state organizations to promote electric transportation. Drive Electric Vermont provides educational outreach to municipalities, developers, business owners, and the driving public.

Illinois DOT is researching recycled materials in many settings and is using more recycled materials in highway construction and maintenance. Illinois DOT has revised specifications, policies, and procedures, resulting in a fourfold increase in tons of recycled materials per mile from 2009 to 2013.

Working with U.S. DOT, many state DOTs are exploring remote sensing technologies to improve imagery and to decrease response time to natural disasters. The additional and timely information can make the response safer and can help in coordinating the response and the data collection by local and state agencies.

Legal Issues

Alternative methods of project delivery, jurisdictional differences in the procurement authority for each method, and the effective resolution of disputes under these methods are pressing issues in construction contract law. Issues that receive routine treatment under typical project delivery sometimes present special challenges in the context of alternative project delivery—for example, satisfying disadvantaged business enterprise requirements and delays of claims.

Public-private partnerships (P3s) present the most challenging issues, because funding is involved. The increased consideration of P3 projects may be a result of the high cost of projects and the unpredictability of federal and state funding. P3 initiatives, as well as new tolling systems, are under active development, and tax alternatives, such as mileage-based user fees, are attracting interest.

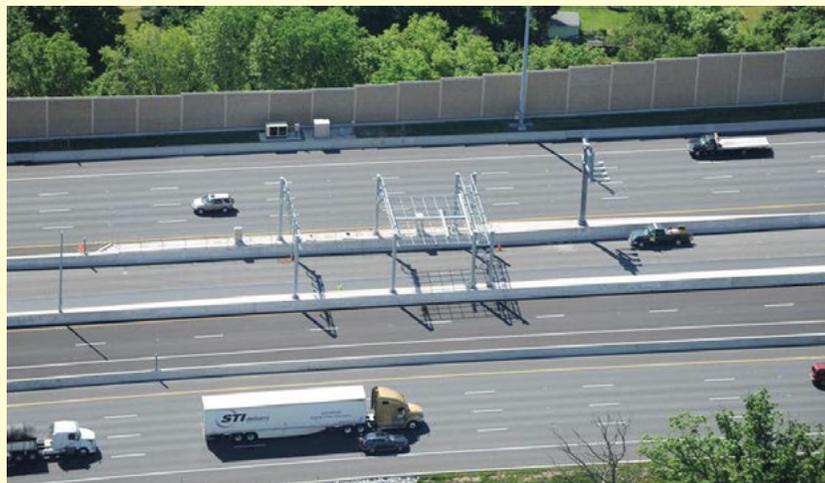
The Federal Highway Administration (FHWA) has devoted considerable attention to implementing provisions in the Moving Ahead for Progress in the 21st Century Act (MAP-21) on environmental reviews for highway and transit projects. The key provisions address the following:

- ◆ Categorical exclusions that apply to operational right-of-way and to projects receiving limited financial assistance;
- ◆ The designation of new categorical exclusions and a reduction in the evaluation and documentation requirements for several other categorical exclusions;
- ◆ The use of planning decisions and studies in National Environmental Policy Act reviews; and
- ◆ Revised procedures for federal decision making and dispute resolution.

Environment, Energy, and Climate Change

Environmental managers are working to communicate the needs for environmental regulatory compliance on design-build projects. One state official explained: “The failure to meet regulatory requirements will be the downfall of design-build.”

PHOTO: JOHN WARD, I-95 EXPRESS TOLL LANES



States are continuing to struggle with increasingly strict stormwater management regulations, particularly for the use and safe storage of sodium chloride for deicing applications.

States are devoting more efforts to climate change adaptation plans and to long-term infrastructure investments. With state budgets decreasing, the plans are analyzing the repair or rebuilding of storm-ravaged roads, as well as the benefits of new technologies.

Other issues include the maintenance of oil and gas industry roads; roadway dust suppression techniques to minimize the impacts on air quality; managing roads that are deemed historic; and improving the alternative fuel infrastructure to increase public use and environmental benefits.

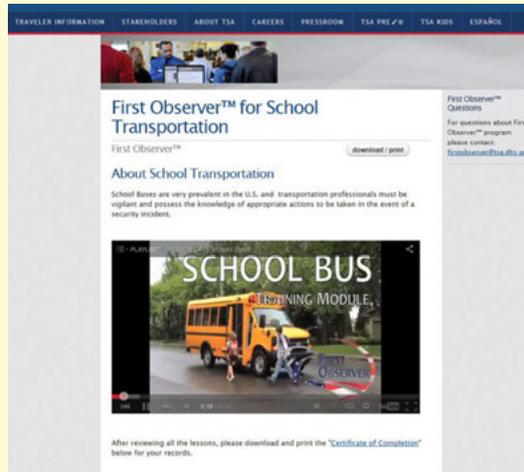
High-occupancy toll lanes on I-95 in Maryland, the product of a public-private partnership, opened in December 2014.

PHOTO: LARRY CARUSO, PHOTO EDITOR, NEWS-HERALD



A salt truck applies deicing material before a storm in Wayne County, Michigan. Strict stormwater regulations have caused state DOTs to examine deicing applications that use sodium chloride.

The Transportation Security Administration's First Observer training program features modules for highway-related transportation professions.



Critical Infrastructure Protection and Security

States are recognizing the role of security and all-hazards emergency management in resilient transportation systems. In October 2014, the American Association of State Highway and Transportation Officials' (AASHTO's) Special Committee on Transportation Security and Emergency Management (SCOTSEM) held a National Peer-to-Peer Exchange and Best Practices Summit addressing resilience, emergency air operations, hazardous materials transportation, rail shipments of crude oil, and the national strategy for transportation security.

At the federal level, the Transportation Security Administration (TSA) released a training program, First Observer, for safeguarding national transportation systems against terrorism and other threats. With modules for all categories of highway-centric transportation occupations, the program focuses on

how to observe, assess, and report suspicious individuals, vehicles, packages, and objects and to communicate the information clearly via appropriate channels.

Cybersecurity remains a high priority within all parts of the transportation system. In June 2014, the Government Accountability Office released a report, *DHS Needs to Better Address Port Cybersecurity*, urging the U.S. Coast Guard to develop and undertake a comprehensive risk assessment of cyberrelated threats, vulnerabilities, and consequences in the maritime environment. The report also identifies shortcomings in information-sharing mechanisms between government entities and nonfederal stakeholders.

Data and Information Technologies

With active transportation on the increase, states are implementing data collection to determine the extent of bicycle and pedestrian activity, to adjust programs and support investments. Pennsylvania DOT has been working with the Delaware Valley Regional Planning Commission, the Philadelphia metropolitan planning organization, to implement innovative collection technologies and to integrate the data into the general traffic database. North Carolina is developing a statewide program for collecting data on nonmotorized transportation.

Understanding and communicating how transportation systems support state economies is fundamental in public relations. Market-oriented data can inform system decisions by indicating the function and value of a link. States like Iowa are working with freight flow information to understand the trans-

North Carolina State University's Institute for Transportation Research and Education team members Kristy Jackson and Chris Cunningham wire the loop for a permanently installed bicycle counter on 4th Street in downtown Winston-Salem. The state is developing a data collection program for nonmotorized transportation.

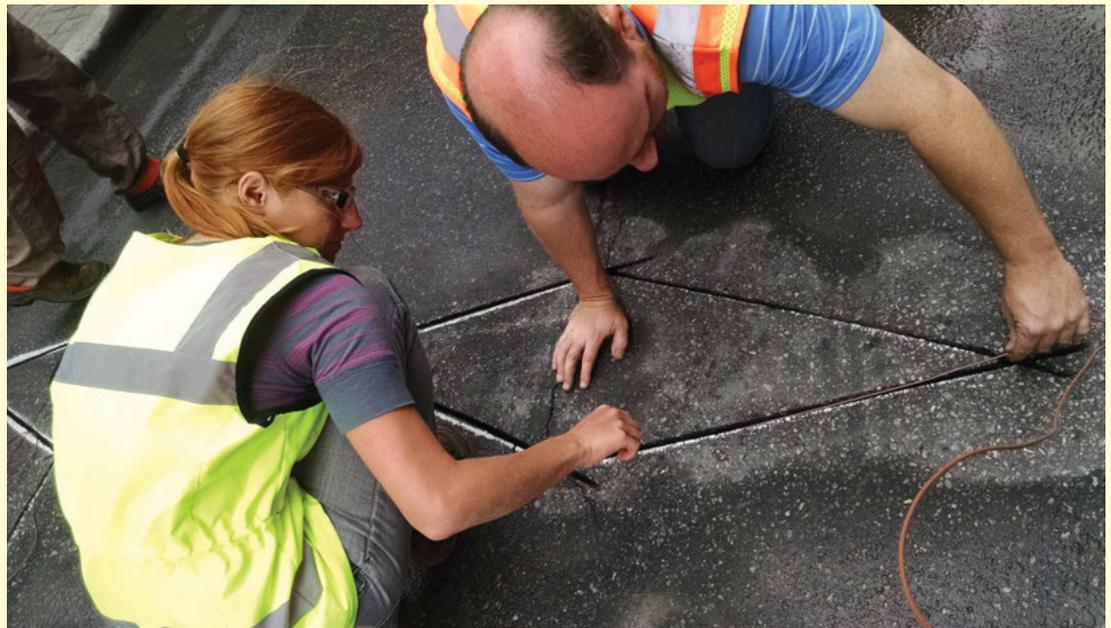


PHOTO: ELIZABETH STOLZ, SPRINKLE CONSULTING

PHOTO: VIRGIN GALACTIC/GETTY IMAGES



portation infrastructure needs of the business community. States are looking forward to the release of the national freight transportation dataset from the 2012 Commodity Flow Survey.

State investments in data as an asset require an understanding of the data's use and quality. Alaska and Minnesota have engaged in business planning for data.

With enterprise systems supporting multiple customers within a state, management of data resources has gained importance, and many states are implementing data governance initiatives. Michigan DOT, for example, has a chief data steward, who works closely with other state departments on information technology, data, and geographic information systems. The Michigan Center for Shared Solutions, which "promotes technology-driven solutions across all levels of government," is a key partner. A National Cooperative Highway Research Program (NCHRP) project is preparing a data self-assessment guide for state DOTs.¹

Aviation

The Federal Aviation Administration (FAA) is drafting regulations to integrate unmanned aerial systems—also known as remotely piloted aircraft—into domestic airspace. Major questions loom for state aviation agencies, however, including their roles in monitoring and managing the activities.

Also at the forefront of discussions are ways to reduce general aviation accident rates, followed by reactions to the disappearance of a commercial aircraft in international airspace and to the airliner shot down over an active war zone. Additional issues include an application by an international carrier to operate within the United States, which would affect

long-standing cabotage laws; development of commercial spaceports to meet increasing demands from commercial space industries; and analyses of current and new funding mechanisms as FAA reauthorization nears.

Freight Systems

States are increasing the connectivity and capacity of their freight systems to bolster economic development. In September, Ohio DOT sponsored the Ohio Conference on Freight, highlighting the state's strategic importance in global logistics. Ohio DOT and the Ohio Rail Development Commission have supported the Norfolk Southern Heartland Corridor and the CSX National Gateway Corridor projects. Ohio DOT also has prioritized Interstate and highway connector improvement projects near the intermodal terminals associated with the major trade corridors connecting East Coast seaports with the Midwest and beyond.

Innovative programs at Maine DOT are providing incentives for multimodal freight. Maine DOT's Industrial Rail Access Program provides for \$2 million in state funds and a maximum cost-share of 50 percent for projects that encourage economic development through industrial rail access. Maine Port

Virgin Galactic spacecraft docked in the bay at Spaceport America in New Mexico. Commercial spaceports are responding to a growing interest in commercial space aviation.

Rendering of a containerized articulated tug barge—the first of its kind in the United States; the barge is being developed under the New England Marine Highway Project.

IMAGE: MAINE PORT AUTHORITY



¹ NCHRP Project 8-92, Implementing a Transportation Agency Data Self-Assessment. <http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3399>.



PHOTO: PAUL SULLIVAN, FLICKR

New hours-of-service rules for truck drivers have increased overnight parking demand at highway rest areas.

Authority, in partnership with McAllister Towing and the U.S. Maritime Administration, has designed the first U.S. containerized articulated tug barge. The purpose-built coastal vessel will support future container-on-barge service between Portland, Maine, and Newark, New Jersey.

The Federal Motor Carrier Safety Administration's new rules for truck driver hours of service have increased the demand for overnight truck parking. Many state DOTs are trying to manage truck parking with new technology that provides commercial vehicle operators with information about the availability of parking at rest areas and weigh stations.

Highways

Design

Stormwater management is a significant and challenging topic for state DOTs and other transportation agencies. Adequate consideration of stormwater at the project development stages is key.

In addition, erosion and sediment controls have become a national focus for the construction industry. National and state environmentalists have emphasized the need to reduce the amount of sediment-laden stormwater runoff that discharges into local waterways from construction sites.

In Alabama, Auburn University's Department of Civil Engineering teamed with the state DOT to establish the Auburn University Erosion and Sediment Control Testing Facility at the National Center for Asphalt Technology Test Facility in Opelika. The facility was designed and constructed to assist Alabama DOT meet environmental commitments to protect state waterways from polluted stormwater runoff from construction sites.

By adopting the tested and improved practices in Alabama DOT's standard specifications, designers and contractors can minimize the environmental impacts of sediment-laden stormwater. Researchers aim to improve the effectiveness of erosion and sediment control practices in the field and to develop new treatment techniques.

With funding challenges for replacing and preserving aging infrastructure, Rhode Island and Indiana DOTs are renewing emphasis on constructability reviews in the development and design processes. The reviews can reduce risk, protect limited funds, and improve projects.

Construction and Materials

State transportation agencies continue to explore alternative project delivery systems. Alliance contracting is a potential addition to the toolbox. An NCHRP synthesis project is expected to provide more information on this highly collaborative approach, not yet in use in the United States.²

State DOTs have concerns about setting contract goals for disadvantaged business enterprises and

² NCHRP Synthesis 20-5, Topic 45-16, Alliance Contracting: Evolving Alternative Project Delivery, <http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3598>.



PHOTO: D. ALLEN COVER, VIRGINIA DOT

Virginia DOT employees set a precast concrete beam for the Route 360 Bridges project.

monitoring compliance on design-build and other alternative delivery projects. An ongoing NCHRP synthesis project is reviewing these issues.³

Several states have renewed interest in continuously reinforced concrete pavement for long-life service under heavy traffic loadings and in harsh environmental conditions. Roller-compacted concrete is also drawing interest and is under consideration in Texas and Louisiana for reconstructing low-volume roads affected by energy development.

Precast concrete pavement technology is gaining acceptance for rapid repair and rehabilitation of concrete pavements, as well as for heavily trafficked asphalt concrete pavements and intersections. Several agencies have used this technology in a variety of applications.

Some states are using concrete overlays to extend the service life of pavements. The use of self-consolidating concrete in precast, prestressed bridge elements has increased. An NCHRP project is developing guidelines for the use of self-consolidating concrete in cast-in-place highway bridge components.⁴ Florida has experimented with self-consolidating concrete in the accelerated replacement of pavement slabs.

State agencies are supportive of recycling and sustainability in materials and construction; however, many are seeking a comfort level in using greater amounts of reclaimed materials without sacrificing performance. NCHRP projects are addressing these concerns.⁵

Geotechnical Engineering

Increased precipitation in several regions has triggered geologic hazards such as landslides, debris flows, and rockfalls along transportation corridors. Washington, California, North Dakota, Wyoming, and Maryland are among the states that experienced landslides or rockfalls. The March 2014 mudslide on State Route 530, near Oso, north of Seattle, Washington, claimed the lives of more than 40 residents.

Maryland joined the large number of states assembling slope inventory systems to monitor hazards proactively. Several state DOTs are using remote sensing technologies to collect information for rock slope evaluations.

Sink holes are another natural hazard emerging as a concern along transportation corridors, partic-

³ NCHRP Synthesis 20-5, Topic 45-3, Current Practices to Set a Disadvantaged Business Enterprises Goal on Design-Build Projects, <http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3580>.

⁴ NCHRP Project 18-16, Self-Consolidating Concrete for Cast-in-Place Bridge Components, <http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2978>.

⁵ www.trb.org/NCHRP/NCHRP.aspx.

Photo: Washington State DOT



ularly in areas with carbonate bedrock, known as karst terrains.

More than a dozen states have plans to adopt AASHTO's specification for the intelligent compaction of soils, and more than two dozen states held workshops for practitioners on this emerging technology.

Florida, North Carolina, and Virginia have tested a new dynamic embedded data collector developed in Florida for monitoring pile installations and have shared their experiences to facilitate adoption of the method by other states. The method promises improvements in worker safety and in the quality of the installation.

Operations

The rapid development of automated and connected vehicle technologies has caught the attention of media, the public, and many state DOTs. These advanced technologies are expected to yield the next major breakthroughs in improved operations and safety. Federal and state agencies, the automobile industry, and other private-sector partners are researching the effectiveness and feasibility of these advanced vehicle technologies.



Washington State DOT crews direct traffic after a landslide sheared off part of US-20. Many state DOTs had to contend with rockfall and landslide events caused by heavier-than-normal precipitation in 2014.

Emergency and highway personnel respond to a pavement collapse on East 26th Street in Baltimore, Maryland. The landslide, caused by heavy spring rains and a weak retaining wall, extended the length of a city block and swallowed multiple trees and parked cars.

A diverging diamond interchange on US-15 in Louisa, Virginia, was designed to accommodate increased traffic exiting I-64.



In preparation for automated driving, a few states have enacted legislation allowing the operation of autonomous vehicles on roadways, and others are contemplating similar legislation. Variations in state legislation, however, can lead to conflicting regulations, which could slow the pace of testing and deployment.

To improve traffic operations and reduce crashes at intersections and interchanges, agencies have explored a range of new configurations shown to be successful. These include diverging diamond interchanges, continuous flow intersections, superstreets, Michigan lefts, J-turns, and others. Utah DOT has implemented most of these designs successfully in

the Salt Lake City area.

Incident management programs, designed to restore normal traffic operations as quickly as possible, to reduce the impacts for road users and to improve safety, have lacked training programs for responders. Tennessee DOT and the Tennessee Department of Safety and Homeland Security recently opened the Tennessee Traffic Incident Management Training Facility, the first of its kind in the United States, to teach best practices for the safe, quick clearance of major highway incidents. The facility features a section of Interstate-like roadway, ranging from two to six lanes, with a guardrail, a two-way interchange, and cable and steel barrier rail, as well as a section of two-lane highway and a full four-way intersection, for simulating a variety of crashes to train emergency responders in safe and efficient clearance techniques.

The Tennessee Traffic Incident Management Training Facility in Nashville, which opened in 2014, features a variety of roadways for training exercises, from an Interstate-like segment to a four-way intersection.



Infrastructure Preservation

State DOTs are updating their maintenance management systems in preparation for the maintenance-related performance measures for pavement and bridge assets under MAP-21. The volume of the data to be collected is expected to increase, and state DOTs are working on tools to transform the data into useful information. Agencies are deploying more structural health monitoring systems; tablet-based, 3-D, wireless bridge inspection systems; remote technology for monitoring highway assets; simulation-based winter maintenance training; and processes to integrate the data from the variety of management systems.

Transportation agencies are exploring tools for managing nonpavement and bridge assets. The collection of condition information on these assets historically has relied on manual inspection, which is costly and time consuming. Michigan DOT compared manual data collection with aerial lidar and mobile, high-resolution photo imaging for 27 highway assets. The test indicated that remote monitoring technologies could reduce agency costs for data collection on nonpavement and bridge assets by 50 percent to 70 percent.

PHOTO: TIM GROZE, MICHIGAN DOT



A Michigan DOT pilot project tested remote sensing technologies to monitor highway assets. With asset extraction software, users can zoom in on multiple points in a single image.

Safety

The United States has experienced a steady decline in the number of highway fatalities since 2005, with a dramatic decrease beginning in 2007. Nevertheless, highway fatalities and serious injuries remain a significant threat to public health, and transportation agencies are finding it increasingly difficult to continue the downward trend.

MAP-21 requires a focus on safety performance targets. Transportation agencies are making use of data-driven tools such as the *Highway Safety Manual*,⁶ the *Human Factors Guidelines for Road Systems*,⁷ and the Federal Highway Administration's Systemic Safety Project Selection Tool,⁸ and are increasing focus on local and rural roads and on safety culture for further reductions in fatalities and serious injuries.

⁶ www.highwaysafetymanual.org/Pages/default.aspx.
⁷ NCHRP Report 600, www.trb.org/Main/Blurbs/167909.aspx.
⁸ <http://safety.fhwa.dot.gov/systemic/fhwsa13019/>.

Connecticut is exploring education and enforcement strategies that have the greatest potential to improve pedestrian and bicycle safety, targeting drivers as well as pedestrians and bicyclists, and is increasing attention on distracted driving and drugged driving. The state is developing a master plan examining input requirements and implementation approaches in the *Highway Safety Manual* for infrastructure improvements.

Oklahoma also is addressing impaired driving by establishing five regional teams for the prevention of driving under the influence, as well as offering incentives for ignition interlocks and focusing more on impairment with prescription and over-the-counter drugs. Other targeted safety efforts include installing rumble strips in work zones to reduce fatalities and serious injuries for workers and motorists.

Ports and Waterways

A rebounding economy and changes in international

PHOTO: PEDESTRIAN AND BICYCLE INFORMATION CENTER



A crosswalk and in-street yield sign in Branford, Connecticut. Pedestrian and bicycle safety initiatives are under way in Connecticut and other states.

Photo: Tim Boyle, U.S. Army Corps of Engineers



A Great Lakes Dredge and Dock Company hopper dredge works to remove approximately 400,000 cubic yards of material from the Delaware River near Philadelphia, Pennsylvania. Larger vessel sizes have required many infrastructure upgrades at ports and inland waterways.

shipping practices are creating a complex mix of problems leading to extraordinary delays at some of the largest U.S. ports. The operational issues include larger ship sizes; vessel bunching caused by cascading schedule slippages on liner service routes; carrier coordination at terminals; and truck and chassis availability. These issues, coupled with a drop in productivity during labor contract negotiations, delayed peak season shipments from West Coast trade gateways to retailers by up to two weeks in 2014.

States and seaports lauded the passage of the Water Resources Reform and Development Act, which authorized more than \$8 billion in navigation projects on U.S. waterways. Seaports commended the legislation for increasing the yearly authorization levels of the Harbor Maintenance Trust Fund, which supports channel maintenance dredging projects, with the goal of achieving full use of the funds by 2025. In recent years, only 50 percent of the \$1.8 billion in collected funds has been appropriated for federal navigation channel maintenance.

Inland waterways were affected by a change in the cost-share formula for the Olmsted Locks and Dam project on the Ohio River. This project has absorbed most of the Inland Waterways Trust Fund in recent

years and has prevented the funding and postponed the schedules for other lock and dam infrastructure needs in the United States. The change will free up more than \$100 million annually for other critical inland system projects.

Rail

Passenger Rail

Although Amtrak again set ridership and revenue records in Fiscal Year 2014, the growth rate was slower than in previous years. An unusually harsh winter and delays caused by freight train congestion were among the factors slowing growth.

In the Northeast Corridor, ridership between Washington, D.C., and Boston, Massachusetts, rose by more than 3 percent, to set a new record, and revenue grew by a robust 8.2 percent. Amtrak continues to be the nonautomobile mode of choice in the Northeast, carrying three times the number of riders as all airlines combined between Washington, D.C., and New York City.

Eighteen states provide funding to Amtrak for passenger service on more than 15 corridors, five of which carry more than 1 million riders annually. Six of these corridor services set ridership records in 2014.

Freight Rail

The shipment of intermodal containers, which overtook intermodal trailer shipments in the early 1990s, now outnumbers trailer shipments by more than 8 to 1. The movement of domestic intermodal freight surpassed international container movements for the first time in 2014.



Photo: Ryan Staveland, Fluor

A MARC train in Odenton, Maryland. Demand has risen for rail passenger services in the Northeast Corridor; Amtrak experienced a 3 percent increase.



A “hackathon” hosted by the New York Metropolitan Transportation Authority in 2013 encouraged young developers to create innovative transit applications using Google Transit Feed Specifications.

The growth of intermodal freight, particularly domestic intermodal, has contributed to the unprecedented financial performance of the U.S. freight rail industry in recent years. Along with this intermodal growth, energy-related freight shipments have helped to offset the decline in coal movements.

This growth, however, comes at the price of increased congestion. Despite increased hiring and capital expenditures, the shortages of track capacity, manpower, and equipment continue to cause delays in rail freight shipments.

Public Transportation

Technology is having a profound effect on public transportation, from services to operations and maintenance. Real-time service information is increasingly available online and on smart mobile device applications. Google Transit Feed Specifications, for example, provide data on transit routes and schedules in an interactive, mapped format on agency websites and mobile applications.

Agencies such as the San Francisco Bay Area’s Metropolitan Transportation Commission are supplying sophisticated apps that enable customers to see the real-time performance of a variety of transportation modes and services to reach their destinations, from walking to transit to parking. Other innovations include coordinated fare collection among multiple service providers and using smart card data to inform operations planning and analysis.

Services are undergoing profound changes. The willingness of the millennial generation to share information also extends to rides. Shared-ride service providers such as Uber, Lyft, and Carma are appearing in cities throughout the United States and around the world, demonstrating a willingness to share car rides if the price and convenience are acceptable.

These market innovators are challenging long-

standing industries such as taxis, paratransit, and shuttle services to be more inventive and responsive to remain competitive and viable. At the same time, regulators are looking to protect the safety, security, and quality of privately offered public transportation services.

Enhancing and Advancing

TRB salutes the transportation organizations, leaders, and innovators who—as the examples in this report demonstrate—are working to enhance the delivery of transportation systems and services. TRB will continue to disseminate research and information on advanced technologies and related developments across the areas covered by its programs and activities.

Did You Know?

- ◆ Iowa is the only U.S. state with eastern and western borders defined entirely by rivers.
- ◆ Tennessee and Missouri have the highest number of bordering states—each has eight.
- ◆ Light-emitting diodes (LEDs) in traffic signals have saved transportation agencies money through the reduced consumption of electricity and a longer bulb life. LEDs do not waste energy by radiating heat, like incandescent bulbs, but this efficiency creates a problem in snow—the lights do not melt the snow that accumulates on the bulbs. Transportation agencies are finding signal design adjustments to overcome the problem, an example of the unintended consequences that can accompany technological advances.

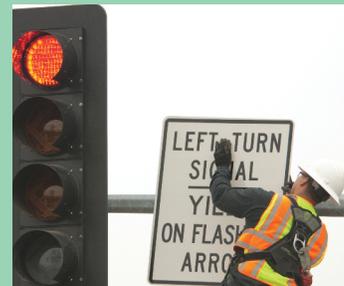


PHOTO: MISSOURI DOT

Missouri DOT personnel install energy-efficient LED traffic signals installed at the intersection of Route F and Westminster in Fulton.

The landslide of March 2014 devastated the North Fork Stillaguamish River Valley, burying several thousand feet of nearby SR-530 in mud, uprooted trees, and other debris, killing 43 people.



PHOTO: WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

The Transportation Impacts of—and Response to—the SR-530 Landslide Disaster *Snohomish County, Washington State, March 2014*

TOM BADGER, CASEY KRAMER, JOHN ANTAPASIS, AND MIKE COTTEN

Badger is Chief Engineering Geologist; Kramer is State Hydraulics Engineer; and Antapasis is Emergency Planning Section Chief, Washington State Department of Transportation (DOT), Olympia. Cotten, former Assistant Regional Administrator, Northwest Region, Washington State DOT, is Senior Project Manager, Parsons, Seattle.

On the sunny Saturday morning of March 22, 2014, an exceptionally mobile landslide with an initiating volume of approximately 10 million cubic yards gave way from the north side of the North Fork Stillaguamish River valley, between the towns of Oso and Darrington in northwestern Washington State. The landslide occurred within a 650-foot-high terrace of unconsolidated glacial and older landslide deposits.

Approximately half of the initiating volume of the landslide spread rapidly out across the valley and up onto the south valley wall, more than 3,000 feet away, pushing a wave of water, sediment, trees, and debris before it. The debris completely inundated—and devastated—the small residential community of Steelhead Haven on the south side of the river.

The landslide claimed the lives of 43 people, making it the deadliest in U.S. history (1). In addi-



PHOTO: TAWN DOTSON, WASHINGTON NATIONAL GUARD

A Washington National Guard liaison officer to the Snohomish County Emergency Operations Center coordinates disaster relief logistics after the SR-530 landslide.

tion, the landslide buried nearly one-half mile of State Route (SR) 530 in up to 20 feet of debris, severing the primary access route for the up-valley community of Darrington. This prevented access by official rescue operations and equipment to the east side of the slide, so that members of the community had to conduct the initial response on their own. Moreover, the necessary detour for Darrington residents via SR-20 to Interstate 5 (I-5) added an hour or more of travel time in each direction, as well as fuel costs.

The landslide debris blocked the river for nearly 24 hours, until the overtopping flow eroded a narrow channel through the nearly 4,000-foot field of debris. The flow was not sufficient, however, and a large lake quickly formed behind the debris dam, flooding upstream residences and an additional mile of highway.

The disaster and response raised a range of concerns about public safety regulations, emergency response and resources, socioeconomic consequences, land use planning decisions, timber harvest assessments, ecological implications, flood hazard predictions, and river channel migration, as well as the residual risks from this and the other potential landslide features in the valley. The Washington State Department of Transportation (DOT) focused on the transportation-related impacts to the highway and provided support to the multiagency response and recovery efforts.

Emergency Support

The most effective emergency response begins at the local level and looks to the state and then to the federal government as the impacts expand. This bottom-up approach is the national standard for emergency management. As the event rapidly exceeded the emergency response capabilities of Snohomish County, the State Emergency Operations Center took action to coordinate state resources in support of the response.

The Washington State Military Department's Emergency Management Division coordinates all state resources in implementing the Washington State Comprehensive Emergency Management Plan. The plan establishes emergency management functions and assigns responsibilities to state agencies for disaster response and recovery. Emergency Support Functions provide the structure for coordinating interagency response with local jurisdictions and tribes.

State DOT Role

As the lead agency for Emergency Support Function 1, transportation, Washington State DOT managed the traffic flow to ensure effective movement of response and recovery supplies, personnel, and

PHOTO: WASHINGTON STATE DOT



equipment. This included facilitating transit and a piloted car escort around the landslide area along an interim detour, as well as the early reopening of the seasonal Mountain Loop Highway to provide another access route for up-valley residents.

Washington State DOT supplemented Snohomish County and other state agency emergency response by helping to staff the emergency operations centers and by assisting as public information officers. Through an onsite mobile air command post, Washington State DOT also directed the Incident Management Team's Air Operations Branch, which established temporary flight restrictions, coordinated air activities in the landslide area, provided situational awareness, established an air command post, and coordinated the state's support for President Obama's visit to the disaster area on April 22.

Washington State Department of Transportation (DOT) managed the movement of response and recovery supplies, coordinating a car escort along a detour route and opening the Mountain Loop Highway to provide additional traffic access.

The field of debris from the landslide, nearly a mile wide, dammed the Stillaguamish River, forming a lake and complicating efforts to create a detour for emergency relief efforts.

PHOTO: MATTHEW SISEL, WASHINGTON NATIONAL GUARD





PHOTO: U.S. FOREST SERVICE

Federal Emergency Management Agency search and rescue canines Hugo and Bayou assisted in search and recovery operations. Washington State DOT coordinated the multiple-agency effort.

Useful Tools

Because Washington State DOT had contractors on call, as well as in-house capabilities for processing and analysis, the agency provided most of the orthophotography and airborne lidar—or light detection and ranging—data and much of the geographic information systems analyses and maps throughout the search and recovery operations and for the preliminary planning. Some of the most useful products included the following:

- ◆ **Orthoimagery**, gridded for handheld Global Positioning System units, enabled the recovery teams to determine their field locations and to assess potential excavation depths rapidly in the search for victims;
- ◆ **Depths and volumes of the impounded lake** helped in assessing the risks associated with potentially catastrophic breaches of the debris dam, as well as the short- and intermediate-term flood hazard and the stability of the channel; and
- ◆ **Topographic models** were developed to evaluate detours and alternatives for permanent highway realignment.

Collaborative Efforts

In partnership with Snohomish County, the Washington Department of Natural Resources (WDNR), and the U.S. Geological Survey (USGS), the Geotechnical Office of Washington State DOT also contributed to the initial hazard assessment after the event and to the landslide monitoring to ensure worker safety during recovery operations. Washington State DOT provided real-time slope deformation instrumentation and performed weekly terrestrial laser scans and change analyses to assess the stabil-



PHOTO: JOHANNAN GOOT, U.S. GEOLOGICAL SURVEY

The U.S. Geological Survey worked with the Washington Department of Natural Resources, Washington State DOT, and Snohomish County to assess slope conditions using a remote sensing spider unit.

ity of the landslide mass and the upslope area.

The Washington State DOT Headquarters Hydraulics Office collaborated extensively with USGS, the Northwest River Forecast Center of the National Oceanic and Atmospheric Administration, WDNR, the U.S. Army Corps of Engineers (USACE), the Federal Emergency Management Agency (FEMA), and Snohomish County to monitor the river during the recovery operations. Washington State DOT developed hydraulic models, applying real-time and forecasted flow data, to determine potential water surface elevations throughout the slide area for the rescue and recovery efforts.

Several Washington State DOT region maintenance personnel who lived in the valley provided countless hours, equipment, and materials to aid in



PHOTO COURTESY OF WASHINGTON STATE DOT

Amphibious excavator constructs a pilot channel to increase flow through the debris dam.

the removal of the debris and to improve accessibility for the search and recovery operations.

Washington State DOT began planning for recovery operations early in the response phase to ensure that SR-530 would reopen quickly, efficiently, and safely, in a manner respectful to the community and to victims' families, to support rescue workers and the community's recovery. The department participated in a multiagency task force to develop an action plan to achieve these goals.

What About the River?

The landslide covered the entire width of the floodplain with up to 60 feet of debris. Because only a small channel had formed to convey the river's flow through the debris dam, more than 15 feet of backwater formed a lake on the upstream side. The lake made recovery of victims in the area nearly impossible.

To reduce lake levels, a contractor opened up a pilot channel close to the historical channel with a unique amphibious excavator (see photo, page 26). As the excavation progressed, the lake level dropped by several feet within days—this aided recovery efforts. In addition, a dewatering plan to lower the lake levels included USACE's construction of a temporary berm, along with the installation of a network of drainage lines, pumps, ponds, and ditches.

Hydraulic Model

A hydraulic model of the reach was needed to assess the hydrologic events forecasted throughout the basin and to understand the potential risks for the recovery efforts and for infrastructure. Aerial photographs and lidar data after the landslide were compared with historical lidar data to estimate the thickness of the debris; the impounded water, however, obscured readings of the water depth and volume and of the depths of the debris upstream of the debris dam.



PHOTO: WASHINGTON STATE DOT

To supplement the lidar data, Snohomish County contracted with a local consulting firm to collect bathymetric data below the impounded lake. These data were combined into a digital terrain model of the affected area; the model was then used to develop a baseline hydraulic model.

Two main hydraulic models helped in assessing conditions through the reach:

- ◆ FEMA and USACE developed a one-dimensional HEC-RAS computer model, which covered the reach from the confluence with the South Fork of the Stillaguamish to upstream of the project site; and

- ◆ The Washington State DOT Hydraulics Office and FHWA developed a two-dimensional river hydraulics model, to determine potential flow paths through the landslide deposits.

Figure 1 (below) shows a two-dimensional hydraulic model depicting one of the scenarios for the design of the highway reconstruction.

Landslide debris dammed the Stillaguamish River, causing a lake to form. Bathymetric and lidar data were combined to create digital hydraulic models to aid in recovery efforts and infrastructure repair.

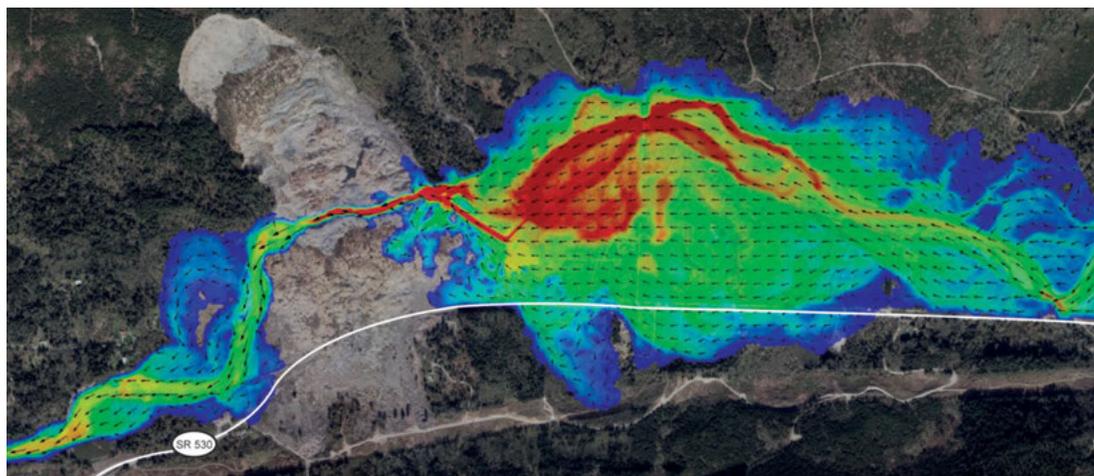


FIGURE 1 Two-dimensional hydraulic model of flow depths for a 25-year event; river flow is right to left. Flow depth increases from blue to red. Black arrows depict flow direction, with longer arrows indicating faster velocities.

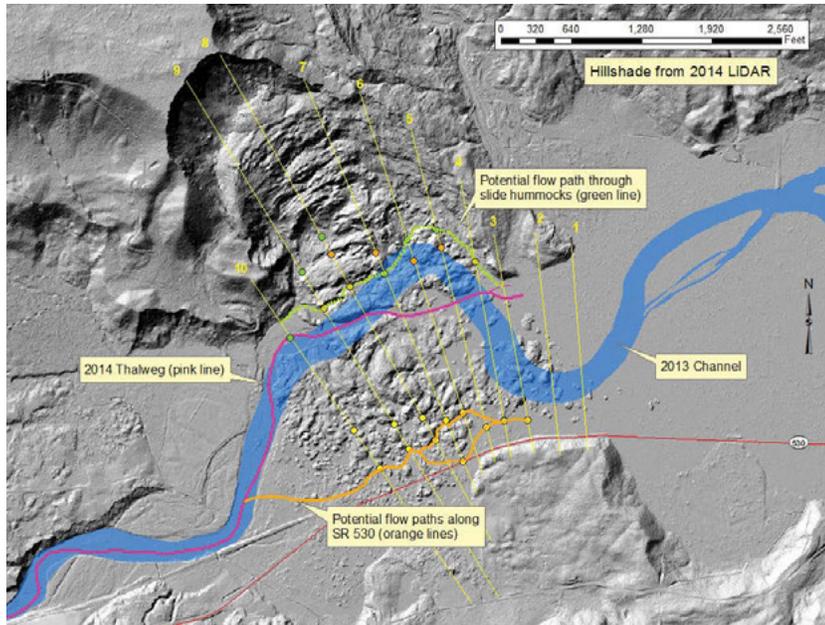


FIGURE 2 Potential flow paths of the river through the debris dam.

After soliciting input from area residents and families of landslide victims, Washington State DOT began efforts to reconstruct SR-530.

Assessing Threats

Concerns persist about the potential for channel migration and the effects. Reoccupation of the channel as it was in 2013 upstream of the debris dam raises the potential for a major channel avulsion through the highly erodible landslide debris; this would direct flow southward, directly at and parallel to SR-530 (Figure 2, above). Because of the steep gradient of any channel in this location, the event

could undermine the reconstructed highway.

Another potential flow path that has raised concern would be a northward attack at the landslide toe, which could destabilize the landslide mass. Preliminary stability analyses, however, suggest that toe erosion would have to be considerable to cause a significant reactivation.

Many agencies are monitoring the downstream and upstream effects of the landslide. A sediment transport analysis is being conducted to understand how the landslide debris will move downstream and to assess the effects on water surface elevations and infrastructure. Washington State DOT continues to monitor the bed elevations for aggradation at the highway and Interstate bridges downstream.

Reestablishing SR-530

Snohomish County immediately assumed command of the impact zone, including the portion of SR-530, for search, rescue, and recovery. Washington State DOT engineering staff began studying the impact of the slide on SR-530 and contemplating alternate routes for the highway, for both the near and long term. Reconnecting the communities affected by the landslide required consideration of the geotechnical feasibility, the potential changes in river location, the environmental impacts, community acceptance, the costs, and the time to implement the selected alternatives.

Community meetings enabled the victims' families and local residents affected by the disaster to express concerns and offer input. The comments and the preliminary engineering information favored the reconstruction of SR-530 within the highway right-of-way. In addition, an interim connection clearly was needed to provide relief from the long and costly detour via SR-20 and I-5.

Detour Route

Washington State DOT decided to prepare three construction contracts to expedite the interim and permanent connections. The first contract was for maintaining the primitive gravel road used by Seattle City Light for servicing the high-voltage transmission corridor south of SR-530. The county made initial improvements to the road early in the search, rescue, and recovery effort.

The project required a contractor to operate the roughly 2-mile-long road in a one-way piloted operation to relieve local traffic and to serve local businesses—including a lumber mill—that were economically affected by the landslide. Washington State DOT secured temporary rights from Seattle City Light and the property owners to allow the state to use the maintenance road. The advertisement of this con-



Photo: Washington State DOT

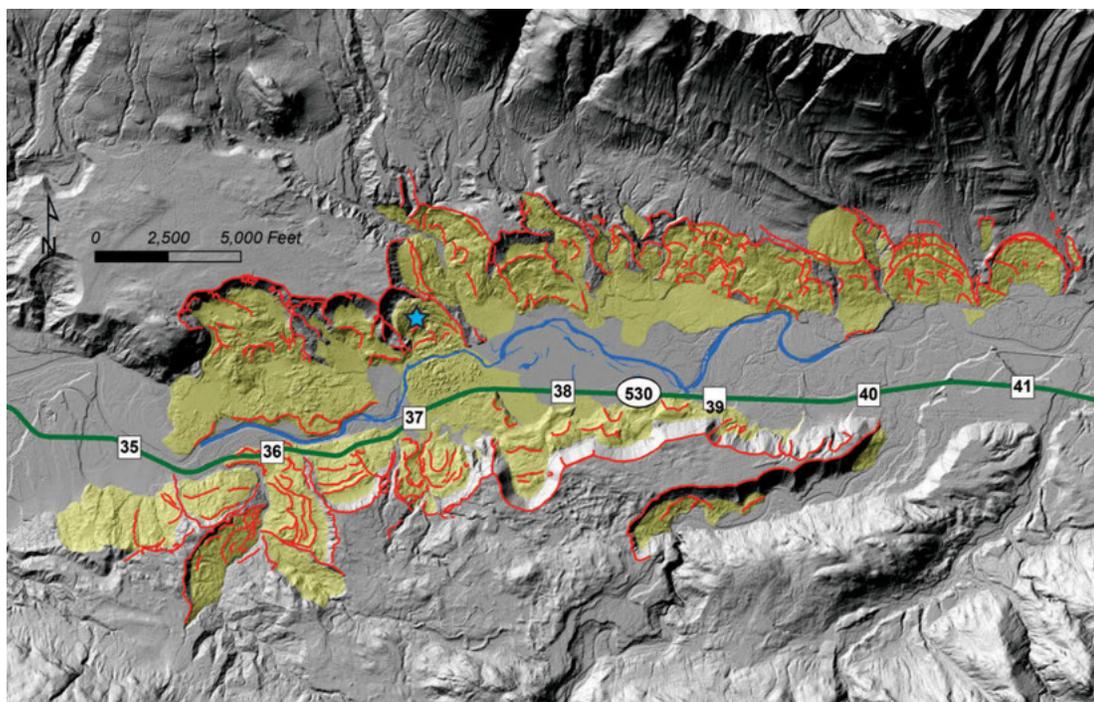


FIGURE 3 Geomorphic map of unstable landforms on a bare-earth model derived from airborne lidar collected in 2010 and immediately after the 2014 landslide. Red lines are primary landslide scarps, and yellow shadings are landslide deposits; star denotes initiation zone of the SR-530 landslide (2).

tract coincided with the conclusion of Snohomish County's official search for victims and the release of SR-530 to Washington State DOT on April 30.

Debris Removal

The second contract addressed the removal of the slide debris from the roadway. Washington State DOT coordinated closely with FEMA, which provided the majority of the project funding, and with other agencies to determine that a width of 50 feet should be cleared. The debris was extremely weak, saturated, and susceptible to liquefaction when excavated; this required grading the cut slopes at a horizontal-to-vertical proportion of 4 to 1.

Construction began on the second project shortly after the first, and it was completed in late May, under budget and slightly ahead of schedule. Once the slide debris was removed, the damage to the roadway could be assessed. At the conclusion of the second project, the detoured traffic was rerouted back to SR-530.

Reconstruction

The third contract provided for the reconstruction of SR-530. Major elements of work included raising the profile of SR-530 to reduce the risk of flooding and erosion while the river channel adjusted to a preslide alignment and water surface elevations and replacing several fish-barrier culverts with fish-passable structures.

The contract specified design-build delivery, with an accelerated procurement schedule to complete work before the river flows increased in the fall. Eight

teams responded to the request for qualifications issued on April 21, 2014—less than one month after the landslide. A short list of four teams received the request for proposals on April 29; the best-value team was announced on May 30; and after the contract was signed, the notice to proceed was given on June 3.

The design-builder restored two-way service on SR-530 on June 20 and completed the project in late September, nearly 6 months after the landslide, ahead of the contract requirement of October 1.

Long-Term Plan

A multiagency task force continues to work on a long-term plan for the North Fork Stillaguamish River valley to address unresolved and complex issues associated with a meandering river system flanked by a high density of landslide zones (Figure 3, above). Because of the dynamic interactions between the river and the unstable valley walls, these and other evolving conditions are likely to threaten SR-530 for a long time to come.

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Implementing Geotechnical Innovations on a Major New Mexico Interchange

Time and Cost Savings

ROBERT MEYERS



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In 1983, the New Mexico Department of Transportation (DOT) constructed the Paseo del Norte (PDN) Interchange of Interstate 25 (I-25). The conventional diamond interchange provided local access from I-25 in northern Albuquerque for commercial developments and warehouse transfer facilities.

Immediately after construction, the PDN traffic volume increased significantly with the completion of a six-lane bridge carrying traffic over the Rio Grande River from the rapidly growing west side of Albuquerque. By 2012, average daily traffic (ADT) on the PDN had grown to nearly 71,000 vehicles, mostly moving through the interchange from the eastbound PDN to I-25 southbound during the morning peak hours and from I-25 northbound to the westbound PDN during the afternoon peak hours. The projected ADT for 2035 is 124,000.

The interchange experienced significant safety issues and traffic congestion. The regional transportation model of the Middle Rio Grande Council

of Governments indicated that without major improvements to the interchange, traffic in the regional Albuquerque metropolitan area would be severely compromised.

Getting Under Way

The City of Albuquerque undertook an interchange improvement study with the New Mexico DOT and the Federal Highway Administration (FHWA) in 2007. The study produced 16 design alternatives for a complete system-to-system interchange. The cost of the preferred alternative would be more than \$400 million, but funding was uncertain.

The city therefore proposed a significantly reduced major arterial to the PDN interchange to handle the peak morning and afternoon traffic. The cost estimate for this construction was \$75 million. By the time the project got under way, the preliminary engineering, the National Environmental Policy Act record of decision, and the right-of-way acquisi-

(Above:) Construction in progress on the Paseo del Norte, looking east to I-25 from Jefferson Avenue overpass.

tion had increased the total cost to \$90 million. The City of Albuquerque led the financing for the project, contributing \$50 million, with state and federal governments supplying the remainder.

A request for proposal (RFP) was developed for a design-build contractor to complete the 30 percent design concept, with a 24-month schedule for the completion of the design and construction. Three design-build contractor engineering teams were short-listed, and Kiewit New Mexico was awarded the project, with the engineering team of Bohannon Huston Inc. and geotechnical subconsultant Terracon Consultants, Inc.

Alternative Technical Concepts

The guaranteed maximum price was \$75 million, and Kiewit New Mexico committed to a contractual completion enhancement of 18 months. In addition, two major alternative technical concepts were developed and accepted as part of the contract proposal:

1. A single-point urban interchange at the PDN Jefferson Overpass and
2. A somewhat controversial left-lane touch-down of the I-25 northbound to the PDN westbound flyover.

The left-lane touch-down concept was accepted with traffic lane restrictions to ensure that traffic on the flyover could not exit at the Jefferson single-point urban interchange but would continue westbound.

The geotechnical portion of the RFP for the I-25-PDN Interchange specified a 30 percent level of geotechnical borings—thirty 125-foot soil borings—and required a geotechnical planning report from the design-build geotechnical consultant. New Mexico DOT accepted the report as the basis for the geotechnical design and construction of the project.

The RFP required load testing of deep foundations, as well as settlement monitoring of structures and walls. The RFP also allowed flexibility in the

PHOTO: NEW MEXICO DOT



(Above:) Paseo del Norte single-point urban interchange over Jefferson Avenue, under construction.

(Below:) Completed Paseo del Norte single-point urban interchange over Jefferson Avenue.

PHOTO: NEW MEXICO DOT



geotechnical applications, however, and as a result, the project was able to use proven geotechnical engineering technologies in innovative ways.

Innovative Applications

Applying the flexibility of the geotechnical model, the geotechnical planning report called for the following innovative applications of procedures and technologies:

(Left:) Northbound-to-westbound flyover MSE wall exit ramp under construction, looking northbound on I-25.

(Right:) Northbound to westbound flyover MSE wall touch-down ramp under construction, looking east from future eastbound Paseo del Norte lanes.

PHOTO: NEW MEXICO DOT



PHOTO: NEW MEXICO DOT



Under construction: Paseo del Norte over the Jefferson Avenue MSE wall true abutment.



PHOTO: NEW MEXICO DOT

- ◆ Cone penetrometer testing (CPT) to complete 100 percent exploration of the soils,
- ◆ Spread footing foundations bearing on mechanically stabilized earth (MSE) walls at the bridge approach fills,
- ◆ Bentonite slurry for drilled-shaft construction of the flyover,
- ◆ Osterberg cell load testing of the drilled shafts, and
- ◆ Geofoam fill to reduce the stress over an existing concrete box culvert.

Cone Penetrometer Testing

The design-build geotechnical engineer selected CPT to complete the 100 percent soils exploration program. With real-time production of soil logs, shear strengths, and modulus, the CPT testing accelerated the design schedule by 3 to 4 months.

A nominal amount of conventional drilling with split spoon sampling was conducted to correlate the

CPT findings with results from the soils laboratory tests. The CPT findings revealed a soil surface crust layering with a high modulus; this eliminated concerns about hydrocollapse layers, which are prevalent in the Rio Grande valley.

The findings also allowed the use of spread footings as the primary foundation elements for all structures—except for the flyover—that would meet the serviceability limits. The choice of CPT was critical in holding to the design-build contractor’s 18-month schedule for design and construction. CPT reduced the costs for soils laboratory testing by approximately \$250,000.

Spread Footing Foundations

For more than 20 years, New Mexico DOT has used bridge abutments supported on MSE approach backfill. The standard has been to set the centerline of bearing 7.5 feet away from the MSE wall backface, with the toe of the footing no closer to the wall than 2.5 feet. New Mexico DOT approved the contractor’s proposed design innovation, which placed the centerline of bearing for the abutment 3.5 feet from the MSE wall backface and the toe of the footing 6 inches from the wall.

The concern about compaction against the MSE wall within this zone was addressed by requiring a coarse-graded stone—American Association of State Highway and Transportation Officials (AASHTO) #68—2.5 feet behind the wall. Settlement monitoring of the bridge at the Jefferson single-point urban interchange has shown that the bridge abutment meets the serviceability limits.



PHOTO: NEW MEXICO DOT

Completed Paseo del Norte over the Jefferson Avenue MSE wall true abutment.

Photo: New Mexico DOT



Completed Paseo del Norte looking east to I-25 from Jefferson Avenue overpass. (Note northbound to westbound flyover touch-down ramp with left lanes to westbound Paseo del Norte).

Bentonite Slurry Drilled Shaft Construction

Although the shaft depths reach 100 feet, no groundwater is present. Nevertheless, the contractor selected bentonite slurry to maintain stability of the hole and to cast the shaft concrete with wet hole placement methods.

The bentonite was processed to a sand content of 1 percent at the bottom of the shafts; a self-consolidating concrete mix was placed with a tremie pipe from the bottom of the shafts to displace the slurry. Crosshole sonic logging of the drilled shafts confirmed the concrete's integrity, although one anomaly was revealed—the tomography indicated that 15 percent of the pier one concrete shaft was compromised with slurry at a depth of 35 feet. Calculations confirmed, however, that the structural capacity of the shaft was adequate.

Osterberg Cell Load Testing

The geotechnical RFP required load testing of the deep foundations. The design-build contractor conducted Osterberg cell load or O-cell testing on a sacrificial drilled shaft; the results confirmed the geotechnical design shaft friction that was indicated by the CPT soils data. The O-cell test also confirmed the choice of the construction method with bentonite slurry.

Load testing optimized the geotechnical capacity of the shaft in accordance with the AASHTO load and resistance factor design (LRFD) by increasing the resistance factor of the shaft from 0.5 to 0.7. This 40 percent increase in capacity significantly reduced the drilled shaft depth requirements, increased the constructability of the drilled shafts, and reduced the size of the cranes required for the construction.

These measures reduced the drilled shaft construction costs by an estimated \$300,000 and trimmed the construction time by at least two weeks—equivalent to a \$750,000 incentive bonus for reducing the construction schedule.

Geofoam Fill for Stress Reduction

The design and construction of new MSE walls over a concrete box culvert on the Santo Domingo drainage channel that crosses under the PDN was particularly challenging. The concrete box culvert had to remain in place to meet the \$75 million budget and the 18-month design-build schedule.

The problem was that the MSE walls would create bearing pressures greatly exceeding the capacity of the concrete box culvert. Lightweight expanded polystyrene geofoam replaced the standard 25-foot-high MSE wall backfill over the concrete box culvert. The geofoam's lightweight fill provided significant cost savings—\$500,000 at minimum—compared with the alternatives of complete replacement of the culvert or bridging over it. Moreover, the technique reduced construction time by at least 30 days—equivalent to a \$1.5 million contractor incentive bonus for reducing the construction schedule.

Critical to Success

The geotechnical applications of these procedures and technologies—as well as the use of the FHWA design for geosynthetic reinforced soil walls at the bridge approaches, application of site-specific seismic response spectra to the flyover, the imperfect trench technology, and implementation of the certified drilled shaft inspector construction quality control—have proved critical to the success of the I-25-PDN design-build project.



Photo courtesy of Louisiana DOTD

Right-Sizing the Louisiana State Highway System

Transferring 5,000 State Miles to Local Governments

HAROLD R. (SKIP) PAUL

The author is Director, Louisiana Transportation Research Center, Louisiana Department of Transportation and Development, Baton Rouge. He is a past chair and current member of the TRB Technical Activities Council and 2014 recipient of the W. N. Carey Distinguished Service Award.

State-owned public roads, on average, comprise approximately 20 percent of total state and local road mileage; only 10 states exceed that national average. Louisiana owns 27 percent of its public roads and oversees more miles on its state highway system than 39 other states.

The Louisiana Department of Transportation and Development (DOTD) has worked to address this issue since 2003. In 2010, the state legislature passed House Concurrent Resolution 38, which requested Louisiana DOTD to prepare a plan to “right-size” the state highway system by transferring state-owned roads to parish—the Louisiana term for county—and municipal governments. Louisiana DOTD developed a voluntary program to transfer approximately 5,000 miles of state roads and to compensate the local governments that participate. Full implementation of the program will bring Louisiana’s percent-

age of state-owned public road mileage in line with the national average.

Program Principles

Spearheaded by Eric Kalivoda, Deputy Secretary of Louisiana DOTD, the plan is known as the Road Transfer Program. The program follows three principles:

1. The state should not be maintaining neighborhood streets in urban or rural areas.
2. State mileage should be inversely proportional to parish population.
3. In urban areas, the state system should consist only of roads that serve a significant interurban function—local governments can best serve intraurban travel needs, even if the streets have high volumes of traffic.

Participation in the Road Transfer Program is voluntary, and cities can accept any of the eligible roads or all of them. Most of the roads eligible for transfer are two-lane facilities with asphalt pavements. Although some local governments are hesitant about assuming the ownership of additional roadways, the program may appeal to parishes and municipalities that have the capacity to handle the day-to-day road maintenance—such as mowing, litter pick up, pothole patching, and sign repair—but lack the resources for capital improvements.

“We want to become more of a construction department and less of a maintenance and operations department,” Kalivoda observes. “To do that, we need to find willing partners to take on more of the day-to-day maintenance and operations responsibilities, and in return, we can help with construction projects. In addition, the reduction in state mileage will allow Louisiana DOTD to focus resources on the remaining highway system, as well as on components of other modal systems that are important to freight movement, tourism, and business travel—the three economic drivers from a state transportation perspective.”

Compensation to Localities

A key element of the program is that Louisiana DOTD will repair the eligible roads that are in less than fair condition, according to the agency’s criteria, before the transfer to the local governments. The participating parishes receive credits for 40 years of routine and capital maintenance applied to the highway capital project or projects of their choosing—for example, bridge replacements, overlays, safety improvements, road reconstruction, additional travel

lanes, or new roadways.

The Road Transfer Program covers the repairs to the roads and the 40-year maintenance credits with an annual budget of \$25 million. This limits the transfer to a maximum of 50 to 60 miles per year. When the budget is depleted, the parishes must wait until the following fiscal year.

To budget accurately and to provide fair compensation to each local government for the transfer, Louisiana DOTD created an outline of what to expect. The department considered the cost of routine and capital maintenance for pavements, bridges, traffic signals, and flashing beacons, and assigned all of these items a present worth value based on Louisiana DOTD’s records and on data from pavement and bridge management systems.

“We calculated what we would spend maintaining various roadways in the next 40 years, discounted that back to present value, using a very low discount rate, and have provided that for the compensation,” Kalivoda reports. “We included the calculations in our documents to make it transparent and available for anyone to see how we came up with the numbers.” According to Kalivoda, the department will update the values every three years.

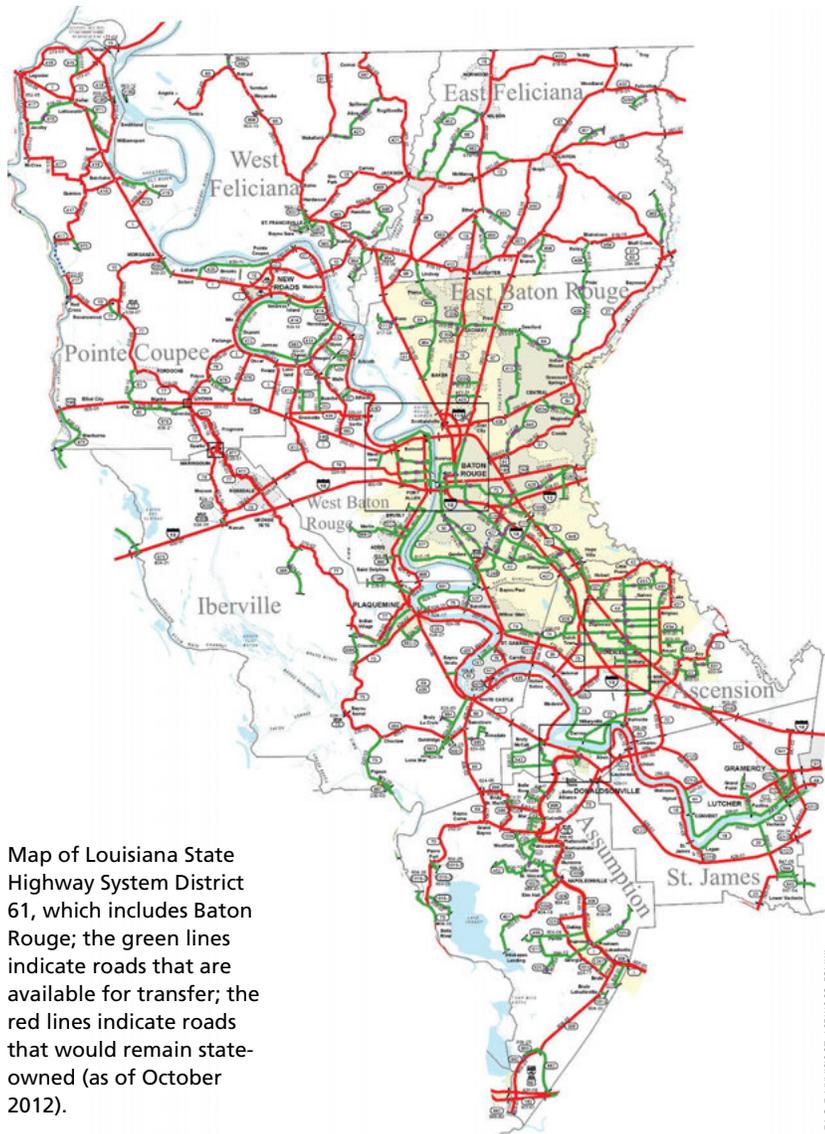
The compensation for the various road types ranges from a little more than \$353,000 per mile to more than \$1 million per mile. Many factors are considered, however, before the final value is determined. For example, the compensation for roads would depend on the number of lanes, the type of pavement, and the condition of the road at the time of transfer. Roads in fair condition receive a higher valuation than those in very good condition.

PHOTO COURTESY, LOUISIANA DOTD



(Facing page:) A tree-lined neighborhood street typical of the roads that the Louisiana Department of Transportation and Development (DOTD) is transferring to local governments.

(Left:) Parishes that participate in the Road Transfer Program receive credits for 40 years of maintenance to the highways or other projects of their choosing.



Map of Louisiana State Highway System District 61, which includes Baton Rouge; the green lines indicate roads that are available for transfer; the red lines indicate roads that would remain state-owned (as of October 2012).

IMAGE COURTESY LOUISIANA DOTD

Local Benefits

Louisiana DOTD has discovered several common benefits for the participating local governments. “The participating parishes and municipalities get immediate help with capital projects for which they may otherwise have difficulty finding money—with only a minimal increase in maintenance responsibilities in the short term,” Kalivoda explains. “For the first 10 years, the increase in maintenance responsibilities from the additional roadways is minimal, because Louisiana DOTD repairs the roads before the transfer.”

An additional benefit is that several recent participants are applying the 40-year maintenance credits to settle previous debts to the state, instead of undertaking a specific construction project. This allows the local government to move forward with its own budget and expenditures.

The program also allows local governments to expand their authority and control over roads within their jurisdictions. Without state approval or interference, localities can set their own speed limits, make decisions about adding traffic signals, issue driveway permits, restrict certain types of traffic—such as trucks—and enforce traffic laws.

Finally, many local governments can experience a financial benefit in the short term with a reduced operations budget for equipment, supplies, labor, and more. “Because they are not taking on a big increase in maintenance responsibilities over the short term, with the state roads in good condition at transfer, local governments can apply their 40-year maintenance credits to address their ‘money pits’ from a maintenance perspective,” Kalivoda explains. “By using the credits to take on problem roads and bridges, the local governments can reduce maintenance expenditures in the short term and free up funds for the rest of their system.”

Despite the benefits to recent participants, some parishes and municipalities remain skeptical. Kalivoda expects that as more local governments get involved, others will follow, after seeing the advantages of the repaired roads and bridges and of the new construction in neighboring communities.

Potential Savings and Progress

The Road Transfer Program eventually will reduce the maintenance and operations budget, so that the state can spend more of its money and time on construction. For instance, if the state transferred all 5,000 miles at once, Louisiana DOTD would reduce its operating budget by approximately \$27 million per year. In the long term, for the 40-year period, the savings in routine and capital maintenance would reach \$2.5 billion—the amount provided to local governments as compensation.

Transfer Process

The first step is for an interested local government to work with the Louisiana DOTD District Administrator to identify eligible state roads. The local government determines which roads it can own, and the administrator calculates the 40-year maintenance value for the selected roads. For this process, Louisiana DOTD makes available district and parish maps showing the routes eligible for transfer.

Next, the local government identifies the capital project or projects to which it will apply the 40-year maintenance credits. Louisiana DOTD then drafts a resolution for the local governing authority to consider and adopt and draws up a cooperative endeavor agreement. Finally, after adoption of the resolution, the execution of the agreement, and the completion of repairs on each route, the ownership of the road transfers from the state to the local government.

PHOTO COURTESY LOUISIANA DOTD



Louisiana highways LA-154 (*left*) and LA-526 (*below*) are eligible for transfer to Caddo and Bienville Parishes, respectively.

Although such a significant transfer is not yet possible, after the first two years of the program, active agreements are in place for the transfer of 80 to 100 miles of roadways. Because of the structure and the fixed budget, Louisiana DOTD predicts that the program will continue for decades unless a higher budget is established.

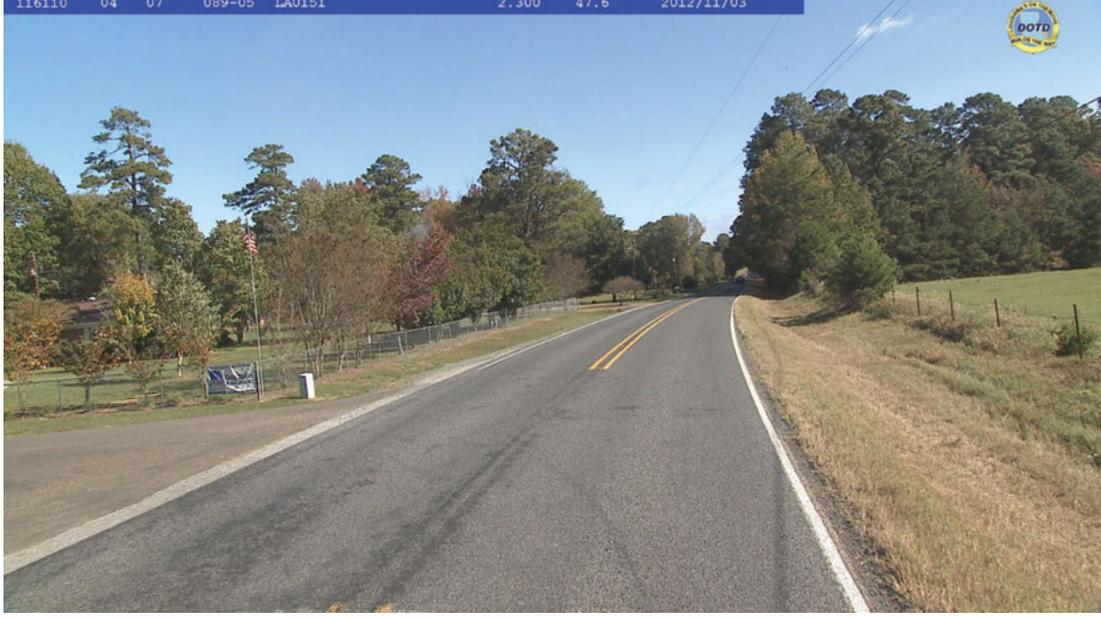
“As the popularity of the program grows, we may be able to allocate additional resources to it,” Kalivoda points out. “The current annual budget would require 100 years for the transfer of all the miles; therefore an increase is needed if we are going to accomplish this in a reasonable amount of time.”

As the Louisiana DOTD program gains traction, other states with large highway systems will be able to use the program as a model for lowering state-owned roadway mileage and giving local governments more power and freedom in serving their citizens.

Learn More

For additional information about Louisiana’s Road Transfer Program, the website www.dotd.la.gov/programs/RoadTransfer/ offers access to a report and to parish maps. Send questions about the program to Eric Kalivoda at eric.kalivoda@la.gov or phone 225-379-1200.

PHOTO COURTESY LOUISIANA DOTD



TRANSIT COOPERATIVE RESEARCH PROGRAM REPORT

Improving Community Transportation for Veterans, Military Service Members, and Their Families

ELIZABETH H. ELLIS

The author is Senior Transportation Planner, KFH Group, Inc., Bethesda, Maryland.

The United States is winding down from wars in Iraq and Afghanistan. Thousands of active duty service members have been returning to their home communities, many of which are rural towns and smaller cities. Service members are reintegrating into civilian life, reconnecting with their families, looking for jobs, or—if injured—continuing to recuperate. They need transportation in their communities.

These younger veterans join older veterans from past conflicts—World War II, Korea, Vietnam, and Gulf War I—Desert Storm. The younger veterans may be looking for employment or going to college; many of the older veterans are retired and face the challenges of aging.

For all these veterans, a fulfilling life requires transportation. Many own private vehicles, but others lack transportation, for a variety of reasons. Veterans from the Korean War and World War II are now in their 70s, 80s, and 90s and may have given up the car keys. For those who drive, the trip to the Veterans Administration (VA) Medical Center for health care may be too long and arduous. Some may have family members who can drive, although spouses also may be older and unable to drive distances.

Some veterans from the more recent wars may not

have found employment yet and cannot afford a vehicle or cannot pay for necessary repairs. Although data show that labor rates are improving for recent veterans, the income for many after military service is low, and owning a car may not be feasible.

Approximately 1.4 million service members are on active duty. When stateside, these individuals may have a car to commute to duty on base, but this may leave family members without a car. Active duty service members may report for temporary training to a base far from the home base, without a vehicle. At the end of a training week, how do these service members travel to a nearby community for R&R? Or how do they access the intercity bus service to take them home when they have leave? They need community transportation.

Recognizing that community transportation has an important role in providing local mobility for veterans, military service members, and their families, the Transit Cooperative Research Program (TCRP) managed and funded a project to explore the topic and published the findings in TCRP Report 164, *Community Tools to Improve Transportation Options for Veterans, Military Service Members, and Their Families*.

Assembling Sources

The research project's early work sought to identify the transportation issues and needs of veterans, service members, and their families through the following efforts:

- ◆ Review of the literature;
- ◆ Review of the 2011 and 2012 grants from the federal Veterans Transportation and Community Living Initiative, which provides capital funds for technology projects to improve access to transportation for veterans;
- ◆ A survey of the volunteer driver programs of the VA's Volunteer Transportation Network and the Disabled American Veterans, a major supporter of the network;
- ◆ An online survey of employment specialists at the Department of Labor who work with veterans

Marines boarding a Morongo Basin Transit Authority vehicle on the base of Marine Corps Air Ground Combat Center at Twentynine Palms, California, one of the largest Marine Corps bases.





One of five Veterans Transportation Service vehicles operated from the Cambridge, Maryland, VA Outpatient Clinic, to transport veterans from Maryland's rural Eastern Shore to the Baltimore VA Medical Center.

through the Disabled Veterans' Outreach Program and the Local Veterans' Employment Representatives program;

- ◆ Review of the Veterans Transportation Service program, a 2010 initiative of the Veterans Health Administration to improve transportation to VA medical centers;

- ◆ Review of community transportation services at seven military installations, highlighting the security concerns and other issues that communities face in improving transportation for military service members and families; and

- ◆ Review of other efforts to improve transportation for veterans and service members, including services for wounded warriors, Native American veterans, and homeless veterans, as well as state efforts to address these needs.

Transportation Needs

The transportation needs of the country's approximately 23 million veterans vary by location of residence, by vehicle ownership and independent driving status, by the types of transportation resources locally available, and by enrollment in the VA health care system.

For the approximately 9.4 million veterans 65 years old or older, medical trips are generally considered to be most critical, particularly for dialysis treatment. Volunteer driver programs, such as Disabled American Veterans, are a resource; but the survey found that 50 percent of the programs operate at capacity daily or weekly.

Health care trips are important for the approximately 2 million veterans of Iraq and Afghanistan, with many suffering from posttraumatic stress disorder, traumatic brain injuries, and spinal cord injuries from improvised explosive devices.

Employment-related trips also rank high in importance for these veterans. The survey of the Department of Labor employment specialists found that transportation is a significant problem for veterans. Most frequently, the specialists refer the veterans to the local transit agency, a local veterans service organization, or a church. Some of the specialists give out gas cards to veterans who own working vehicles. A few specialists reported that they had driven veterans to job interviews, and two said that they had provided bicycles to veterans without cars.

The transportation needs of the estimated 3.25 million veterans who have a service-connected disability vary by the type of disability and the location of the treatment. The volunteer driver programs typically do not have wheelchair-accessible vehicles and are not an option for a veteran who uses a wheelchair and is unable to transfer to a vehicle seat.

The estimated 67,000 to 100,000 homeless veterans often depend on transit. The research found, however, that homeless veterans newly admitted to shelters or to transitional housing may not be aware of how to use the available public transit.

Getting to the VA

Some of the mobility needs of veterans overlap with needs of the general public, such as needs that stem from aging and frailty, disability, lower income, unemployment or underemployment, or homelessness. For veterans, a distinguishing factor is use of the VA medical system. For the approximately 38 percent to 40 percent of all veterans who use the system, transportation to the VA medical center may be an issue, because the centers are located regionally, and some medical specialists are available only at certain facilities. Trip distances therefore can be long.

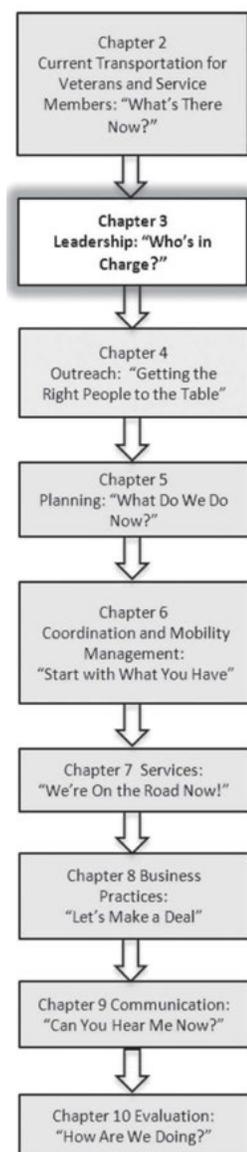
A disproportionate number of veterans from the two recent wars live in rural areas. According to the VA Office of Rural Health, almost one-third of the enrolled Operation Enduring Freedom and Operation Iraqi Freedom veterans live in rural areas.

If public transit is available, long-distance trips to the VA medical center may require one or more transfers from one transit system to another. Rural



Transit information provided by Jacksonville (North Carolina) Transit, which serves Camp Lejeune and three additional Marine installations nearby. The transit agency includes a quick response (QR) code, a shortcut link to the route and schedule information for the many Marines with smartphones and a QR reader.

Meeting veterans' transportation needs, which include health- and employment-related trips, requires community outreach, partnering, and planning.



Each chapter in TCRP Report 164 begins with a version of this graphic, highlighting the contents—here, for Chapter 3—and illustrating the logical progression of transportation improvement building on coordination.

areas may not offer public transit, and often the volunteer driver programs in these areas operate at capacity. Almost 75 percent of the volunteer driver programs responding to the survey said they do not have enough volunteers or vehicles for the demand.

Family members of veterans are also often caregivers; the literature indicated that eight out of 10 families provide their veteran with transportation and that they would like help or options when schedule conflicts arise.

Active Duty Needs

The needs of active military are generally different from those of veterans and vary by location of the base. Fewer communities today host a military installation because of the Base Closure and Realignment Commission policy that closed and consolidated bases.

The transportation needs of active duty military also vary by residency on base or in the community outside. Only approximately 30 percent of service members live on base.

The research revealed particular needs among the junior enlisted ranks, notably for those who are married and raising children. Those service members are more likely to live off base, outside the informal family-support network of the on-base community, accentuating transportation problems.

The survey also found that service members temporarily stationed at a base away from their home base for training, typically for several months and without their own vehicles, constitute another group with transportation needs. The transit agency in Jacksonville, North Carolina, for example, reported that its most-traveled routes serve Camp Lejeune, a large Marine base that receives continuous groups of trainees.

Helping Communities

TCRP Report 164 includes guidance and tools for communities that want to improve and expand their local transportation resources specifically to serve veterans, military members, and their families. The report's first two chapters provide an overview and background, and the remaining eight chapters present an organized and logical process for improving transportation, building on the framework of transportation coordination.

Transportation coordination typically starts with a lead agency or person taking charge; the next steps involve outreach, to find partners in the community, and planning, to assess the needs and



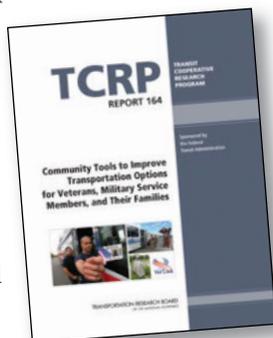
The transportation needs of active-duty military differ from those of veterans. Often, soldiers in short-term duty stations do not have their own vehicles.

identify gaps in meeting those needs. The community then can consider how to use or enhance available transportation resources to meet needs and to identify new transportation services that might be needed.

Coordinating and implementing a new service may require the community to consider new funding sources, to formalize a transfer policy with a neighboring transit agency, or to develop an agreement to share vehicles. Communication is critically important throughout, and the report identifies activities and media needed at different stages. Finally, when the transportation improvements are in place, the community should assess the effectiveness in increasing mobility options for veterans, service members, and families and understand what is working and what might need more work.

Chapters 2 through 10 include lists of additional resources, such as reports and websites, and Chapters 4 through 10 include tools. For example, Chapter 5, Planning, offers examples of survey instruments that a community can use to help identify transportation needs. Chapter 9, Communication, includes examples of messages to communicate to veterans, active duty military, or family members, as well as suggestions for publicizing the transportation improvements—from print media to social media, including the use of QR or quick response codes and widgets.

TCRP Report 164, *Community Tools to Improve Transportation Options for Veterans, Military Service Members, and Their Families*, is available from the TRB Bookstore at <https://www.mytrb.org/Store/Product.aspx?ID=6079> or can be viewed online via www.trb.org/Main/Blurbs/170466.aspx.



AIRPORT COOPERATIVE RESEARCH PROGRAM REPORT

Evaluating Impacts of Sustainability Practices on Airport Operations and Maintenance

JENNIFER SALERNO

PHOTO: SAN DIEGO COUNTY REGIONAL AIRPORT AUTHORITY



Low-water landscaping at San Diego International Airport. Airports are increasingly implementing sustainability practices.

The author is Lead Associate, Booz Allen Hamilton, McLean, Virginia.

As part of its Recovery Action Plan, San Francisco International Airport protects the habitat of the endangered San Francisco garter snake on its undeveloped property.

PHOTO: SAN FRANCISCO INTERNATIONAL AIRPORT



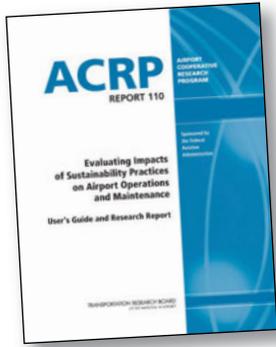
Many airports are implementing sustainability practices, which range from a changeover to light-emitting diode (LED) bulbs or low-flow toilets to purchasing alternative-fuel vehicles or expanding the recycling program. These sustainability initiatives often introduce new systems, practices, or equipment that airport maintenance departments must support and maintain. Nevertheless, many maintenance departments are not given the opportunity to evaluate or raise concerns about the requisite support and maintenance before the implementation.

To ensure the success of new sustainability practices, airports should assess the full life-cycle budgetary and operational implications of a practice—some practices may require more maintenance and upkeep than anticipated. Airports also should engage operations and maintenance departments early on, to ensure that the planning is proper and comprehensive. To help in this planning, the Airport Cooperative Research Program (ACRP) launched a project to develop an evaluation process and cost-benefit tools so that airport staff could consider and address the operations and maintenance impacts of sustainability practices.

Tool Capabilities

Published in conjunction with ACRP Report 110, *Evaluating Impacts of Sustainability Practices on Airport Operations and Maintenance*, the evaluation process and cost-benefit tool (EP&CBT) evaluates the day-to-day impacts on airport operations and maintenance from the implementation of sustainability initiatives. The tool assesses sustainability practices related to water or energy conservation, waste management, alternative fuels, and consumables and materials and can assist in comparisons of alternatives.

The spreadsheet-based EP&CBT assists airport facility operations and maintenance staff, airport managers responsible for selecting sustainability initiatives, and airport groups that establish sustainability policies to address operations and maintenance considerations in the decision-making process. Some airports already have their own fully developed operations and maintenance cost-benefit procedures and tool suites for analyzing the implementation of new sustainability practices. The ACRP tool primarily will be of interest therefore to the small to medium-size airports that lack cost-benefit tools. Nevertheless, the EP&CBT can supplement the decision-making process at airports of all sizes.



ACRP Report 110, *Evaluating Impacts of Sustainability Practices on Airport Operations and Maintenance*, is available from the TRB Bookstore at <https://www.mytrb.org/Store/Product.aspx?ID=7228> or can be viewed online via www.trb.org/Main/Blurbs/170580.aspx.

The EP&CBT consists of an inputs section and an outputs section. The EP component guides the user to scope the analysis and to collect relevant data for the cost-benefit component. The tool interface consists of a progression of worksheets that provide information and obtain inputs from the user, producing calculations and displays of output results.

Tool Development

The tool development required a case study to obtain data about current practices and potential improvements to the way airports evaluate the operations and maintenance impacts of sustainability practices. The case study served as the foundation for the EP&CBT. The project followed a three-phase approach:

- ◆ Interviews with airport personnel to validate the tool requirements and to collect data;
- ◆ Development of the EP&CBT proof-of-concept from research information and from recommendations in the interviews; and

- ◆ Testing the proof-of-concept with airport staff to refine the EP&CBT.

The resulting tool allows the user to enter quantitative and qualitative information to display key metrics in numerical and graphical form. Potential enhancements and adaptation of the evaluation process and tool are possible as new sustainability practices emerge.

Meshing with Other Tools

The EP&CBT complements other ACRP reports and tools, including the website of the Sustainable Aviation Guidance Alliance (SAGA)¹ and ACRP Report 119, *Prototype Airport Sustainability Rating System: Characteristics, Viability, and Implementation Options*.²

Synergistic relationships with these and other projects are possible. For example, the EP&CBT could be used to evaluate practices identified in the SAGA sustainability database.

¹ www.airportsustainability.org.

² <http://www.trb.org/ACRP/Blurbs/171840.aspx>.

Rockfall: Characterization and Control

Timely Practical Resource!

On many major transportation routes, the degradation of rock exposures constructed 30 to 40 years ago has increased rockfall-induced traffic disruptions, accidents, and injuries.

Demands for improved rockfall evaluation and mitigation have encouraged adoption of new technologies to support new approaches to provide protections from rockfall hazards.

To make comprehensive information about these technologies and approaches widely available, the Transportation Research Board (TRB) has published *Rockfall: Characterization and Control* to address rockfall hazard identification and evaluation, investigation, mitigation, and maintenance and management.

The 658-page book comprises 18 chapters authored by internationally recognized rockfall experts. An accompanying DVD features instructive video clips—including historic footage—documenting rockfall field tests.

The text is written to appeal to a diverse audience, including transporta-

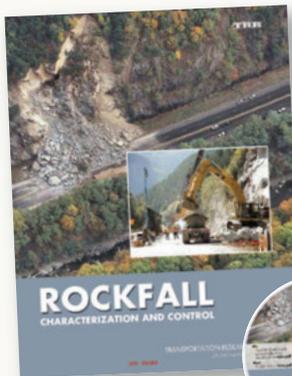


tion engineers responsible for rockfall investigations, students, and researchers who need a definitive resource on rockfall investigation and mitigation.

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Optimization of Tack Coat Applications in Asphalt Pavements

Louisiana Develops Evaluation Tools and Pilot-Tests Guidance

LOUAY N. MOHAMMAD, MOSTAFA A. ELSEIFI, AND WILLIAM (BILL) KING, JR.

Mohammad is Professor of Civil and Environmental Engineering, Louisiana State University (LSU), and Director, Engineering Materials Characterization Research Facility, Louisiana Transportation Research Center (LTRC), Baton Rouge. Elseifi is Associate Professor, Civil and Environmental Engineering, LSU. King is Materials Research Administrator, LTRC.

Tack coat is a light application of asphalt—usually asphalt emulsion diluted with water—onto a relatively nonabsorptive pavement surface. The tack coat provides an adequate bond between the surface and the newly placed pavement (1). Bonding at the interface of pavement layers ensures that the layers behave as a single system in withstanding traffic and environmental stresses. Practitioners have favored emulsified tack coats instead of cutback asphalts because emulsified tack coats provide additional benefits, such as reduced energy consumption, fewer environmental impacts, and increased personnel safety.

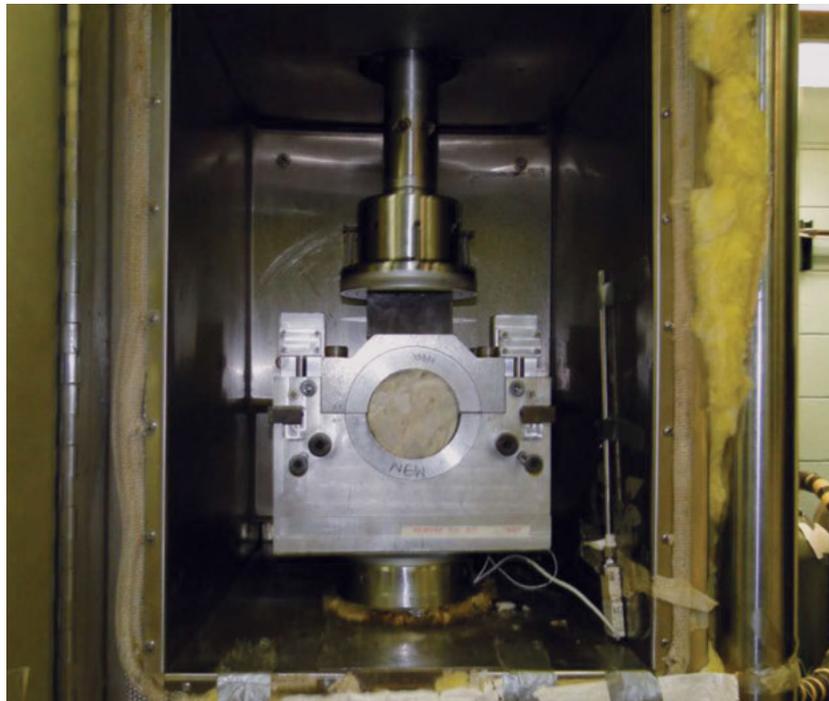
Problem

The selection of the optimum tack coat material and the determination of an application rate appropriate to the condition of the pavement surface are critical for developing the bond strength between pavement layers. Generally, the tack coat does not cover the entire surface; moreover, an excessive application of tack coat may promote shear slippage at the interface.

For the most part, experience, convenience, or empirical judgment have guided the selection of tack coats. Quality control and quality assurance testing of the tack coat construction process is rare. Research was needed, therefore, to develop procedures for



The Louisiana Tack Coat Quality Tester, developed to evaluate the quality of the bond strength of tack coat in the field.



The Louisiana Interlayer Shear Strength Tester, developed to characterize the interface shear strength of cylindrical specimens in the laboratory.

selecting tack coats and evaluating their quality in field applications.

Solution

Research Scope

For National Cooperative Highway Research Program (NCHRP) Project 9-40, Optimization of Tack Coat for Hot-Mix Asphalt (HMA) Placement, investigators assessed many plausible factors affecting the characteristics of the interface bond between newly placed pavement and the surface covered (2). The research results identified the optimal application methods, including the types of equipment, the procedures for calibration, and the rates for tack coat application. The findings led to proposed revisions to the American Association of State Highway and Transportation Officials' (AASHTO's) methods and practices related to tack coats.

During the NCHRP project, the research team developed the Louisiana Tack Coat Quality Tester (LTCQT) to evaluate the quality of the bond strength of tack coat in the field with an acceptable repeatability, described by a coefficient of variation (CV) of 11 percent. The Louisiana Interlayer Shear Strength Tester (LISST) also was developed during the NCHRP project to characterize the interface shear strength of cylindrical specimens in the laboratory. The LISST was designed to fit into any universal testing machine and to achieve an acceptable repeatability with a CV of less than 15 percent.

The research team also constructed full-scale test overlays with different tack coat application rates

between a new HMA overlay over four surfaces: old HMA, new HMA, milled HMA, and grooved portland cement concrete (PCC). Three application rates were used for each of five types of tack coat materials: slow setting (SS-1h), SS-1, cationic rapid setting (CRS-1), nontracking tack coat, and Performance Grade 64-22. The quality of the tack coat application was evaluated with the LTCQT, and specimens were cored from the test pavements to measure the interface shear strength on the LISST.

Results and Findings

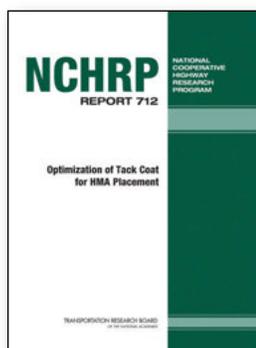
The NCHRP project investigated the effects of emulsified tack coat types, surface types, and application rates. The effects of conditions such as the dustiness of the pavement surface and the wetness of the tacked surface—for example, from a rainfall—also were investigated. The analysis led to the following conclusions:

- ◆ Among the emulsified tack coats, the nontracking tack coat exhibited the highest interface shear strength, and the CRS-1 emulsion the lowest.

- ◆ All tack coat materials showed the highest interface shear strength at a residual application rate of 0.155 gallon per square yard (gsy). This may indicate that under actual field conditions, optimum application rates are greater than what is commonly predicted from laboratory-based experiments. Higher application rates may increase interface shear strength, but excessive tack coat may migrate into the new asphalt mat during compaction, decreasing the air void content of the mix.

- ◆ The differences between clean and dusty conditions were statistically significant, but the differences between dry and wet conditions were not. These results indicated that a small amount of water can be flashed away by the heat from the HMA mat, so that the effects on the quality of the tack coat may be inconsequential. Nevertheless, only a small amount of water was used to simulate rainy conditions; therefore the recommendation specifies a dry and clean surface, to avoid any negative effects from water on the bonding at the interface.

- ◆ The roughness of the surface directly affected the shear strength at the interface. The milled HMA



NCHRP Report 712, *Optimization of Tack Coat for HMA Placement*, is available from the TRB Bookstore at <https://www.mytrb.org/Store/Product.aspx?ID=2355> or can be viewed online at www.trb.org/Main/Blurbs/166969.aspx.

TABLE 1 Recommended Tack Coat Residual Application Rate

Surface Type	Residual Application Rate (gsy)
New HMA	0.035
Old HMA	0.055
Milled HMA	0.055
Portland cement concrete	0.045

surface provided the greatest interface shear strength, followed by the grooved PCC, the old HMA, and the new HMA surfaces.

◆ Table 1 (page 44) presents the recommended residual application rates of tack coat for different surface types. A 50 percent coverage reduced the interface shear strength by 50 to 70 percent. Moreover, increases in the tack application rate tended to decrease the interface shear strength in laboratory-prepared specimens, but to increase the interface shear strength in the field.

◆ According to a finite element analysis of results from the LISST, 40 pounds per square inch is the minimum laboratory-measured interface shear strength that provides acceptable performance.

Application and Implementation

AASHTO is considering adoption of two test procedures for tack coats; the procedures determine the interlayer shear strength of the asphalt pavement layers and evaluate the tack coat quality in the field with the LTCQT or in the laboratory with the LISST. Many state DOTs are considering adjustments to the required tack coat materials and application rates for different surface types.

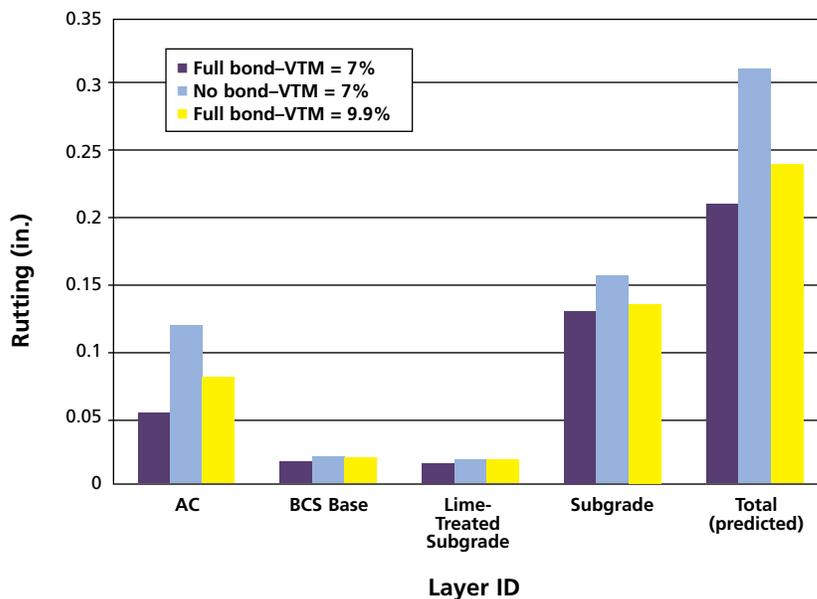
Louisiana DOTD was the first agency to implement the recommended tack coat application rates. Six pilot projects in the state evaluated the new specifications, including the recommended application rates. Florida DOT is using the LISST in conflict resolution and forensic cases and in the approvals for new tack coat materials based on field tests.

To support the implementation of the LISST test method by state DOTs, NCHRP initiated a follow-up project to evaluate the device in field projects. The objective is to validate the LISST test method in the field and to recommend application rates. Field projects will be selected and sampled with the LISST device, and pavement performance will be monitored—for example, rutting, slippage, roughness, and more.

Benefits

Calculations with the AASHTOWare Pavement Mechanistic–Empirical Design software suggested possible cost savings from the changes in state specifications. A simulation was performed with data from a rehabilitated pavement section of US-190 in West Baton Rouge Parish, Louisiana, and the performance was evaluated for major pavement distresses. The simulation explored three cases for the effects of tack coat application rates:

◆ Fully bonded, with adequate voids in total mix (VTM);



- ◆ No bonding, with optimum VTM; and
- ◆ Fully bonded, with high VTM.

As shown in Figure 1 (above), the unbonded case exhibited the highest level of rutting, both in the asphalt layer and in the total pavement layers, and the fully bonded case with adequate VTM after construction exhibited the lowest level of rutting. These results demonstrate the need for applying the tack coat to the interface at the recommended rate.

For more information, contact Louay N. Mohammad, Louisiana State University, LTRC Building, 4101 Gourrier Avenue, Baton Rouge, LA 70808; telephone: 225-767-9126; e-mail: louaym@lsu.edu.

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EDITOR'S NOTE: Appreciation is expressed to G. P. Jayaprakash, Transportation Research Board, for his efforts in developing this article.

Suggestions for Research Pays Off topics are welcome. Contact G. P. Jayaprakash, Transportation Research Board, Keck 488, 500 Fifth Street, NW, Washington, DC 20001 (202-334-2956; gjayaprakash@nas.edu).

FIGURE 1 Predicted rutting performance for different pavement analysis cases (AC = asphalt concrete; BCS = blended calcium sulfate).

Larry Galehouse

National Center for Pavement Preservation

An early champion for infrastructure preservation, Larry Galehouse managed maintenance programs at the Michigan Department of Transportation (DOT) long before starting the National Center for Pavement Preservation (NCP). In the 1990s he developed guidelines, specifications, and new processes for Michigan DOT's Capital Preventive Maintenance Program, a model used for similar programs nationwide to extend highway pavement life. He also worked on the original Lead States Team for Pavement Preservation designed by the American Association of State Highway and Transportation Officials (AASHTO). "Every team member was personally committed to the success of pavement preservation and felt that we were blazing a new trail," Galehouse comments.



"Our highway infrastructure took decades and generations of Americans to build and is simply too valuable to be left to languish."

"Our highway infrastructure took decades and generations of Americans to build and is simply too valuable to be left to languish," Galehouse observes. "As with any valuable asset, we must work hard to preserve it by judicious and timely proactive maintenance."

In 2003, Galehouse founded NCP, a collaborative agreement between Michigan State University and FP², Inc., to advance preservation through outreach, teaching, and research. "Starting any new venture takes perseverance, but with the help of many people, we were successful," he notes.

NCP manages the Transportation System Preservation—Technical Services Program (TSP-2), created to disseminate information to AASHTO member agencies for preserving their highway infrastructure, particularly pavements and bridges. The program serves as a clearinghouse of comprehensive, up-to-date information on efficient and effective preservation measures. NCP also administers the AASHTO Equipment Management Technical Services Program (EMTSP), which supports successful governmental highway equipment fleet management. Under these programs, separate regional partnerships have been created for pavement preservation, bridge preservation, and equipment management, drawing professionals from federal, state, and local agencies; private industry; consulting firms; and academia.

"When you think about it, three of the largest assets of any

highway agency are its pavements, bridges, and equipment fleet," Galehouse observes. NCP, TSP-2, and EMTSP each host an extensive website with a freely accessible library of technical and policy resources.

"Understanding the theory and practice of pavement and bridge preservation and equipment fleet management is critical for successful program implementation within highway agencies," Galehouse notes, adding that these programs have helped coordinate and expand resource management efforts among agencies. "Many highway agency personnel now realize the positive benefits of these programs."

For many years Galehouse and his staff have collected and reviewed baseline information for the Federal Highway Administration (FHWA) on the pavement preservation activities of federal, state, and local agencies. This data collection has involved on-site appraisals with the agencies to discuss their programs and obstacles to implementing a preservation program. More than 40 agencies—state DOTs, the National Park Service, the U.S. Fish and Wildlife Service, the FHWA Federal Lands Division, and several county highway departments—have been evaluated. The resulting information has helped develop national guidance on preservation and now resides in an accessible online database to help agencies set their own preservation benchmarks.

Galehouse also has facilitated pavement preservation technical transfers to highway agencies in Estonia, Latvia, Lithuania, the Caribbean Islands, and China, and he has negotiated and helped arrange engineering student exchanges between Michigan State University and the South China University of Technology in Guangzhou, China.

"I am keenly aware of the necessity to train ever-changing highway agency and contract personnel in the application of new materials and the operation of sophisticated equipment," Galehouse shares. "Training and certification can help ensure reliable and high-quality preservation."

Galehouse affirms the value of both basic and applied research, which are vital to assessing innovative practices in the real world. "Basic research is needed to develop new materials and techniques; applied research is needed to incorporate advances and improvements into day-to-day operations," he comments. "To do this successfully, we must recognize opportunities and make the case for innovation with officials who may have natural tendencies to resist change."

Galehouse helped champion the formation of a TRB Standing Committee for Pavement Preservation. He became the first chair of the committee and worked to increase awareness of preserving the nation's highway investment. Galehouse received bachelor's degrees in civil engineering from Michigan State University and in surveying from Ferris State University in Big Rapids, Michigan. He served in the U.S. Navy Seabees during the Vietnam War.

Cecil L. Jones

Diversified Engineering Services, Inc.

Early in his career, Cecil L. Jones—then a field engineer at the North Carolina Department of Transportation (DOT)—benefited from the knowledge of experienced mentors on such major projects as constructing a link of Interstate 95. “I realized a need early on for dedicated research to help solve problems faced by practitioners,” he recalls. When assisting with implementation of products from the first Strategic Highway Research Program in the 1990s, Jones relied on research and realized its value for practitioners. “Sound and focused research facilitates a good understanding of technology and ensures a smooth transition during implementation,” he comments.



“Sound and focused research facilitates a good understanding of technology and ensures a smooth transition during implementation.”

President of Diversified Engineering Services, Inc., which he founded in 2009, Jones applies his expertise to issues related to transportation research, standards and specifications, training and certification, the evaluation and implementation of new technology, recycled materials, resolution of construction disputes, pavement preservation, and general materials quality management. He has developed specifications for the American Association of State Highway and Transportation Officials (AASHTO) and has conducted research for the National Cooperative Highway Research Program (NCHRP) on pavement marking, concrete permeability, training standards, and the update of the *Mechanistic–Empirical Pavement Design Guide*, among other topics.

Jones notes that his involvement in transportation research and with the Transportation Research Board helps him meet the needs of his clientele. “The ability to see and understand the new technologies developing today is a benefit to me and to clients in these rapidly changing times,” he comments, adding that well-managed research quickly finds its way into implementation and rarely sits “on the shelf.”

After receiving a bachelor’s degree in civil engineering from North Carolina State University in 1973, Jones joined North Carolina DOT as an engineer. He worked in field construction, coordinating contracts, personnel, payments, and specifica-

tions for major projects and in the Central Construction Unit, managing claims and specifications revisions.

“As my career progressed to the central construction unit, I became more aware that the problems I faced were exactly the same as those of engineers in other offices across the state,” Jones observes. At this time he was introduced to TRB by colleagues who would return from the TRB Annual Meeting with copies of papers to circulate throughout the department.

“I began to get a more global perspective about the existence of an organization that was able to offer solutions to the bigger issues affecting practitioners,” Jones comments.

Jones then became the state materials engineer, supervising quality control for the materials and manufactured products used in North Carolina’s 80,000-mile transportation system and overseeing lab facilities and training, certification processes, and quality assurance programs. Jones also attended his first TRB Annual Meeting in the late 1980s. At the time, a limited number of copies of the papers presented at the meeting were available to take home; Jones recalls strategizing with colleagues to maximize the amount of papers they collected.

TRB staff encouraged participation in committees and on Cooperative Research Programs project panels; in 1995, Jones joined an NCHRP panel investigating the refinement of Superpave® gyratory compaction procedures. He credits his time in that group for the confidence to adapt North Carolina DOT’s specifications during the agency’s Superpave implementation process. Jones also has participated in NCHRP project panels examining such subjects as thermoplastic drainage pipe design and testing, culvert rehabilitation, and the field performance of corrugated pipe.

As a state materials engineer, Jones was required to be familiar with many different issues related to materials. “Through such organizations as TRB, dependable and technically sound resources are available to help navigate the complex matrix of issues faced today,” he notes.

Jones became a member of the TRB Standing Committee on Characteristics of Nonasphalt Components of Asphalt Paving Mixtures in 1998. In 2001, he joined the Standing Committee on Subsurface Soil–Structure Interaction and became chair in 2006. Jones also is a member of the Standing Committee on Culverts and Hydraulic Structures and of the Design and Construction Group.

“Serving on a committee is one way to have a voice in the direction of future research and guiding the direction it takes in a way to benefit everyone,” Jones observes.

A Professional Engineer in the state of North Carolina, Jones has been active in the AASHTO Subcommittee on Materials since 1992 and has served as Regional Vice Chair and chair of the Recycling Task Force. He is a fellow of the American Concrete Institute and a member of ASTM.

TRB HIGHLIGHTS

Expanding Partnerships and Collaboration: TRB, National Parks, and Federal Lands

KATHERINE F. TURNBULL

The author is Executive Associate Director, Texas A&M Transportation Institute, and past Chair, TRB Technical Activities Council. She is the recipient of the 2014 W. N. Carey, Jr., Distinguished Service Award.

The Transportation Research Board (TRB) provides forums to engage diverse stakeholders in defining and addressing critical transportation issues. The Standing Committee on Transportation Needs of National Parks and Public Lands hosted the Conference on Transportation and Federal Lands: Enhancing Access, Mobility, Sustainability, and Connections at the National Academy of Sciences building in Washington, D.C., September 15–17, 2014.

The committee's first-ever sponsored conference attracted 140 participants from TRB's traditional partners, the U.S. Department of Transportation, universities, and consulting firms. Representatives of several new stakeholders also attended from the National Park Service (NPS), the U.S. Fish and Wildlife Service (FWS), the U.S. Forest Service, and other land management agencies.

More than 50 presentations in 13 breakout sessions explored the diversity of transportation issues and opportunities associated with national parks and public lands—innovative transit services, intelligent transportation systems (ITS), smartphone apps, bicycle facilities, multiuse trails, and more. Speakers also discussed new planning applications, the rehabilitation of historic roadways, enhanced multiagency cooperation, and ways to attract diverse demographic and age groups to parks and public lands. Other workshops and roundtables focused on implementation of the Federal Lands Access Program contained in the Moving Ahead for Progress in the 21st Century Act, alternative transportation systems business models, the NPS Long-Range Transportation Plan, and the use of existing data sets for transportation planning.

At the opening plenary session, Greg Winfree, Assistant Secretary for Research and Technology, U.S. Department of Transportation (DOT), and Jon Jarvis, NPS Director, highlighted the importance of collaboration and cooperation between land management and transportation agencies. Winfree noted the recent collaborative efforts between U.S. DOT and NPS on ITS and on new transit services, including the successful Island Explorer bus line in Maine's Acadia National Park.

Jarvis addressed the importance of collaboration among federal and state agencies, local communities, and volunteer groups in addressing transportation needs in and around parks. He noted that the theme of the 2016 NPS Centennial, "Find Your Park," is broad and aims to encompass and promote visits to national parks and other public lands.

A panel featuring consultant Alan Pisarski; Todd Davidson, Travel Oregon; Art Guzzetti, American Public Transportation Association; and Jana Lynott, AARP Public Policy Institute, discussed trends in tourism, recreation and travel, and the implications for NPS and public lands. Participants suggested that several trends point to an increase in visitors to parks from the United States and abroad.

Attendees also learned about the history and the unique transportation challenges associated with the National Mall, Theodore Roosevelt Island, and the FWS Patuxent Research Refuge in Laurel, Maryland, on tours led by NPS and FWS staff.

The Standing Committee on Transportation Needs of National Parks and Public Lands is planning sessions on the NPS Centennial and the Federal Road Act of 1916 for the 2016 TRB Annual Meeting.



The Standing Committee on Transportation Needs of National Parks and Public Lands convened its first-ever conference in September 2014 at the National Academy of Sciences building in Washington, D.C.

TRB Library Collection and Services

The TRB Library collection includes all publications from the Transportation Research Board, Highway Research Board, the first and second Strategic Highway Research Programs, and the Marine Board—from 1923 to the present—along with current and back issues of nearly 300 journals. A small general collection also includes transportation and engineering books and conference proceedings.

The library was founded in 1946 to provide information services to TRB staff, sponsors, TRB committees and panels, and researchers, and offers the following services:

- ◆ Consulting to help focus transportation research;
- ◆ Identifying the appropriate TRB staff member to help answer questions;
- ◆ Conducting literature reviews for projects;
- ◆ Verifying the accuracy of citations;
- ◆ Compiling transportation-related bibliographies;
- ◆ Reading through the literature to identify pertinent information; and
- ◆ Training users on the TRB research databases, including TRID, Research in Progress, and the Publications Index.

For more information, contact the TRB Library at 202-334-2989, or e-mail trblibrary@nas.edu.

IN MEMORIAM

Elaine King, 1943–2014

Former TRB staff member Elaine King, 71, died December 18, 2014, in Silver Spring, Maryland.

The first female senior program officer at TRB, King retired in 2010 after 25 years coordinating more than 80 committees and task forces in the Rail and Freight Systems Groups, as well as supporting policy studies and Cooperative Research Program projects. She was an integral part of the rail and freight communities and pioneered many rail initiatives and agreements. From late 1987 until early 1990, she chaired the *TR News* editorial board.

Originally from Kittanning, Pennsylvania, King graduated with an economics degree from the Wharton School at the University of Pennsylvania. She worked in banking and statistical analysis before moving to Nepal to work in hotel management at the Tiger Tops Hotel in Kathmandu, now a famous high-end ecotourism establishment.

King's interest in rail was sparked in the 1970s, when she evaluated branch lines on the Penn Central Railroad for the Governor's Office of State Planning and Development. She joined the Pennsylvania Department of Transportation (DOT) as a rail economist and negotiated operating agreements between Conrail and shortline railroads that allowed many rail lines to stay open. She then became Chief of Goods Movement at Pennsylvania DOT and helped create their Rail Freight Program, a model for state rail programs nationwide.



Elaine King speaking at a TRB reception for her retirement in 2010.

SECOND STRATEGIC HIGHWAY RESEARCH PROGRAM NEWS

Workshop Showcases SHRP 2 Implementation

SHRP 2 tools for pavement preservation were highlighted in a workshop hosted by Minnesota DOT in September. Transportation professionals from across the United States and Canada examined guidance developed in SHRP 2 and Minnesota DOT's experience in implementing the guidance.

Minnesota DOT received funding from the Implementation Assistance Program, managed by the Federal Highway Administration and the American Association of State Highway and Transportation Officials, to use *Guidelines for the Preservation of High-Traffic-Volume Roadways*, developed under SHRP 2 Project R26, to test and implement pavement preservation treatments. Along with the report *Preservation Approaches for High-Traffic-Volume Roadways*, the guidelines provide the technical background and a decision-making framework for deploying preservation strategies on high-traffic roads.

A new SHRP 2 brochure shows examples of the 14 agencies that have used the SHRP 2 guidance, as



FINAL MEETING—Members of the second Strategic Highway Research Program (SHRP 2) Oversight Committee gather at the Keck Center for their final meeting in December. The committee has supervised all aspects of the program, developing procedures, practices, and applications to advance the nation's highway system. Authorized by Congress in 2005, SHRP 2 will continue through March 2015.

well as implementation assistance funding. According to AASHTO, agencies are testing approximately 13 preservation treatments on more than 30 high-traffic roads.

For more information on pavement technologies and other SHRP 2 solutions, visit SHRP2.transportation.org or www.fhwa.dot.gov/goshrp2.

CALENDAR

TRB Meetings

March					
23–26	2015 Joint Rail Conference* San Jose, California	24–26	5th International Symposium on Nanotechnology in Construction* Chicago, Illinois	28–31	TRANSED 2015: 14th International Conference on Mobility and Transport for Elderly and Disabled People* Lisbon, Portugal
April		TBD	Workshop on Connected Vehicle Dynamic Mobility Applications and Multimodal Intelligent Traffic Signal Systems	TBD	14th AASHTO-TRB Conference on Transportation Infrastructure Maintenance and Operations* Des Moines, Iowa
13–14	Moving Active Transportation to Higher Ground: Opportunities for Accelerating the Assessment of Health Impacts Washington, D.C.	June			
16–17	Ferry Safety and Technology: Design and Operations Conference New York, New York	1–2	5th International Conference on Transportation Systems Performance Measurement and Data Denver, Colorado	August	
19–22	AASHTO GIS for Transportation Symposium* Des Moines, Iowa	7–10	American Society of Civil Engineers 2015 Airfield and Highway Pavements Conference Miami, Florida	2–5	International Symposium on Systematic Approaches to Environmental Sustainability in Transportation Fairbanks, Alaska
21–23	International Highway Technology Summit: Cities, Transportation, and People* Shanghai, China	10–12	6th International Conference on Bituminous Mixtures and Pavements* Thessaloniki, Greece	9–12	44th Annual International Congress and Exposition on Noise Control Engineering* San Francisco, California
26–28	International Bridge, Tunnel, and Turnpike Association Transportation Finance and Road Usage Charging Conference Portland, Oregon	22–24	5th International Symposium on Highway Geometric Design* Vancouver, British Columbia, Canada	9–13	9th International Conference on Road and Airfield Pavement Technology Dailan, China
May		TBD	Workshop on 2015 <i>Highway Capacity Manual</i> Update Little Rock, Arkansas	TBD	2nd International Conference on Public-Private Partnerships* Austin, Texas
7–8	Transportation for Sustainability: An International Conference Washington, D.C.	TBD	North American Transportation Statistics Interchange 2015 Washington, D.C. (invitation only)	September	
10–15	International Choice Modeling Conference* Austin, Texas	July		1–3	Transit GIS Conference* Washington, D.C.
17–19	9th National Aviation System Planning Symposium Charleston, South Carolina	12–15	11th International Conference on Low-Volume Roads Pittsburgh, Pennsylvania	7–9	3rd Conference on Smart Monitoring, Assessment, and Rehabilitation of Civil Structures* Antalya, Turkey
17–21	15th TRB National Transportation Planning Applications Conference Atlantic City, New Jersey	18–22	54th Annual Workshop on Transportation Law Chicago, Illinois	14	Geotechnical Risk Assessment and Performance Management Sturbridge, Massachusetts
18–22	9th International Conference on Managing Pavement Assets* Alexandria, Virginia			15–17	International Symposium on Nondestructive Testing in Civil Engineering* Berlin, Germany

Additional information on TRB meetings, including calls for abstracts, meeting registration, and hotel reservations, is available at www.TRB.org/calendar or send an e-mail to TRBMeetings@nas.edu.

*TRB is cosponsor of the meeting.

NEWS BRIEFS

Photo: Roni Rietz, Flickr



(Photo, left:) Salt Lake City's GreenBike program doubled in size in its first year.

reported increasing their use of rail transit. Most respondents from Montreal, Canada; Toronto, Canada; and Mexico City, Mexico, reported that their rail use decreased; and respondents in other cities did not report a change. According to researchers, however, nearly all users reported that they drove less than before they began bikesharing.

For more information, visit <http://transweb.sjsu.edu/project/1029.html>.

Motorcycle Crash Data Point to Safety Measures

Although the fatality rate for motorcyclists has decreased from nearly 70 per 100,000 registered vehicles in 2003 to less than 60 per 100,000 vehicles in 2012, the total number of motorcyclists killed in motor vehicle traffic crashes has increased 7 percent, to 4,957, since 2011, according to the National Highway Traffic Safety Administration (NHTSA). The number of motorcyclists injured in crashes also rose, from 81,000 in 2011 to 93,000 in 2012. Motorcycles comprise 3 percent of all registered vehicles in the United States; the total number of registered motorcycles has increased from approximately 5.4 million in 2003 to slightly less than 8.5 million in 2012.

According to NHTSA, nearly one-quarter of motorcyclists involved in fatal crashes in 2012 were riding without a valid license at the time of the crash, and 34 percent were speeding. An alcohol-impaired rider accounted for 27 percent of all fatal motorcycle crashes. Approximately 59 percent of fatally injured motorcycle riders were wearing helmets at the time of the crash, according to the data; NHTSA estimates that helmets are 37 percent effective in preventing fatal injuries to riders—that is, 37 percent more riders would have died in accidents had they not been wearing helmets—and 41 percent effective for motorcycle passengers.

For more information, visit www.nhtsa.gov/Safety/Motorcycles.

Thefts, Helmet Use Down for Bikesharing Operations

A study by the Mineta Transportation Institute surveyed bikesharing operations in the United States, Canada, and Mexico. A literature review, interviews with nearly two dozen bikesharing organizations, and examination of information technology-based bikesharing programs, surveys, data analysis, and applications of geographic information systems contributed to several key findings:

Bicycle theft, which was prevalent in early bikesharing systems, is rare in newer programs. Features such as fines for lost bicycles and electronic smartcards that record user information, control access, and track usage have contributed to low rates of vandalism and theft.

Most bikeshare users rarely or never wear helmets; according to researchers, many jurisdictions that have compulsory helmet usage laws also report a lower usage of bikesharing programs. Some cities have revoked their helmet laws; others are considering helmet dispensing and sanitizing systems.

A diverse user base is crucial to a bikesharing system's long-term feasibility. Most users are young, white, and male, and are wealthier than the general population. Outreach subsidies and system deployment in low-income communities can help bikesharing systems serve all socioeconomic groups equitably. A system that serves mostly casual users instead of mostly regular users is more economically viable, according to researchers.

The effects of bikesharing programs on rail use were mixed. Bikesharing program members in Salt Lake City, Utah, and Minneapolis–St. Paul, Minnesota,

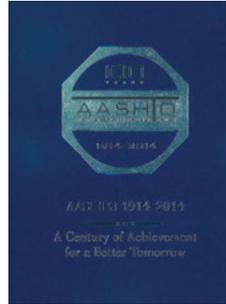
MOTORCYCLE DATA FOR SAFETY—Using naturalistic driving data from motorcycles equipped with data acquisition systems, Virginia Tech graduate student Alexandria Noble is exploring the potential for connected-vehicle technology to improve motorcycle safety. Noble is working with Virginia Tech Transportation Institute to conduct research connecting static alert systems—traffic signs and signals—with vehicles on the road. By harnessing naturalistic driving data and connected-vehicle technology, Noble hopes her research will alert motorcyclists to such problems as potholes that can pose hazards potentially fatal to them but minor to automobile drivers.



Photo: Virginia Tech News

AASHTO 1914–2014: A Century of Achievement for a Better Tomorrow

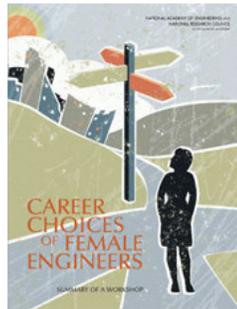
Chris Becker. *American Association of Highway and Transportation Officials (AASHTO)*; 2014; 336 pp.; AASHTO members, \$65; nonmembers, \$85; 1-56051-590-6.



This commemorative book, along with the AASHTO Centennial website at <http://centennial.transportation.org>, celebrates the 100th anniversary of AASHTO's founding. Timelines, snapshots, and state profiles track the transformation of American transportation since 1914 and AASHTO's leading role.

Career Choices of Female Engineers: A Summary of a Workshop

Policy and Global Affairs, National Research Council, and National Academy of Engineering. *National Academies Press*; 2014; 92 pp.; \$50; 978-03-0930-581-5.

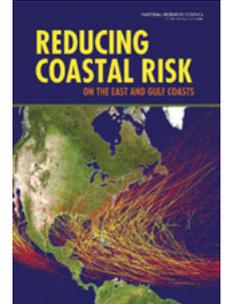


This volume summarizes a 2013 workshop of the National Research Council's Committee on Women in Science, Engineering, and Medicine on emerging research on the career pathways, decisions, and outcomes of women with engineering degrees.

The titles in this section are not TRB publications. To order, contact the publisher listed.

Reducing Coastal Risk on the East and Gulf Coasts

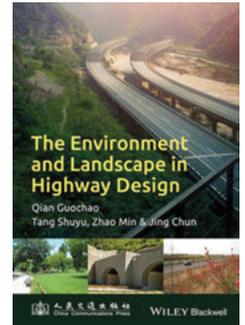
Water Science and Technology Board, Ocean Studies Board, Division on Earth and Life Studies, and National Research Council. *National Academies Press*; 2014; 208 pp.; \$55; 978-03-0930-586-0.



This report evaluates the economic, safety, and environmental effectiveness of coastal risk reduction strategies; most of these strategies and related issues are only funded once a disaster occurs. The development of a national vision for coastal risk management would include a long-term view, regional solutions, and recognition of the benefits of risk reduction.

The Environment and Landscape in Motorway Design

Guochao Qian, Shuyu Tang, Min Zhang, and Chun Jing. *Wiley-Blackwell*; 2014; 384 pp.; \$160, hardcover; \$128.99, e-book; 978-11-183-3297-9.



With effective landscaping, modern highways can be built to minimize the impacts of construction and operation on local residents and on ecological features. This volume explores the successful design of the Nanjing–Hangzhou Expressway in Jiangsu Province, China, to examine all aspects of highway landscaping.

TRB PUBLICATIONS

Developing Countries 2013

Transportation Research Record 2394

Vehicle ownership behavior of Indian households; bus rapid transit and metro systems in Mexico City, Mexico; and a comparison of joint mode and destination choice in Jakarta, Indonesia, are some of the topics addressed in this volume.

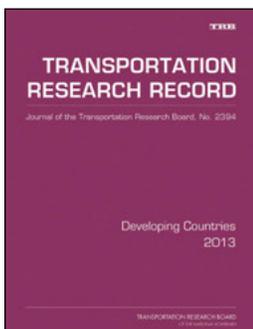
2013; 136 pp.; TRB affiliates, \$53.25; nonaffiliates, \$71. Subscriber categories: *planning and forecasting; environment; public transportation.*

Highway Capacity and Quality of Service 2013

Transportation Research Record 2395

The papers in this volume explore the breakdown maturity phenomenon on Wisconsin freeway bottlenecks, the development of an oversaturated speed–flow model, a capacity analysis procedure for nonstandard two-way stop-controlled intersections, and other topics.

2013; 138 pp.; TRB affiliates, \$53.25; nonaffiliates, \$71. Subscriber categories: *operations and traffic management; planning and forecasting.*



TRB PUBLICATIONS *(continued)***Freeway Operations; Regional Systems Management and Operations; Managed Lanes 2013**

Transportation Research Record 2396

Collisions in freeway traffic, an analysis of corridor management strategies, and lane-changing behavior along different types of high-occupancy vehicle facilities are some of the topics explored in this volume.

2013; 150 pp.; TRB affiliates, \$56.25; nonaffiliates, \$75. Subscriber category: operations and traffic management.

Planning 2013

Transportation Research Record 2397

The papers in this volume investigate such subjects as statewide multimodal planning, travel behavior and transit trip generation in transit-oriented developments, and resiliency performance measures for megaregional planning.

2013; 170 pp.; TRB affiliates, \$56.25; nonaffiliates, \$75. Subscriber categories: planning and forecasting; education and training; administration and management.

Highway Safety Performance 2013

Transportation Research Record 2398

Authors present research on the safety effects of horizontal curve and grade combinations on rural two-lane highways, estimating annual average daily traffic for local roads, safety performance functions, and more.

2013; 109 pp.; TRB affiliates, \$48.75; nonaffiliates, \$65. Subscriber category: safety and human factors.

Information Systems, Geospatial Information, State Data, and Advanced Computing 2013

Transportation Research Record 2399

Addressed in this volume are topics including the prediction of individual travel modes, data density requirements as functions of design speed, and translating transportation data between linear referencing systems.

2013; 120 pp.; TRB affiliates, \$48.75; nonaffiliates, \$65. Subscriber categories: administration and management; planning and forecasting.

Public-Sector Aviation: Graduate Research Award Papers, 2012–2013

Transportation Research Record 2400

Papers selected for awards in a nationwide graduate research competition explore topics including screening times at airport security checkpoints, runway incursion risks, airport capacity enhancement and flight predictability, and more.

2014; 97 pp.; TRB affiliates, \$48.75; nonaffiliates, \$65. Subscriber category: aviation.

Geomaterials 2014

Transportation Research Record 2401

The six papers in this volume examine flexural strength and elastic moduli of cement-stabilized materials, recementation reactivity of recycled concrete aggregate fines, and other topics.

2014; 57 pp.; TRB affiliates, \$43.50; nonaffiliates, \$58. Subscriber categories: materials, geotechnology; pavements.

Truck and Bus Safety; Roundabouts 2014

Transportation Research Record 2402

Research on such topics as truck impact hazards for Interstate overpasses, the construction of double-lane roundabouts, and managing peak period demands for U.S. roundabouts is presented in this volume.

2014; 77 pp.; TRB affiliates, \$45.75; nonaffiliates, \$61. Subscriber categories: safety and human factors; operations and traffic management; vehicles and equipment.

Environment and Sustainability 2014

Transportation Research Record 2403

The eight papers in this volume address habitat conservation plans, wayside traffic noise levels, livability ethics, and other topics.

2014; 71 pp.; TRB affiliates, \$44.25; nonaffiliates, \$59. Subscriber categories: environment; energy.

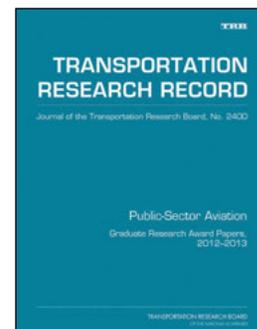
Operational Effects of Geometrics and Access Management 2014

Transportation Research Record 2404

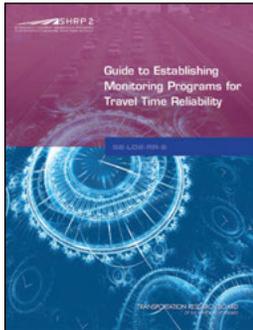
Authors present research on subjects including freeway deceleration speed-change lanes, double-crossover diamond interchanges in VISSIM microsimulation, and an assessment of how drivers react to driveway activity.

2014; 84 pp.; TRB affiliates, \$47.25; nonaffiliates, \$63. Subscriber categories: operations and traffic management; design; safety and human factors.

The TRR Journal Online website provides electronic access to the full text of approximately 14,800 peer-reviewed papers that have been published as part of the Transportation Research Record: Journal of the Transportation Research Board (TRR Journal) series since 1996. The site includes the latest in search technologies and is updated as new TRR Journal papers become available. To explore the TRR Online service, visit www.TRB.org/TRROnline.



TRB PUBLICATIONS (continued)

**Travel Survey Methods**

Transportation Research Record 2405

Trip purpose identification from GPS tracks, outliers in cell phone data, and the links between online activity and car use are among the topics explored in this volume.

2014; 77 pp.; TRB affiliates, \$47.25; nonaffiliates, \$63. Subscriber categories: data and information technology; planning and forecasting; passenger transportation.

**Structures 2014, Volume 1**

Transportation Research Record 2406

The papers in this volume address the design of an ultrahigh-performance concrete waffle deck for accelerated bridge construction, realistic heat-straightening repair on damaged steel beams, a concrete bridge data schema for interoperability, and more.

2014; 97 pp.; TRB affiliates, \$48.75; nonaffiliates, \$65. Subscriber categories: bridges and other structures; design.

Structures 2014, Volume 2

Transportation Research Record 2407

Authors present research on such topics as ultrasonic tomography to detect structural impairment in tunnel linings, a full-scale inflatable plug for flood mitigation in tunnels, and synthetic fiber-reinforced concrete pipes under long-term sustained loading.

2014; 93 pp.; TRB affiliates, \$47.25; nonaffiliates, \$63. Subscriber categories: bridges and other structures; design.

Guide to Establishing Monitoring Programs for Travel Time Reliability

SHRP 2 Report S2-L02-RR-2

The development, utility, and implementation of a travel time reliability monitoring system are examined in this volume.

2014; 149 pp.; TRB affiliates, \$51; nonaffiliates, \$68. Subscriber categories: highways; data and information technology; operations and traffic management; planning and forecasting.

Framework for Collaborative Decision Making on Additions to Highway Capacity

SHRP 2 Report S2-C01-RR-1

Presented in this volume is a framework supporting collaborative business practices for reaching decisions on adding highway capacity. Supporting materials are provided online at Transportation for Communities: Advancing Projects Through Part-

nerships at www.transportationforcommunities.com.

2014; 98 pp.; TRB affiliates, \$45.75; nonaffiliates, \$61. Subscriber categories: environment; highways; planning and forecasting; society.

Incorporating Reliability Performance Measures in Operations and Planning Modeling Tools

SHRP 2 Report S2-L04-RR-1

This report explores the underlying conceptual foundations of travel modeling and traffic simulation and provides a practical means for generating realistic reliability performance measures using network simulation models.

2014; 135 pp.; TRB affiliates, \$51; nonaffiliates, \$68. Subscriber categories: highways; operations and traffic management; planning and forecasting.

Measuring and Removing Dissolved Metals from Stormwater in Highly Urbanized Areas

NCHRP Report 767

Prototype best management practices for the removal of dissolved metals in stormwater runoff are explored using three conceptual configurations. An Excel spreadsheet on CD-ROM is included with the printed report.

2014; 172 pp.; TRB affiliates, \$54.75; nonaffiliates, \$73. Subscriber categories: highways; environment; hydraulics and hydrology.

Guide to Accelerating New Technology Adoption Through Directed Technology Transfer

NCHRP Report 768

This report presents a framework and guidance on how to use technology transfer to accelerate innovation within a state department of transportation or similar agency.

2014; 96 pp.; TRB affiliates, \$43.50; nonaffiliates, \$58. Subscriber categories: administration and management; education and training; research.

Guide for Public Transportation Pandemic Planning and Response

NCHRP Report 769

This guide is designed to help public transportation organizations prepare appropriately for service and response during pandemics and outbreaks of other infectious diseases.

2014; 56 pp.; TRB affiliates, \$36.75; nonaffiliates, \$49. Subscriber categories: public transportation; security and emergencies.

TRB PUBLICATIONS *(continued)****Estimating Bicycling and Walking for Planning and Project Development: A Guidebook***

NCHRP Report 770

Comprising a guidebook, GIS model, spreadsheets, and a contractor's report, this volume assists practitioners in estimating bicycling and walking demand for regional-, corridor-, or project-level analyses.

2014; 151 pp.; TRB affiliates, \$58.50; nonaffiliates, \$78. Subscriber categories: highways, pedestrians and bicyclists, planning and forecasting.

Strategies to Optimize Real Property Acquisition, Relocation Assistance, and Property Management Practices

NCHRP Report 771

Presented in this volume are integrated real property procedures and business practices in the project development and delivery process. A CD-ROM featuring a procedure model accompanies the print version of the report.

2014; 131 pp.; TRB affiliates, \$63.75; nonaffiliates, \$85. Subscriber categories: administration and management, planning and forecasting.

Evaluating the Performance of Corridors with Roundabouts

NCHRP Report 772

This report offers measurement and evaluation methods for comparing the performance of a corridor with a functionally interdependent series of roundabouts to a corridor with signalized intersections, to facilitate design solutions.

2014; 244 pp.; TRB affiliates, \$60; nonaffiliates, \$80. Subscriber categories: highways, design, operations and traffic management.

Capacity Modeling Guidebook for Shared-Use Passenger and Freight Rail Operations

NCHRP Report 773

This guidebook examines the modeling processes for defining and evaluating railroad capacity so that state agencies can determine if present capacity can support increased rail service or if infrastructure improvements are needed.

2014; 94 pp.; TRB affiliates, \$43.50; nonaffiliates, \$58. Subscriber categories: railroads, passenger transportation, planning and forecasting.

Superelevation Criteria for Sharp Horizontal Curves on Steep Grades

NCHRP Report 774

The results of field studies and vehicle dynamics

simulations to investigate combinations of horizontal curve and vertical grade design are presented.

2014; 192 pp.; TRB affiliates, \$54.75; nonaffiliates, \$73. Subscriber categories: design, operations and traffic management, safety and human factors.

Applying GPS Data to Understand Travel Behavior, Volumes I and II

NCHRP Report 775

This two-volume report offers research background, methods, and tests and a set of guidelines on the use of multiple GPS data sources to understand travel behavior and activity.

2014; 197 pp.; TRB affiliates, \$56.25; nonaffiliates, \$75. Subscriber categories: highways; data and information; planning and forecasting.

Guidebook for Energy Facilities Compatibility with Airports and Airspace

ACRP Report 108

This report describes processes to plan, develop, and construct energy production and transmission technologies at and around airports, with emphasis on aviation safety practices.

2014; 83 pp.; TRB affiliates, \$45.75; nonaffiliates, \$61. Subscriber categories: aviation; energy; environment.

Improving Terminal Design to Increase Revenue Generation Related to Customer Satisfaction

ACRP Report 109

Innovative airport planning and terminal design—and using technology and other resources to improve the airport customer experience—are examined in this handbook.

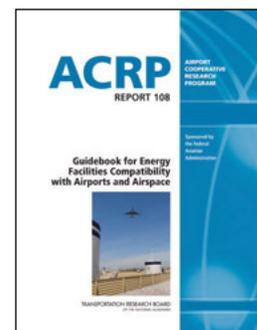
2014; 104 pp.; TRB affiliates, \$45.75; nonaffiliates, \$61. Subscriber categories: aviation; terminals and facilities.

Evaluating Impacts of Sustainability Practices on Airport Operations and Maintenance

ACRP Report 110

This report provides guidance on using an evaluation process and cost-benefit tool to evaluate life-cycle costs of sustainability practices being considered by airport operators. A CD-ROM accompanies the print version of the report.

2014; 123 pp.; TRB affiliates, \$48; nonaffiliates, \$64. Subscriber categories: aviation; environment.



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TRB PUBLICATIONS (continued)

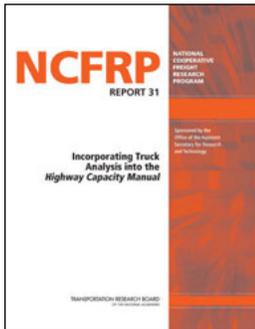


Establishing a National Transit Industry Rail Vehicle Technician Qualification Program—Building for Success

TCRP Report 170

Presented is a system of qualification developed for rail vehicle technicians that integrates national training standards, progressive classroom curricula, on-the-job learning modules, an apprenticeship framework, mentoring, and on-the-job learning.

2014; 60 pp.; TRB affiliates, \$15; nonaffiliates, \$20. Subject area: public transportation.



Suballocating FTA Section 5307 Funding Among Multiple Recipients in Metropolitan Areas

TCRP Synthesis 113

This synthesis documents the approaches, methodologies, and practices for the suballocation of U.S. Federal Transit Administration Section 5307 Formula Funds in urbanized areas of multiple types and sizes.

2014; 73 pp.; TRB affiliates: \$15; nonaffiliates, \$20. Subject areas: finance; planning and forecasting; public transportation; society.

Incorporating Truck Analysis into the Highway Capacity Manual

NCFRP Report 31

This report presents capacity and level-of-service techniques to improve transportation agencies' abilities to plan, design, manage, and operate streets and highways to serve trucks and to evaluate the effects of trucks on other modes of transportation. The techniques are being incorporated into the *Highway Capacity Manual* but will be useful to planners and designers working on projects with significant truck traffic.

2014; 145 pp.; TRB affiliates, \$48; nonaffiliates, \$64. Subscriber categories: design, freight transportation, planning and forecasting.

Transportation Research E-Circulars

E-Circulars comprise committee reports, interim research findings, and problem statements on timely topics. Recent circulars include the following:

- ◆ Progress Toward Performance-Graded Emulsified Asphalt Specifications (January 2014)
- ◆ Monitoring Bicyclist and Pedestrian Travel and Behavior (March 2014)
- ◆ Critical Issues in Aviation and the Environment 2014 (April 2014)
- ◆ The Future of TransXML: Workshop Summary (April 2014)
- ◆ Enhancing the Durability of Asphalt Pavements: Papers from a Workshop (September 2014)
- ◆ Developing Freight Fluidity Performance Measures (October 2014)
- ◆ Application of Reclaimed Asphalt Pavement and Recycled Asphalt Shingles in Hot-Mix Asphalt: National and International Perspectives on Current Practice (November 2014)
 - ◆ Application of Asphalt Mix Performance-Based Specifications (November 2014)
 - ◆ Innovative Applications of the *Highway Capacity Manual 2010* (December 2014)
 - ◆ Aligning Data Systems to Communicate with Decision Makers: A Peer Exchange (December 2014)
 - ◆ Data and Statistics for Valuing Transportation Infrastructure and Transportation's Contribution to the Economy (February 2015)
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INFORMATION FOR CONTRIBUTORS TO

TR NEWS

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FEATURES are timely articles of interest to transportation professionals, including administrators, planners, researchers, and practitioners in government, academia, and industry. Articles are encouraged on innovations and state-of-the-art practices pertaining to transportation research and development in all modes (highways and bridges, public transit, aviation, rail, marine, and others, such as pipelines, bicycles, pedestrians, etc.) and in all subject areas (planning and administration, design, materials and construction, facility maintenance, traffic control, safety, security, logistics, geology, law, environmental concerns, energy, etc.). Manuscripts should be no longer than 3,000 words (12 double-spaced, typed pages). Authors also should provide charts or tables and high-quality photographic images with corresponding captions (see Submission Requirements). Prospective authors are encouraged to submit a summary or outline of a proposed article for preliminary review.

RESEARCH PAYS OFF highlights research projects, studies, demonstrations, and improved methods or processes that provide innovative, cost-effective solutions to important transportation-related problems in all modes, whether they pertain to improved transport of people and goods or provision of better facilities and equipment that permits such transport. Articles should describe cases in which the application of project findings has resulted in benefits to transportation agencies or to the public, or in which substantial benefits are expected. Articles (approximately 750 to 1,000 words) should delineate the problem, research, and benefits, and be accompanied by one or two illustrations that may improve a reader's understanding of the article.

NEWS BRIEFS are short (100- to 750-word) items of interest and usually are not attributed to an author. They may be either text or photographs or a combination of both. Line drawings, charts, or tables may be used where appropriate. Articles may be related to construction, administration, planning, design, operations, maintenance, research, legal matters, or applications of special interest. Articles involving brand names or names of manufacturers may be determined to be inappropriate; however, no endorsement by TRB is implied

when such information appears. Foreign news articles should describe projects or methods that have universal instead of local application.

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- ◆ All manuscripts should be supplied in 12-point type, double-spaced, in Microsoft Word, on a CD or as an e-mail attachment.

- ◆ Submit original artwork if possible. Glossy, high-quality black-and-white photographs, color photographs, and slides are acceptable. Digital continuous-tone images must be submitted as TIFF or JPEG files and must be at least 3 in. by 5 in. with a resolution of 300 dpi. A caption should be supplied for each graphic element.

- ◆ Use the units of measurement from the research described and provide conversions in parentheses, as appropriate. The International System of Units (SI), the updated version of the metric system, is preferred. In the text, the SI units should be followed, when appropriate, by the U.S. customary equivalent units in parentheses. In figures and tables, the base unit conversions should be provided in a footnote.

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Access Management Manual— New, Updated, and Expanded!

TRB's *Access Management Manual*, second edition, provides a comprehensive, coordinated approach to transportation and community design to enhance mobility, mode choice, and environmental quality. The interdisciplinary guidance addresses access management as a critical part of network and land use planning and pertains to government decision makers at all levels, as well as to pedestrians, bicyclists, and operators of motorized vehicles. The revised and expanded new edition includes the following key updates:

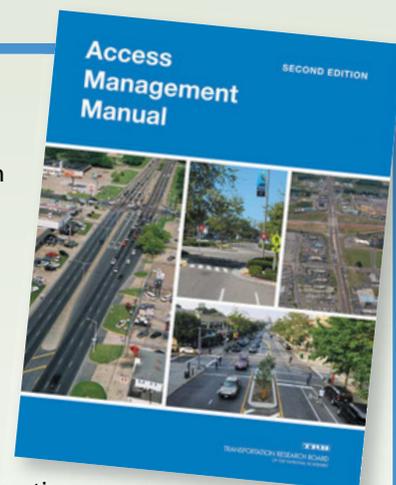
- Network and circulation planning and modal considerations;
- Frameworks and strategies for applications in a variety of contexts;
- Performance measures and monitoring;
- Corridor management planning, alternative funding, and cooperative agreements;
- Network planning, regional policies and programs, interchange areas, auxiliary lane warrants, rights-of-way, and access controls;
- Program development, staffing, training, internal coordination, and roles for transportation agencies; and

- Methods to improve coordination and cooperation between state agencies, local jurisdictions, and private developers—plus sample cooperative agreements.

Most chapters coordinate with sections of a companion volume in preparation, the *Access Management Application Guidelines (AMAG)*, which offers additional technical information, design criteria, and practical guidance, along with case examples. The AMAG is scheduled for publication in fall 2015 and will be sold separately.

Order your copy of *Access Management Manual*, second edition, today for \$120 (TRB affiliates \$90) from the TRB Online Bookstore:
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