
# TR NEWS

September–December 2023 NUMBER 347


# Transportation in Rural America

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Transportation Jurisdiction on Tribal Land

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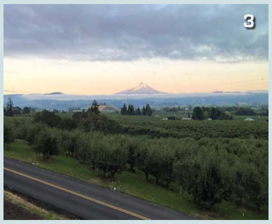

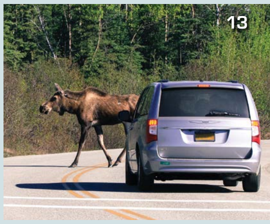




Christine Gerencher

**COVER** Lonely drives on winding roads define much of rural America, where the transportation needs are as diverse as the communities they serve.

## Coming Next Issue

The January–March 2024 issue of *TR News* features articles on a variety of topics. Authors examine the intercity bus industry's post-pandemic struggle to recover and its ramifications, a maritime transportation safety demonstration project, and strategies for reducing roadside fire risks. Also included are interviews with the winners of TRB's Standing Committee on Native American Transportation Issues "Call for Artwork".

National Park Service

*Driving past a wall of flames, a firefighter monitors a prescribed roadside burn along Buffalo National River in northern Arkansas. Clearing undergrowth and managing vegetation are among the strategies for reducing the risk that wildfires will start or spread along transportation routes and threaten residential areas.*

*ALSO IN THIS ISSUE*



### TRB COVID-19 Resources

Agencies and organizations can use TRB publications and online resources for useful and timely information to help address issues related to the COVID-19 pandemic. To read about TRB's current research and activities, and for a list of relevant publications, visit www.nationalacademies.org/trb/blog/transportation-in-the-face-of-communicable-disease.

The *TR News* Editorial Board thanks Katherine Kortum, TRB, for her work assembling and developing this issue.


**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.

***TR News* is produced by the Transportation Research Board**

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Cathy Frye

# Transportation in Rural America

NATALIE VILLWOCK-WITTE AND KARALYN CLOUSER

Villwock-Witte is an associate research professor and Clouser is a research associate at Western Transportation Institute at Montana State University in Billings, Montana, and Minnetonka, Minnesota, respectively.

Faraway Mount Hood crowns the horizon near Hood River, Oregon, the seat of the county of the same name. Beneath breathtaking beauty, however, transportation on quiet country roads here and elsewhere in rural America is disproportionately dangerous.

Rural America is so geographically diverse that what constitutes rural in one part of the country may be considered urban in another. Rural spans from the most remote corner of snowy Montana to the farmlands of Illinois, the bayous of Louisiana, the deserts of Arizona, and the ice roads of Alaska. Rural has been described as "you know rural when you see it."

Several methods for categorizing rural areas have been offered by agencies such as the U.S. Office of Management and Budget (Metropolitan Statistical Areas) and the U.S. Department of Agriculture (Rural–Urban Continuum Codes, Urban Influence Codes, and County Typologies). All methods use variables such as population, population density, commuting patterns, adjacency to a metropolitan area, and economic dependence to define a spectrum from urban to rural. However, several of these categorization systems do not consider the many differences among U.S. rural areas. A 2021 study attempted to better describe and categorize the "ruralness" of an area by assigning classifications at the county level, where the data sources are rich (*1*). This study suggested categorizing based on population size, population density, and spatial or economic relationship with a metropolitan area. This results in the following eight categories for counties: fringe, micropolitan, rural towns, remote, agriculture and extraction, older age, destination, and tribal. An additional consideration would include states and territories outside of the contiguous states and the District of Columbia: the Lower 48. These locations are unique in their remoteness and can be primarily dependent on air and marine transportation.

## Mode Use

Driving a private vehicle, biking and walking, traveling by horse-drawn carriage, flying, taking public transit, operating an agricultural vehicle, and using shared-mobility options are all transportation modes that can be found in rural America.

Additionally, freight passes through much of rural America. Tourism also draws people to and through rural areas—on motorcycles, in recreational vehicles, and with all-terrain vehicles or snowmobiles. However, when transportation modes are compared to other contexts, such as urban or suburban, their valuation and characteristics may be different for rural settings.

A private vehicle remains key to transportation in rural America. Access to employment, education, and other necessary services can require trips spanning long distances. Cost-effective, reliable, and safe transportation alternatives are required for rural residents to continue to thrive.

Biking and walking are so popular in many rural communities that the proportion of rural residents who ride bicycles ranges from 0.74 to 1.04 times the national average rate, and rural residents walk between 58 percent and 80 percent more than the national average. This is even greater for small rural towns (*2*).

Often not seen in an urban area, horse-drawn carriages associated with Amish and Old Order Mennonite religious groups are common in some rural areas. When traveling on paved roadways, horse-drawn carriages share the road with high-speed motor vehicles, agricultural equipment, pedestrians, and bicyclists. The speed differentials between these road user groups can create safety concerns.

Air travel in Alaska, Hawaii, and the U.S. territories can be akin to many people's daily commute by private vehicle in the Lower 48. Services like air taxis provide critical services to the nation's most remote communities, some of which are not normally accessible by ground transportation.

Public transportation, too, is often limited in rural America, and the systems that serve rural communities can be a lifeline for residents. However, these systems tend to have large service areas or are modeled around on-demand operations that may not allow for much spontaneous travel since they often require scheduling a trip at least 24 hours before the ride occurs. This can make last-minute trips—like unanticipated doctor's appointments—difficult or impossible.

Natalie Villwock-Witte

**Pedaling along a tree-lined street in a small town, this bicyclist upholds the statistics: People in rural America bike and walk more than their urban counterparts.**

Much of rural America is farmland. When farmers plow fields in the spring or harvest crops in the fall, agricultural vehicles access roadways to get to the fields. This process can result in dust traveling across roadways, which may impact driver visibility. Furthermore, slow-moving farm equipment traveling on a roadway may require additional space to maneuver through turns. In locations with limited roadway width—which is common on two-lane rural roadways—agricultural equipment may take up more than one motor vehicle lane. If queues develop, drivers may become frustrated with agricultural equipment slowing them down and make unsafe passing maneuvers.

Additional shared-mobility options like microtransit, rideshare, bikeshare, and scooters have increasingly provided a mobility option. However, these services often rely on some form of technology like a smartphone application, which can be a barrier for many.

Freight has a significant influence on the rural context. Freight may be moved via rural highways, railways, and inland waterways. In fact, 46 percent of the truck vehicle miles traveled occur in rural areas (*3*).

Vehicles such as motorcycles, recreational vehicles, snowmobiles, and all-terrain vehicles support tourism and in some rural areas like Alaska, provide primary mobility. Motorists may often overlook the presence of motorcycles. However, each of these vehicle types has its own challenges. Recreational vehicles can be large and tall, tend to move slowly, and have larger blind spots than passenger vehicles. The clearance of bridges on some rural roads may prohibit their passage. All-terrain vehicles and snowmobiles may pass over a roadway at unmarked locations as they connect between off-road recreational travel ways, which can present safety concerns.

## Rural Challenges

The definition of rural varies significantly and, likewise, rural roads have a wide variety of unique road users. Some examples of rural transportation challenges include connectivity, access to resources, localized congestion, safety, failing infrastructure (and associated long detours), unique biking and walking needs, animal–vehicle collisions, and unique weather.

Although significant advances in broadband and cellular connectivity across the United States have been leveraged, gaps and opportunities to improve service levels remain. Connectivity can reduce the need for trips—for example, through telemedicine appointments. Connectivity also can provide opportunities for remote work (i.e., teleworking) and education, improve notifications from public and emergency services, and provide opportunities for implementing modern transportation solutions such as intelligent transportation systems, connected vehicles, and autonomous vehicles. The connectivity gaps still prevalent in rural areas are influential, as these gaps not only affect access to necessary services but can hinder implementation of technologies like the previously mentioned intelligent transportation systems to improve safety and mobility.

Rural America also tends to have limited access to resources and staff. From applying for grant funding to transportation planning, and from public transit operations to emergency services, rural professionals often have limited resources, which results in the need for rural workers to fill multiple roles. When considering household income and tax base, proportionally speaking, rural areas have less spending power than do metropolitan areas (*2*). Considering access to resources specifically, 136 rural hospitals closed from 2010 to 2021 (*4*). These facilities were more accessible and often provided dependable local jobs to rural community members. This, in turn, has had an impact on transportation needs.

Most people do not associate congestion with the rural context. As home to many of the nation's public lands and recreational opportunities, rural communities can experience significant increases in population during peak tourist seasons, particularly if they are gateways to public lands. For example, Springdale, Utah, is a gateway to Zion National Park. This congestion can negatively impact year-round residents' quality of life. The tourist experience also can create safety challenges.

With regard to safety, with only 19 percent of the U.S. population and 30 percent of the nation's vehicle miles traveled, rural America is overrepresented with 45 percent in traffic fatalities from 2016 to 2020, as shown in Figure 1 (*3, 5*). The rural traffic fatality rate is 1.7 times the urban rate. America needs infrastructure upgrades, and this is evident in rural areas, too. In 2021, almost 3,000 bridges in rural areas were closed and 57,000 were rated as poor or worse (*3*). When a bridge in a rural area is closed, the detour is almost twice as long as that for a closed bridge in an urban area. These detours may be an inconvenience to travelers, but they can mean the difference between life and death for those needing emergency services.

Much has been learned over the years about the importance of providing appropriate facilities for individuals walking and biking in the urban environment. Yet, in the rural environment, a better understanding of the need and best practices have lagged.

Rural areas generally have a great deal of wildlife and roadways that often cut through wildlife habitat. Without safe crossings, human and animal lives may


Natalie Villwock-Witte

Stamped with "1939," the year it was installed, a nearly 100-year-old Works Progress Administration sidewalk is among many that remain throughout rural America. Although some may be intact, all are beyond their intended service life and signs of deterioration are often prevalent.

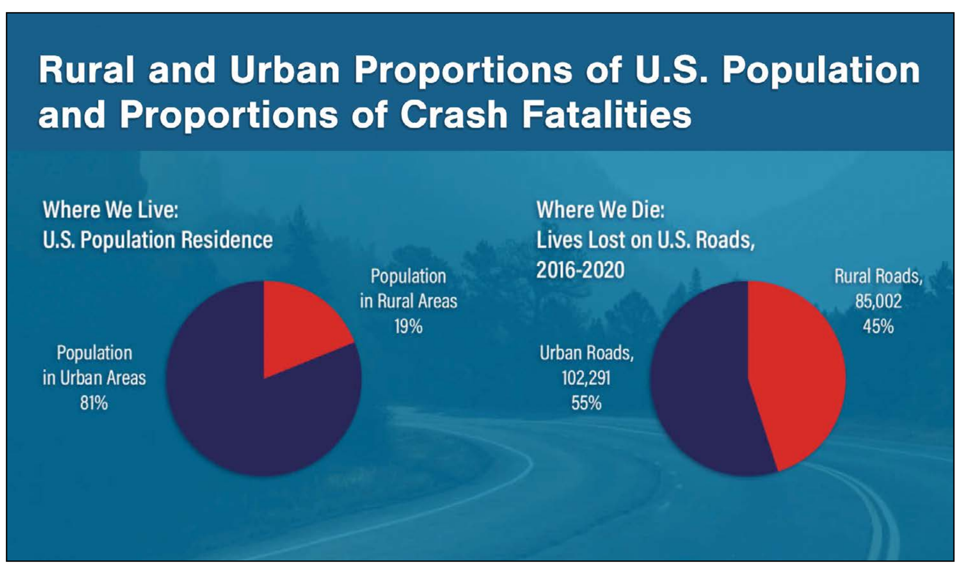


**FIGURE 1** **Rural versus urban population and crash fatalities (*5*).**

be at risk, and collisions can prove fatal for one or both. In some areas, wildlife crossings are being built to prevent such collisions.[1]

Weather in the rural context can result in many microclimates. These can be difficult for weather prediction models to calculate and consequently warn drivers of dangers. Additionally, rural maintenance service areas tend to be large, which can cause delays in treating roadways and returning to the desired level of service. In instances where a roadway may be closed due to a natural event such as flooding or high winds, there are often few—if any—alternative routes for travelers. For example, the I-80 corridor through Wyoming can have intense wind and snowstorms; long-haul trucks have been known to wait out the storms because there are few alternative routes (*6*).

## Equity

Historically, the lack of rural investment results in old designs remaining in place—precluding designing a cross-section wide enough to expand into more lanes, expecting that traffic volumes will continue to grow. In addition, rural areas often have lower household incomes that result in a lower tax base. This is significant when considering federal programs that require a match. Often, a small community will have to choose between replacing aging infrastructure or equipment—like a fire truck—or using those same funds to match federal funds.

Many tribal areas are in rural locations. As shown in Figure 2, American Indian and Alaska Native people experienced a staggering 145.6 traffic deaths per 100,000 population from 2015 to 2019. This is 2.5 times the total population average, which far exceeds any other racial group (*7*).

[1] Learn more at Getting Safely to the Other Side: Decision Support for Wildlife Crossing Programs, *TR News 342* (November–December 2022) at https://onlinepubs.trb.org/onlinepubs/trnews/trnews342.pdf and Over and Under: Improving Safety and Habitat, *TR News 338* (March–April 2022) at https://onlinepubs.trb.org/onlinepubs/trnews/trnews338.pdf.

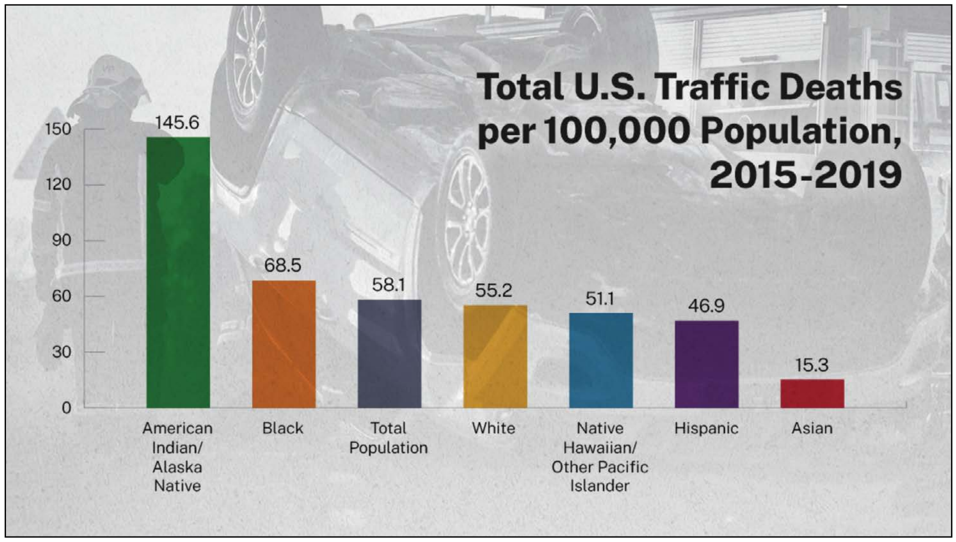


**FIGURE 2** Traffic death rate by race and ethnicity. [Source: Governors Highway Safety Association.]

## Innovations in Rural America

Combine the challenges discussed, and it is easy to see that transportation solutions in the rural context can be unique. What is innovative for rural can be common in urban areas. When thinking about innovations, many tend to focus on new technologies. However, innovation is simply a new method or idea not used before in a specific environment or for a particular application, even if it has been used elsewhere.

Innovations in urban areas may be expected to translate to the rural context, but for urban innovations to be successful in a rural environment, usually they must be modified. As technologies continue to change, activities like information sharing or peer exchange can be extremely valuable while continuing to address transportation challenges in all types of environments. The articles in this issue of *TR News* were designed with rural communities in mind and offer a treasure trove of lessons learned and solutions that are being used successfully in rural settings across the nation.

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## ADDITIONAL RESOURCES

Rural Opportunities to Use Transportation for Economic Success provides user-friendly tools and information, offers technical assistance, and combines U.S. Department of Transportation's resources into one location with the intent of addressing the disparities in rural transportation infrastructure. https://www.transportation.gov/rural.

The National Association of Development Organizations has been providing technical assistance for rural communities since 2017. Reports describing these efforts are on their website, along with other information describing rural needs beyond transportation, and may be tied to the ability to access resources. https://www.nado.org/rural-transportation-ta/.

The National Center for Rural Road Safety, an FHWA Center of Excellence, exists for the sole purpose of helping rural agencies eliminate deaths on their roadways. The center provides training, resources, and technical assistance to rural agencies. https://ruralsafetycenter.org/.

The National Rural Intelligent Transportation Systems Steering Committee provides guidance to small communities and rural areas on transportation technology applications. Their conference draws from multiple disciplines to provide participants with a platform to network and share experiences. https://www.nationalruralitsconference.org/steering-committee/.

The National Rural Transit Assistance Program provides resources, training, technical assistance, and peer networking to rural and tribal public transit system operators and stakeholders across the United States. https://www.nationalrtap.org/.

The Rural Health Information Hub provides resources and tools focused on addressing rural public health challenges. https://www.ruralhealthinfo.org/am-i-rural.

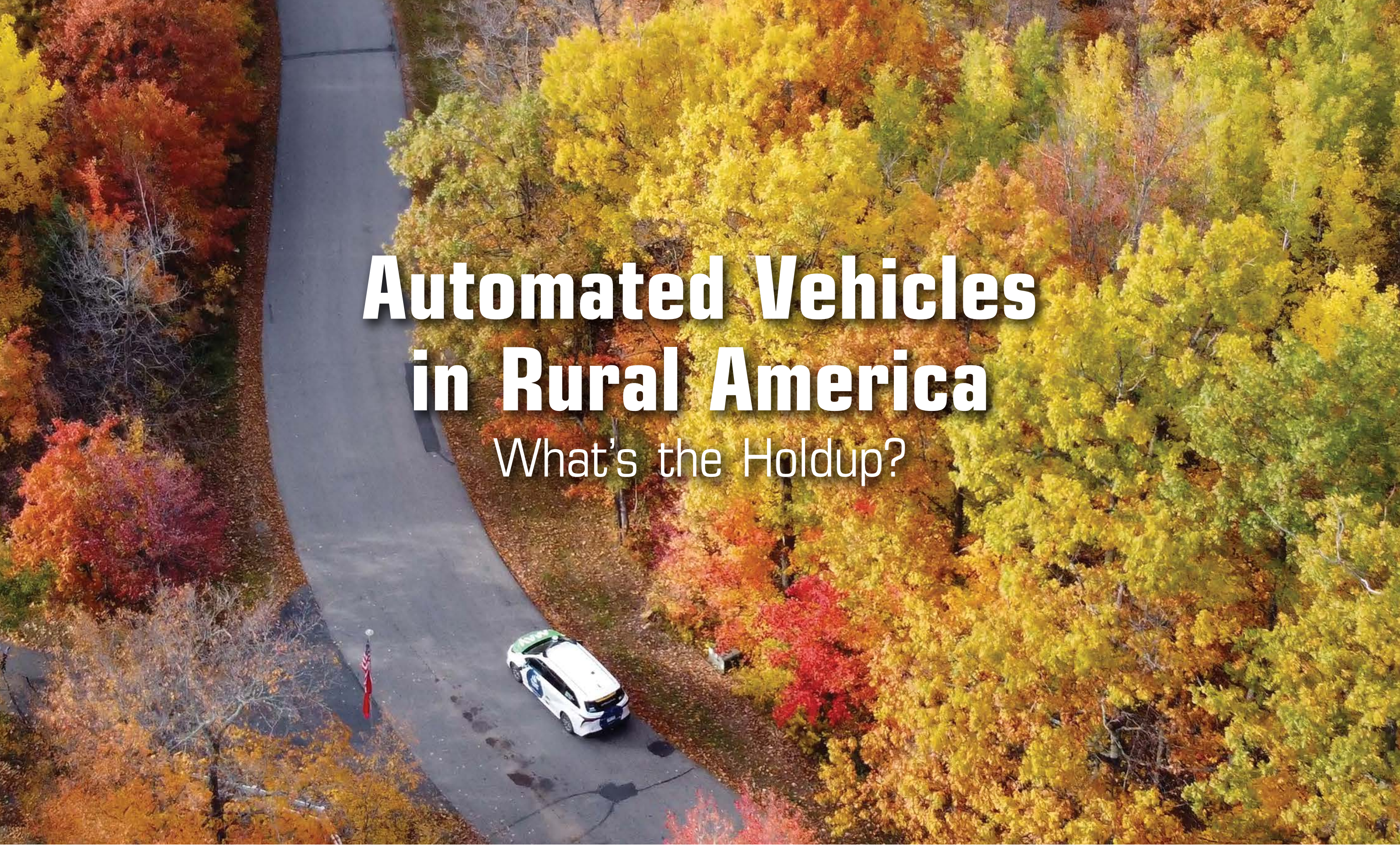
The Transportation Research Board's *National Cooperative Highway Research Program Research Report 988: Rural Transportation Issues—Research Roadmap* (see Highlights on Page 42) identifies transportation-related issues faced by rural communities and suggests research needed to inform infrastructure investment decisions. https://doi.org/10.17226/26343.

The Transportation Research Board's Rural Transportation Issues Coordinating Council (see Highlights on Page 43) is a forum for discussions on research, projects, and policy for all modes and interested transportation professionals dealing with rural transportation issues. https://www.trba0040c.com/.

## VOLUNTEER VOICES

So, you're going to the TRB Annual Meeting for the first time! Take a deep breath. Prepare your schedule ahead of time. Sit back and laugh as you realize you can't be 10 places at once. Make committee meetings, special sessions, and networking a priority. Take time to visit the Exhibit Hall. If you miss a presentation, reach out to the speaker after the meeting. And wear comfortable shoes!

**—MELISA FINLEY**
Senior Research Program Engineer and Program Manager
Texas A&M Transportation Institute
Bryan



# Automated Vehicles in Rural America

## What's the Holdup?

Courtesy of goMARTI


CHER CARNEY, THOMAS JOHNSON-KAISER, AND OMAR AHMAD

Carney is a senior research associate and Ahmad is the deputy director of the Driving Safety Research Institute at the University of Iowa in Iowa City. Johnson-Kaiser is an engagement and project manager at the Office of Connected and Automated Vehicles of the Minnesota Department of Transportation in St. Paul.


Autumn splendors frame a self-driving passenger shuttle on its route around Grand Rapids, Minnesota, gateway to the Northwoods wilderness. Such pilot programs aim to demonstrate the potential of automated vehicles to improve mobility in rural communities by safely navigating unpaved, snowy, or poorly marked roads.

Rural areas, home to just one in five Americans, contain an outsized share of the nation's roadways, accounting for 68 percent of total lane miles (*1*). These roads, which transport agricultural, manufacturing, and other freight as well as people, differ significantly from their urban and suburban counterparts. And that complicates efforts to introduce automated vehicles (AVs) as a way to improve safety, mobility, and access to essential services in rural communities, where getting to work, the supermarket, or a doctor's office often requires a long-distance drive.

Compared with roadways in developed areas, where the bulk of AV testing and development has taken place, rural roads have a wider variety of surface types and serve a greater diversity of users that range from horse-drawn buggies to combine harvesters to 18-wheeler trucks, each traveling at different speeds. Many lack safety features typically found on nonrural roads, such as lane and edge markings, sidewalks, and curbs.

Overall, rural roadways are much less structured than urban and suburban roads, with large variability even within a single road. They are also more dangerous. Despite lower traffic volumes, rural roadways have disproportionately higher crash rates compared with their urban counterparts. According to a Governors Highway Safety Administration analysis of NHTSA's Fatality Analysis Reporting System data, the risk of dying in a crash was 62 percent higher on a rural road in 2020 compared with an urban road for the same trip length (*2*). Road departures and head-on collisions top the list of common fatal crash types, with 61 percent of rural road fatalities occurring on straight sections.

Along with reducing the frequency of these crashes by mitigating some of the risk factors that lead to them, AVs have the potential to increase mobility. The Census Bureau estimates that more than a million American households—approximately 2.5 million people—in primarily rural counties lack access to a private vehicle (*3*). Moreover, rural residents do not have the convenient public-transportation options or other alternatives to driving that abound in urban areas. The limited transportation options that are available usually consist of demand–response services, which require individuals to schedule rides ahead of time from one location to another rather than being able to rely on fixed routes.

Studies suggest that AVs have the potential to improve safety and mobility. To date, however, most AV testing and development is taking place in cities or and suburbs and fails to examine specific issues that rural populations commonly experience, such as traveling long distances for routine errands or medical appointments. This is problematic for widespread, equitable, and successful implementation to ensure that AVs and their benefits become a reality for all.

This article discusses AV testing underway in rural areas and how these demonstrations can influence public perception and use of driverless vehicles. It addresses infrastructure needs and presents a health care use case, followed by lessons learned and future considerations.

## Rural Demonstrations and Deployments

Automated Driving Systems (ADS) for Rural America, a U.S. Department of Transportation (U.S. DOT) ADS Demonstration Grant project led by the University of Iowa, aims to produce a publicly available dataset on the performance of automation on rural roadways in various traffic conditions, at different times of the day, and in all four seasons.[1] Using an automated transit shuttle, data were collected to help identify risks, opportunities, and insights regarding the challenges. Available data include information from the following:

- Automation sensors on the vehicle;
- Biometric monitors worn by passengers;
- Weather sensors;
- Videos of the roadway, passengers, and safety driver; and
- Qualitative responses to questionnaires by riders and safety driver.


Jacob W. Frank, National Park Service

A compact package of efficiency, TEDDY—Yellowstone National Park's driverless electric bus—is the world's first 3-D–printed AV.

North Carolina DOT

During a 2021 demonstration project, visitors to Wright Brothers National Memorial on North Carolina's Outer Banks could travel around the park—including to the summit of Kill Devil Hill, site of America's first flight—aboard CASSI, the first autonomous shuttle piloted on public recreational lands.

The Electric Driverless Demonstration in Yellowstone (TEDDY)[2] [National Park] and the Connected Autonomous Shuttle Supporting Innovation (CASSI)[3] were two pilot projects conducted in 2021 by the National Park Service as part of its Emerging Mobility Initiative.[4] These demonstrations examined the use of automated shuttle technologies for public use on recreational public lands. The TEDDY pilot used a pair of Local Motors Olli shuttles, owned and operated by Beep, to transport visitors on two nonconsecutive routes from the park's Canyon Village area to nearby lodges or up to the campground. At Wright Brothers National Memorial in North Carolina, the Park Service partnered with the North Carolina Department of Transportation (DOT) to use CASSI, their leased EasyMile EZ10 shuttle, to transport passengers from the parking lot near the visitor center to the base of the First Flight Monument.

Minnesota's Automated Rural Transit Initiative (goMARTI) project, serving and led by the northern community of Grand Rapids and the state DOT, is an

[1] Learn more about the ADS for Rural America at https://adsforruralamerica.uiowa.edu/.

[2] Find out more about TEDDY at https://www.nps.gov/yell/learn/management/automated-shuttle-pilot.htm.

[3] Explore the CASSI pilot project at https://www.nps.gov/wrbr/learn/news/autonomous-vehicle-pilot-wright-brothers-national-memorial.htm.

[4] Learn more about the National Park Service's Emerging Mobility Initiative at https://www.nps.gov/subjects/transportation/emerging-mobility.htm.

AV deployment program that provides on-demand, point-to-point rides over nearly 17 miles of roadway.[5] The pilot includes about 70 pick-up and drop-off points with a fleet of five AVs equipped with May Mobility technology. Through the goMARTI deployment, the project partners hope to

- Advance and inform the operation of AV technology in rural winter conditions,
- Engage and educate the local community by providing real-world automated vehicle experiences,
- Increase accessibility and transportation options for residents and visitors, and
- Understand the potential of this innovative pilot to spur economic development and attract future talent and technology.

Minnesota DOT also leads the DriveMN project, which deployed technology-equipped research vehicles on a preplanned and diverse route across more than 1,000 miles statewide to assess the existing roadway network's readiness for automated driving. The project grouped areas into eight categories that—depending on the specific infrastructure, setting, and context—could cause the technology to disengage. These findings are meant to inform existing public–private AV planning committees, advisory councils, and agency professionals when making improvements that, in most cases, will benefit ADS and human drivers.

DriveOhio's ADS for Rural America is a U.S. DOT ADS Demonstration Grant project to examine how connected and automated semi-trucks and passenger vehicles could improve safety for drivers, passengers, and other travelers in rural settings.[6] The first of two deployments included three passenger vehicles equipped with AutonomouStuff technology traveling on divided highways and rural two-lane roads in Ohio's Athens and Vinton counties. The vehicles will continue to be tested in different operational and environmental conditions, including during periods of limited visibility and in work zones. The second deployment will feature a pair of 53-foot, platoon-equipped tractor–trailers connected by technology that enables them to travel closely together at highway speeds. The findings will help define technology needs and limitations, as well as inform the safe scaling up of future automation deployments in the United States.


Courtesy of goMARTI

Guided by laser-based sensors to measure distances and detect obstacles, a May Mobility–equipped goMARTI AV is one among five AVs—three of them wheelchair accessible and all operated by human safety drivers—that offers free, on-demand transportation over a 17-mile network in rural Grand Rapids, Minnesota. The goMARTI pilot, which runs through spring 2024, stops at the local hospital, high school, and airport—among other destinations.

Courtesy of DriveOhio

Human drivers are at the wheel to monitor operations during a year-long test of DriveOhio AVs, which traveled rural roads between Athens and McArthur in southeastern Ohio.

Table 1 shows a comparison of these rural AV projects. The type of project generally describes its scope and focus. Demonstration projects are exploratory and broader in scope, whereas deployments are designed to highlight a specific use. Demonstration projects can be seen as predecessors to a deployment, which then potentially can lead to the establishment of a service. These projects use the following two broad categories of vehicles:

- Low-speed, box-shaped shuttles that are designed to move people over short distances with a limited operational design domain and

[5] Find more about goMARTI at https://www.gomarti.com/.
[6] Explore DriveOhio's ADS for Rural America at https://drive.ohio.gov/programs/av-cv/rural-automated-driving-systems.

**TABLE 1** Comparison of Rural AV Projects

| Project Name | ADS for Rural America | TEDDY | CASSI | DriveOhio | goMARTI | DriveMN |
|---|---|---|---|---|---|---|
| Type of Project | Demonstration | | | | Deployment | |
| Vehicle Type | Ford F350 Transit command-by-wire platform | Beep shuttle | EasyMile shuttle | Lincoln MKZ and Ford F350 Transit command-by-wire platforms | Toyota Sienna Auto-no-Maas vehicle | VSI Labs and University of Minnesota research vehicles |
| Maximum Speed | 65 mph | 15 mph | 10 mph | 70 mph | 35 mph | 70 mph |
| Route Type | Fixed | Fixed | Fixed | Fixed and on-demand | On-demand | Fixed |
| Road Types | Divided and undivided highways, local roads, blacktop, gravel, parking lots | Blacktop, parking lots | Blacktop, parking lots | Divided highways and two-lane roads | Local roads | Mostly two-, four-, and six-lane highways |
| Oversight | Safety driver and co-pilot | Trained operator | Trained operator | Safety driver | Safety driver | Human-driven data gathering |

- Traditional vehicles retrofitted with onboard equipment that enables them to be controlled by automation software, driven normally by operators in mixed traffic at higher speeds, or both.

Low-speed shuttles—designed to move people over short distances such as a fixed route within a retirement community or college campus—have yet to show their utility when operating at higher speeds in mixed traffic on public roadways that typically connect rural communities. Additionally, their lack of mandated safety features limits their operation to predefined routes approved by NHTSA through a waiver process.

The route type is an important consideration for rural areas, where some passengers may be better served by on-demand services as opposed to fixed routes that may not be economically feasible. With the greater variability of road types and surfaces in rural areas compared with urban areas, it remains important to test AVs on as many different roadway types as possible. Despite showing great promise, AV testing still requires oversight by trained human safety drivers. In some cases, multiple operators may be needed to accomplish all facets of an individual project or to help passengers with disabilities get in and out of the vehicle.

## Public Perception

AVs have the potential to provide many benefits to society, including increased safety, more equitable access to mobility, economic and workforce development, improved environmental quality, and more efficient movement of people and goods. For rural America to realize these advances, however, it is important to identify and understand the appropriate uses for AV technology. It is incumbent on practitioners and AV experts to educate the public on current and future AV technology and the variety of possible uses. Being present in communities from the outset is critical to the success of each project so that those deploying a system can talk with residents, present real-world uses, and answer questions.

Firsthand experience with AV technologies can be one of the most effective ways to build trust and acceptance. Pre- and post-ride survey data from the ADS for Rural America shuttle, for example,

Courtesy of the Driving Safety Research Institute, University of Iowa

Tested over hundreds of miles on rural roadways, the University of Iowa's sensor-studded autonomous bus proved capable of navigating paved and gravel surfaces with good, poor, or no lane markings in different weather conditions. Researchers hope the findings, which include passenger-experience data, will help improve automated driving technologies.

show that the percentage of passengers who strongly or somewhat agreed that they could trust an AV increased from 50 percent to 71 percent (*4*).

It is also important to engage and get input from rural community members on AV technology and its perceived future benefits. Post-ride interviews with ADS for Rural America passengers indicated that access to transportation can be a huge challenge for rural residents, particularly those with mobility impairments. While respondents could see the potential of AVs, they also understood that challenges remain before the technology reliably can be rolled out.[7]

## Rural Health Care Potential Use Case

The number of hospitals in rural counties is declining, and the remaining facilities tend to have very few, if any, beds in intensive care units. Rural residents who experience a medical emergency often must travel to neighboring counties for critical care. This trend is driving up demand for options to convey people from their rural homes to regional hospitals. AVs have the potential to be part of the solution by providing mobility where no other public transportation options exist. For that to happen, however, they must safely navigate many different types of roadways. To serve people with the greatest mobility needs, AVs also must function as point-to-point vehicles that can pick up passengers from homes located off unpaved and gravel roadways.

## Infrastructure Needs

AVs rely on information about their surrounding environments, such as traffic signals, speed limit or other posted signs, and lane and intersection geometry. A vehicle can use onboard sensors, such as cameras, to get this information. While that reduces the need for additional roadway infrastructure, a camera-based approach may be less accurate. For example, an onboard camera approaching an intersection has the potential to look at the wrong traffic signal or miss the signal head altogether if its view is blocked by a tall vehicle, such as a semi-truck. An infrastructure-based system, though more accurate, requires the installation of special equipment at each intersection. This represents a major challenge for rural municipalities that barely have funding to maintain physical roadways.

At high levels of automation, an AV also must be able to locate and position itself much more precisely in its lane of travel than traditional GPS systems permit. A digital high-definition map, which shows such minute details as road signage and lane markers—combined with onboard equipment—enables such pinpoint positioning and allows automation where no lane markings are present or when lane markings are covered by snow. One drawback, however, is that high-definition maps must be updated when construction changes the roadway or new striping is applied. Onboard equipment that helps a vehicle locate itself is prone to interruptions in communications due to poor weather or inadequate cell service. Furthermore, an AV that relies on high-definition maps can't operate on roadways for which no high-definition map is available. This presents additional challenges for municipalities with long stretches of rural roadways.

## Lessons Learned and Next Steps

With AV technology and best practices constantly evolving, it can be challenging for practitioners to know how to prepare for AVs in rural areas. At present, with no universally accepted standards or investment guidelines, the best approach for practitioners is to learn as much as possible about AV technologies and the potential benefits for their communities. Practitioners at all levels—federal, state, and local—can determine what responsibilities they are willing to take on to help AV technology function. Agencies can be continually involved in discussions as state DOTs weigh the investments necessary to support the future of transportation built on technology and the benefits to the public today.

Two key areas of focus for rural communities when thinking about preparing for AVs are pavement markings and network communications. Traditionally, AVs have struggled to operate on gravel, dirt, and other roads that lack clear pavement markings. Enhanced pavement markings could improve performance and safety for autonomous and human-driven vehicles. While newer technologies are less dependent on the presence of pavement markings, the pace of change makes preparation and specific guidance challenging. The same can be said for network communications. It is likely that future AV technology will require some level of system connectivity. However, this is all under active research and may vary, depending on the architecture of the system that is ultimately implemented and its resilience against loss of connectivity. Since improving Internet connectivity in rural areas is a widespread political and economic priority, these challenges likely will become less significant over time.

Resources such as the 2022 Minnesota Local Road Research Board project, Autonomous Vehicles: What Should Local Agencies Expect? provide further detail on what practitioners can do to prepare for AVs.[8] The main takeaway is that the guidance is constantly changing, so the best course of action for practitioners is to become as educated as possible on AV technologies and how they potentially could benefit the communities they serve.

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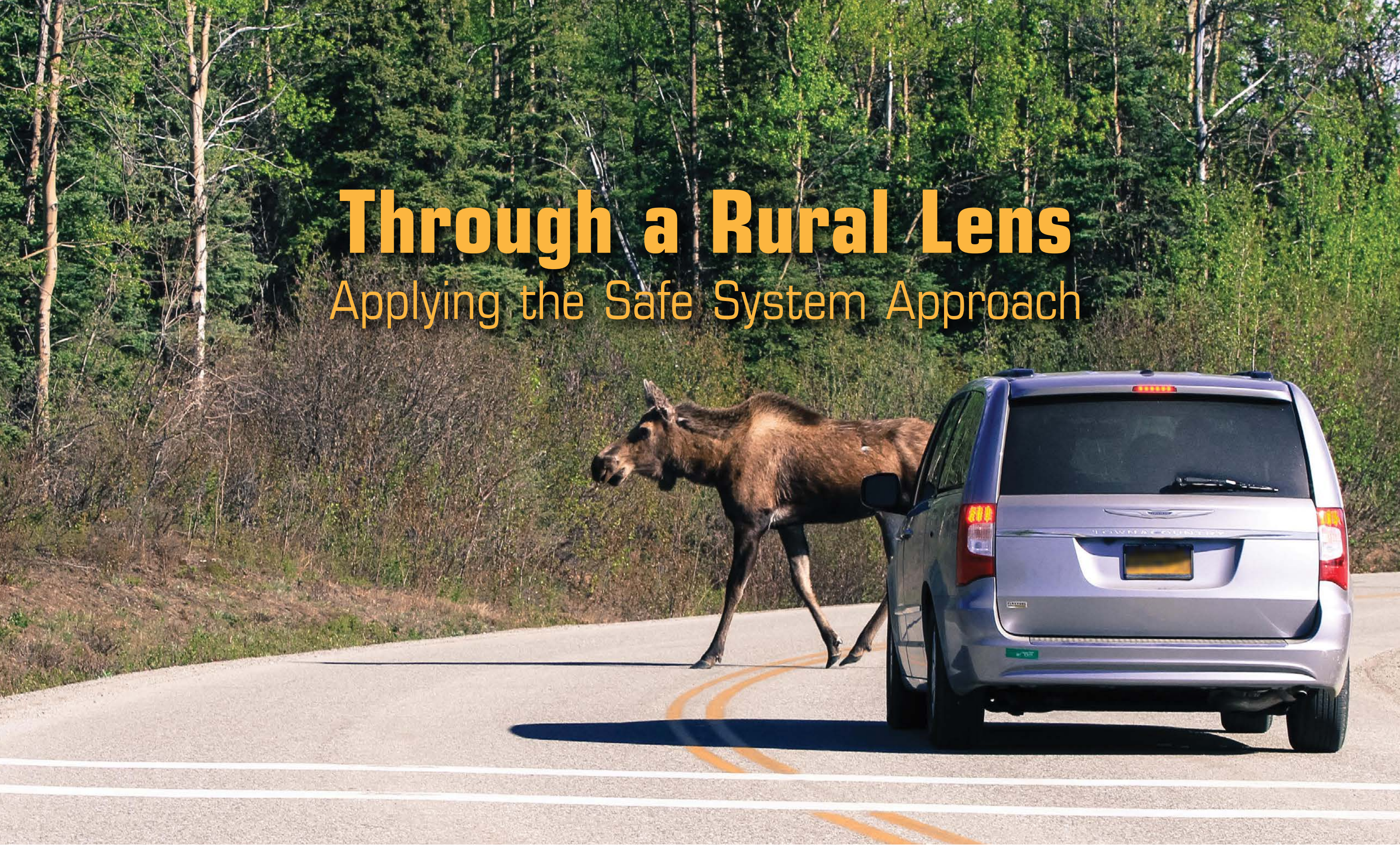
# Through a Rural Lens

## Applying the Safe System Approach





HILLARY ISEBRANDS, JAIME SULLIVAN, AND KEVIN ELLIOTT

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Drivers on rural roads must keep an extra sharp eye out for crash hazards, such as a moose sauntering across a road in Alaska. Wildlife and slow-moving farm equipment, as well as the many miles of empty road far from emergency responders, are part of the safety equation for travelers along rural roads.

The statistics are distressing. From 2017 to 2021, the number of people who died on rural roadways came to 83,206.[1] That is 43 percent of all roadway deaths when only 19 percent of the U.S. population lived in rural areas and only 31 percent of the total vehicle miles traveled were in rural areas (*1, 2*).

[1] The authors compiled statistics based on data from the NHTSA Fatality and Injury Reporting System Tool, 2017–2021. https://cdan.dot.gov/query.

## A Safety Reboot

To counter spiraling fatalities, the U.S. Department of Transportation (U.S. DOT) and FHWA recently adopted the Safe System Approach as referenced in the *National Roadway Safety Strategy* (*3*). It is a guiding paradigm to address roadway safety. Used internationally for three decades in places like Sweden, where the number of road fatalities per 100,000 inhabitants decreased from 6.7 in 2000 to 1.8 in 2020 (an astonishing 73 percent reduction), the Safe System Approach is well respected (*4*). As shown in Figure 1, the Safe System Approach puts aside business

| Traditional | Safe System |
|---|---|
| Prevent crashes → | Prevent deaths and serious injuries |
| Improve human behavior → | Design for human mistakes/limitations |
| Control speeding → | Reduce system kinetic energy |
| Individuals are responsible → | Share responsibility |
| React based on crash history → | Proactively identify and address risks |

**FIGURE 1** Comparison of traditional and Safe System Approach (*5*).

as usual, requires a new mindset, and encourages culture change.

By building and reinforcing multiple layers of protection, the Safe System Approach works to prevent crashes and minimize the severity of crashes that do occur. This shift from a conventional safety approach focuses on human mistakes, as well as human vulnerability, and provides an effective way to address and mitigate the risks inherent in the U.S. transportation system. The Safe System's many redundancies work together to strengthen all parts of the transportation system "so that if one part fails, the other parts still protect people" (*5*).

## The Principles

Transportation professionals can incorporate the following six principles of the Safe System Approach (Figure 2, outer ring) to create a positive traffic safety culture, which is "integral to helping our nation move toward a vision of a highway system with no fatalities" (*6*). For progress on safety improvements to be made, there must be a shift away from how safety has been approached in the past. Reframing safety culture can be accomplished by applying the six principles, listed in the remainder of this section with specific examples for rural roads.

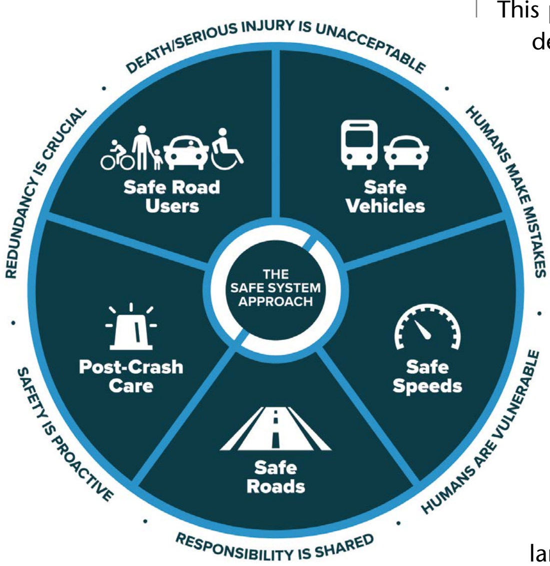


**FIGURE 2** Safe System Approach (*5*).

FHWA, Central Federal Lands Highway Division

Cut through evergreens and outlined with snow, the circular construction of a roundabout near unincorporated Tahoe City, California, promotes lower speeds and results in fewer fatal crashes in rural areas.

### DEATH AND SERIOUS INJURY ARE UNACCEPTABLE

According to NHTSA, there were a staggering 15,322 fatal traffic crashes and 17,103 fatalities in rural areas in 2021.[1] To reduce or eliminate these deaths requires assessing the safety culture. For many rural agencies and their employees, this is personal. The job is to help their neighbors get to work and return home safely. This perspective is critical for making decisions when it comes to investing in roadway safety.

### HUMANS MAKE MISTAKES

Roadway departures—crashes occurring after a vehicle crosses an edge line or center line, or otherwise leaves the traveled way—are a prime factor in rural roadway deaths. In fact, 10,988 people died in 2020 in roadway departure crashes on rural roads (*2*).

Three ways to counter roadway departure crashes are to keep vehicles on the roadway and in the lane, provide for a safe recovery, and reduce crash severity if the vehicle does leave the roadway.

### HUMANS ARE VULNERABLE

The Safe System Approach focuses not just on managing speed but on managing the transfer of kinetic energy. The sum of kinetic energy is important in determining injury severity. The kinetic energy released in a crash is equal to one half of the vehicle mass multiplied by the square of the vehicle's velocity.

The roundabout, for example, is one intersection configuration that reduces the kinetic energy of crashes. Roundabouts reduce fatal and severe crashes by 88 percent in rural environments (*7*). Well-designed roundabouts significantly reduce human vulnerability through

- Forcing slow speeds—15 to 25 miles per hour—for all users,
- Reducing conflict points from 32 in a traditional four-way intersection to eight in a roundabout, and
- Creating a smaller angle of conflict between two vehicles that result in sideswipe crashes that are common in roundabouts rather than more serious T-bone crashes.

### RESPONSIBILITY IS SHARED

Compared with urban transportation agencies, the resources available to rural agencies are extremely limited. Those who own and maintain rural roadways often have multiple job duties. Jurisdictions are large. Coordination and collaboration are essential between law enforcement, emergency services, and road supervisors. And everyone has a part to play in saving lives.

Development of a local road safety plan or safety action plan can help rural roadway owners prioritize safety and focus on the goal of zero fatalities and serious injuries. Plan development can be championed by a multidisciplinary team and include stakeholders and collaboration of those who use a data-driven approach to identify risk factors and prioritize solutions and safety projects based on the Safe System Approach. On its web page, which is devoted to local road safety plans (LRSPs), FHWA provides a do-it-yourself template, training, resources, and examples of LRSPs. This website's comprehensive explanations of how and where to start a plan are particularly useful for those in the early stage of plan development, but the LSRP do-it-yourself web page also can be used to modify, refine, or update an existing plan.

### SAFETY IS PROACTIVE

Crash locations in rural areas tend to be random rather than clustered in hot spots. However, rural fatal crash types are predictable—they often occur on curves and at intersections. Therefore, rather than using a traditional site-specific approach to implement safety improvements, rural areas may find more success if applying a proactive approach called systemic safety. The Systemic Safety Approach is based on risk factors of roadway features or characteristics correlated to specific severe crash types. For instance, deploying low-cost curve and chevron signs on curves with radii between 500 and 1,000 feet across the network may prevent the next death or severe injury crash.

### REDUNDANCY IS CRUCIAL

Reducing risk requires that all parts of the roadway system be strengthened so that if one part fails, people are still protected. Examples of redundancy on a rural divided highway would be a median, an inside shoulder, and the use of cable median barrier to prevent crossover head-on crashes. The median itself provides separation, the shoulder provides a recovery area, and the barrier adds redundancy against a severe head-on crash.

## Elements That Make Roads Safe

In addition to the six Safe System Approach principles that can guide safety culture change, there are five elements—the inner circle in Figure 2—that provide layers of protection and shared responsibility to promote a holistic approach to safety across the entire transportation system.

### SAFE ROAD USERS

Roadway owners must consider the safety of all road users—who vary in age, experience, physical abilities, and so on—and all roadway modes (i.e., freight, transit, motorcycle, pedestrian, bicycle, and more). For instance, 63 percent of occupants killed in rural pickup truck crashes in 2020 were unrestrained—the highest percentage of any passenger vehicle occupants killed in rural and urban areas (*2*). Furthermore, in 2021, NHTSA reported the following breakdown of rural roadway deaths:[1]

- Large trucks: 3,228,
- Motorcycles: 1,956,
- Pedestrians: 1,170, and
- Pedalcyclists: 142.[2]

Education and designing for human mistakes and limitations must go hand in hand for change to occur. For this reason, the National Center for Rural Road Safety created Rural Road Safety Awareness Week, an annual social media campaign to help rural practitioners increase awareness of the need to reduce fatalities and serious injuries.

[2] According to NHTSA, pedalcyclists are bicyclists and other cyclists, including riders of two-wheel, nonmotorized vehicles, tricycles, and unicycles.

High-visibility enforcement is a technique that not only reinforces safety policies and road user choices, but also educates the public on why they should choose positive behavior. An example is Iowa's High Five Rural Traffic Safety Project, which is focused on seatbelt use on rural roads.

Another resource for rural agencies is NHTSA's *Countermeasures That Work*, a guide that provides proven educational and enforcement countermeasures that can be used by transportation, public health, and law enforcement agencies (*8*).

### SAFE VEHICLES

FHWA defines safe vehicles as those "designed and regulated to minimize the occurrence and severity of collisions using safety measures that incorporate the latest technology" (*5*). The advancement of safe vehicles over the past few decades includes seat belts, antilock brakes, and airbags. Newer vehicle models include back-up cameras, lane assist technology, and semiautonomous features.

However, rural areas tend to have more unpaved roads, fewer pavement markings, and less communication infrastructure, all of which affect the usefulness of some vehicles' safety features.

Good quality tires can have significant effects on friction. Vehicles have different friction demands, depending on the characteristics of the roadway. For example, a vehicle traversing a horizontal curve requires a greater level of friction than a vehicle on a straight section. Common locations that require higher friction values are horizontal curves, steep grades, or intersection approaches. Pavement friction is critical for changing vehicle direction and ensuring the vehicle remains in its lane.

Vehicle-to-vehicle infrastructure examples in rural areas include Wyoming's connected vehicle pilot to provide freight fleets with important weather information and Missouri's addition of a real-time digital warning system on their motorist-assist vehicles that communicates with popular navigation applications (e.g., Waze) and alerts the public of vehicles on the shoulder (*9*).

## SAFE SPEEDS

Speed plays a part in crash risk—smaller field of vision and increased time for stopping and braking—and crash severity. Figure 3 shows the relationship between impact speed for various types of crashes and the fatality risk to those users. In 2020's rural fatal crashes, 71 percent of drivers were on roadways where the posted speed limit was 55 miles per hour or higher (*2*). In 2021, crashes involving speeding on rural roadways claimed the lives of 4,833 people.[1] The grim statistics in rural areas, where high speeds are already expected, make the challenges even greater. Some strategies include addressing high-speed roadways that quickly become rural town centers' main streets. Within a short distance, the road changes quickly and necessitates that drivers slow from highway speeds to safely navigate a road with pedestrians, bicyclists, and traffic going to or from local businesses. This situation requires posted and operating speeds to be reduced to ensure safety. Washington State Department of Transportation (DOT) uses a target speed approach for determining design speed. This approach's objective is to establish the design speed at the desired operating speed.

Similarly, many agencies use speed feedback signs to educate the public about traveling speeds and encourage drivers to slow down. Wyoming DOT uses variable speed limit signs to reduce the regulatory speeds in inclement weather. This strategy can prevent crashes and reduce roadway closures.

## SAFE ROADS

Roads in rural areas have unique features such as narrow lanes, minimal shoulders, sharp curves, lack of cell service, high speeds, lack of pedestrian and bicycle facilities, and uncontrolled intersections. These can all become risk factors. Several ways to improve rural road safety include the implementation of proven safety countermeasures. These data-driven solutions are known to reduce fatal and injury crashes. In rural areas, where funding is limited, low-cost countermeasures are a way to improve safety within an existing budget. For example, Montana DOT includes the systemic installation of centerline rumble strips. Other low-cost countermeasures—such as clearing vegetation at intersections, installing delineators on curves, testing and replacing signs and pavement markings for retroreflectivity on a regular basis, and using maintenance logs to prioritize damaged guardrails or missing signs—can all have significant safety impacts.

Additionally, a road with wide shoulders can be reconfigured to have narrower lanes and a bicycle lane or a shared-use lane for the safety of all road users. A rural example of a road diet—a transportation planning technique where the number of travel lanes or the effective width of the road is reduced to achieve systemic improvements—is found in Battle Lake, Minnesota.

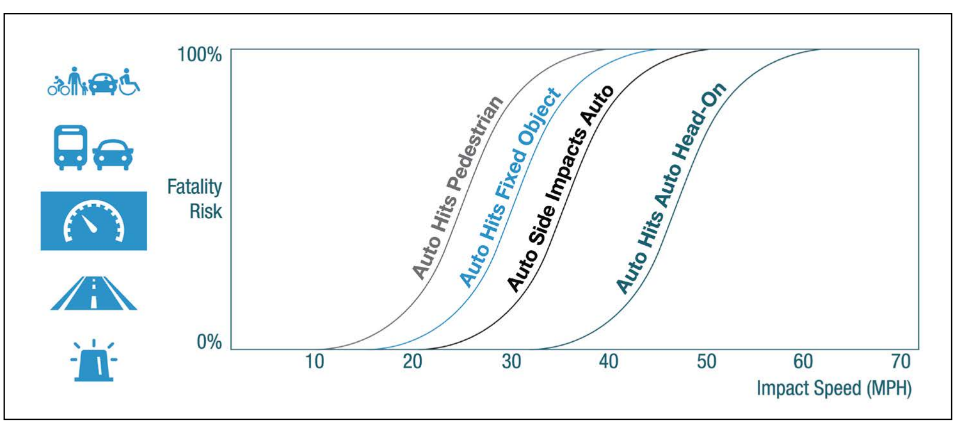


**FIGURE 3** **Crash types, speeds, and fatality risks. (Source: FHWA as adapted from Australian Roads and Traffic Authority of New South Wales.)**

Engineering solutions were identified to reduce the frequency of fatal and serious injury crashes occurring on the roadways in South Carolina through the use of the state DOT's Rural Roads Safety Program.

Separating vulnerable road users in time and space includes providing time via a signal or beacon, or space such as sidewalks, bicycle lanes, separated paths, or wide shoulders that keep vulnerable road users away from vehicles. In Washington State, the Lummi Nation Haxton Way pedestrian path and lighting project improved safety on Haxton Way, a rural two-lane road where there were numerous deaths of tribal members (*10*). The completed two-mile, multipurpose trail system consists of a paved trail, porous pavement, elevated boardwalks, new pedestrian bridges over Red River and the Lummi Slough, intersection improvements, and solar LED trail lighting.

## POST-CRASH CARE

In 2020, 66 percent of drivers killed in rural areas died at the scene of the crash. Of all drivers who were transported to hospitals and died en route, 57 percent were in rural areas and 42 percent were in urban areas (*2*). Emergency responders and access to trauma centers are essential to survival in rural crashes. In rural areas, emergency response personnel are more likely to be volunteers than paid emergency response personnel centrally located at a medical facility or fire station. The time it takes for volunteers to reach the scene can increase response times. Limitations in cellular service also can make notifying first responders difficult.

As part of its new rural road safety program, the Washington Traffic Safety Commission is working with the Washington Chapter of the American College of Surgeons Committee on Trauma to implement rural trauma team development courses that emphasize a team approach to initial assessment, stabilization, and transfer of injured people from a crash scene. This type of course can improve coordination of care, result in increased competence with advanced trauma life support principles, and decrease patient transport times.

Traffic incident management training specific to rural areas is important to ensure that rural responders are equipped to deal with incidents that include crashes involving horse-drawn vehicles or livestock. FHWA is in the process of finalizing a rural lesson addendum to their national traffic incident management training.

A discussion of post-crash care is not complete without mentioning communications. To assist with broadband network expansion and improve communications, Colorado has created public–private partnerships to leverage transportation rights-of-way in expanding access (see Page 30).

## Summary

As U.S. agencies work to integrate and institutionalize the Safe System Approach, the unique challenges faced by rural agencies and communities can be met with customized solutions. Some agencies own and operate rural, as well as urban roadways; some agencies are 100 percent rural. Their approaches may be different and tailored to their own communities, but the hope is that their goals and intentions are the same: zero roadway deaths via a safe system. This can be achieved using the many resources available and lessons learned from agencies eager to share their experiences.


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Cab02 at the English-language Wikipedia, CC BY-SA 3.0

An Amish driver guides a horse-drawn carriage to town—a common sight along Route 340 in rural Pennsylvania. In states with sizable Amish or Mennonite communities, such as Pennsylvania, Ohio, Indiana, Wisconsin, and New York, emergency responders must be ready to handle crashes where human and equine injuries may need to be addressed.


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### ADDITIONAL RESOURCES

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FHWA, National Traffic Incident Management Responder Training, https://ops.fhwa.dot.gov/tim/training/index.htm.

FHWA, Proven Safety Countermeasures, https://highways.dot.gov/safety/proven-safety-countermeasures.

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# The Path Forward for Low-Volume Roads

Laura Fay

LAURA FAY, DAVID ORR, ERIC CHASE, KEITH KNAPP, VANESSA GOETZ, AND DAVID JONES

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Transportation professionals attending the 2023 International Low-Volume Roads Conference gather on Iowa's Mehaffey Bridge for an insider's tour.

Most people drive low-volume roads every day to get from home to work, school, and play. Open to public travel but outside of city and town boundaries and excluding residential streets and alleyways, low-volume roads carry annual average daily traffic of less than 400 vehicles.[1] With such roads in mind, TRB first convened the Task Force on Low-Volume Roads in 1972 to "provide a better information base for the designers and builders of low-volume roads."[2] One early task force activity was to help establish and hold a workshop on low-volume roads in Boise, Idaho, in 1975. This task force became the TRB Standing Committee on Low-Volume Roads in 1978 and was chaired by Melvin B. Larsen from the Illinois Department of Transportation (DOT).

Held once every four years in the United States, the International Conference on Low-Volume Roads has focused on practical research and engineering issues for these vital parts of the transportation network. Building on the success of the 2019 Low-Volume Roads Conference held in Kalispell, Montana, TRB convened the 13th International Conference on Low-Volume Roads in Cedar Rapids, Iowa, in 2023. Workshops and sessions offered approximately 300 participants ideas to take back with them, as well as opportunities to learn about current research and practitioner-focused efforts.

## Preconference Workshops

Before the conference, half-day workshops were held with the goal of providing attendees with information and tools to take back to their agencies.

[1] Learn more in the *Manual on Uniform Traffic Control Devices* at https://mutcd.fhwa.dot.gov/knowledge/faqs/faq_part5.htm#:~:text=Low-volume%20roads%20are%20those,or%20less%20than%20400%20AADT.

[2] Personal communication, March 8, 1976, from Andrian Plezner, member, TRB Task Force on Low-Volume Roads to E. J. Yoder, Purdue University, USDA Forest Service, Washington, DC.

Topics ranged from safety and road design to workforce development and intelligent compaction (see Preconference Workshops).

## Welcome

In the opening session, hosts in Iowa welcomed attendees and provided a keynote on the rich history of transportation research in Iowa. This was followed by presentations on funding and technical assistance in the Bipartisan Infrastructure Law and an international perspective on innovations in low-volume road technology within developing countries.

## Research

Like the TRB Annual Meeting, this conference focused on presentations and posters of submitted papers on practical research. Extended abstracts—added in 2019—allowed sharing of ongoing work, early findings, and practitioner activities that might not be enough for a full paper.

The change in format allowed traditional papers—which may be published in TRB's journal, the *Transportation Research Record*—and extended abstracts to be a part of the conference summary report. This concept allows the conference to be focused both on researchers and practitioners. A sample of subject areas covered in the sessions included new technologies; drainage; climate resiliency; pavement design, construction, maintenance, and preservation; geotechnical stabilization and dust control; low-volume road safety; asset management; bridges; workforce development; and funding.

As has been true since the first low-volume roads conference, the variety of sessions showed the breadth of issues involving low-volume roads.

## Lightning Round

Poster sessions traditionally wait for attendees to read the poster and ask questions. The lightning round poster sessions provided an option for those not accustomed to typical research presentations. Each presenter gave a short presentation focused on salient points to build interest in the topic. Then, attendees could visit each poster displayed around


Laura Fay

At this year's poster session, Todd Kinney (*left*) from Clinton County, Iowa, and Dwayne Heintz from Jefferson County, Iowa, discussed the application and use of cape seals for protecting pavement.

## Preconference Workshops

- Rural Road Design Using the Dynamic Cone Penetrometer: A Paradigm Shift.
- Bridge Technology for Low-Volume Roads.
- Remote Sensing Tools from Drones to Satellite Imagery in Low-Volume Road Management.
- Iowa's Use of Validated Intelligent Compaction Technology to Improve Pavement Foundation Layers and Unpaved Granular Roads.
- A Safe System Approach for Roadway Departures on Low-Volume Roads.
- Finding, Retaining, and Training the Workforce to Maintain Low-Volume Roads.

Laura Fay

Research scientist Richard Dobson (*left*) and research engineer Ben Hart (*right*), both from the Michigan Tech Research Institute in Ann Arbor, present their drones at one of the conference's workshop sessions. They stressed the importance of matching road assessment requirements with the right type of drone and camera for the task.

the room to engage with the authors for more information.

## Taking It to the Streets

Field trips have always been an integral part of the conference, from trips through national forests in Idaho and New York, to subdivisions and developments in Nevada and Texas, to research activities at universities and field sites in Florida, Pennsylvania, and Montana. Attendees see cutting edge, practical research on roads that are often understudied.

In Iowa, the 2023 field trip included the landmark Mehaffey Bridge over the Iowa River and Coralville Reservoir in Johnson County. This is one of only a few U.S. extradosed bridges—those with the main elements of a prestressed box girder bridge and a cable-stayed bridge. Site visits also enabled participants to see methods used to upgrade low-volume roads, such as surface coatings and a rural roundabout, as well as techniques for collecting data on unpaved road strength.

## Miniworkshops

Highlighting the practical nature of the conference, three miniworkshops provided one last opportunity to pick up new ideas to use back home. In each miniworkshop, a trio of ideas was shared with the attendees (see Topics and Tools).

## The Last Word

During the closing plenary session, Laura Fay, chair of the TRB Low-Volume Roads Committee, summarized suggestions gathered during the conference and from the attendees in the audience. The identified research needs and focus areas will be used by the committee and developed into research ideas, webinar topics, and TRB Annual Meeting workshops and lectern sessions. These outcomes will be shared to help build on past needs and outcomes and generate future ideas for the committee.

Ron Eck of West Virginia University, a practitioner with a long career in low-volume roads, provided closing remarks on his perspective. As a counterpoint, Brandon Jutz from the U.S. Fish and Wildlife Service provided a view from someone in the early to mid-career stage, discussing how to embrace change in a transportation career. Conference planning committee chair Keith Knapp of Iowa State University provided the final closing remarks.

*Learn more about TRB's 13th International Conference on Low-Volume Roads at https://trb.secure-platform.com/a/page/lowvolumeroads. Explore the TRB Standing Committee on Low-Volume Roads at https://sites.google.com/view/trb-akd30.*

### Topics and Tools

- Road Surfaces
  - Local road surface selection tool
  - Grading optimization tool
  - Gravel road management tool
- Paved Road Management and Monitoring
  - Flooded road management tool
  - Automated pavement monitoring tool
  - Life-cycle assessment pave tool
- Geotechnical Issues and Truck Weights
  - Geosynthetics field installation pocket guide
  - Unstable slope management program
  - Truck weight calculator

> "Held once every four years in the United States, the International Conference on Low-Volume Roads has focused on practical research and engineering issues for these vital parts of the transportation network."

# Shared-Use Mobility for Rural America


Courtesy of Southeast Vermont Transit

RANJIT GODAVARTHY

The author is an associate professor at the Small Urban and Rural Center on Mobility in the Upper Great Plains Transportation Institute at North Dakota State University in Fargo.

Painted to resemble the region's Holstein dairy cows, a black-and-white spotted MOOver bus travels its route between Wilmington and Readsboro in southeastern Vermont. In rural America, shared-use mobility ranges from fare-free public transit to on-demand microtransit to library bike-share programs, and the innovations keep rolling along.

The sights are familiar. Around the country, streetscapes feature people waiting at the curb for digitally hailed rides or whizzing by on public grab-and-go bicycles. These scenes reflect the tremendous growth of ridesourcing, bike sharing, and other flexible, user-centered transportation options in recent years. While largely successful in cities, shared-use mobility services have been slower to catch on in rural areas because of lower population densities and the lack of resources to conduct safe, economically sustainable operations. However, some creative implementations have emerged to address public transportation needs in rural regions, including the use of ride-sourcing services to transport older adults and people with disabilities to medical appointments, the introduction of community-based bike-share programs, and the transformation of existing demand–response transit into nimbler, real-time microtransit services.

Demand–response transit, also known as dial-a-ride service, has been part of the transportation mix in many U.S. communities for years. These services usually are operated by public transit agencies and provide curb-to-curb or door-to-door trips that customers reserve by phone 24 hours in advance. Microtransit service is also on demand but typically is provided by private operators. Users can request a ride on their smartphone app, and the company's algorithms match them immediately with the nearest available vehicle, which arrives within 15 to 20 minutes.

Shared-use mobility services have the potential to expand valuable options for getting to a medical appointment, the workplace, or other distant destination. For some rural communities, these services could become the sole means of public transportation. This article highlights several innovative and successful rural implementations that exemplify various categories of shared-use mobility services, along with lessons learned and best practices for rural communities.

## Successful Rural Shared-Use Mobility Rollouts

Studies suggest that rural communities would utilize shared-use mobility services if they were available. For instance, a recent analysis of data from the 2017 National Household Travel Survey found interest among rural residents, particularly for ride-sourcing services (*1*). Such services were nonexistent in most rural communities when the survey was conducted, as the data reflect: Only 1.85 percent of rural respondents reported using ride-sourcing services, with 0.24 percent using car-sharing services and 0.31 percent using bike-sharing services. The corresponding percentages for urban respondents were 8.1 percent, 0.7 percent, and 0.5 percent. When asked about other transportation services, 5.6 percent of rural respondents said they used public transit.

In contrast to business models for shared-use mobility services in urban areas, rural implementations require tailoring approaches to local community needs. This involves taking into consideration such challenges as long travel distances, sparse populations, low demand for shared-use mobility services, a shortage of contract drivers, and limited funding for upfront capital investment. By addressing these challenges and adjusting the business model, shared-use mobility services can successfully operate in rural areas.

Rural communities also can tap federal, state, and local funding opportunities to explore such shared-use mobility services as ride-sourcing, microtransit, and bike- and car-share programs. For example, FTA's Mobility-on-Demand demonstration program already has helped introduce these services to rural areas and generated promising use cases for improving mobility. Other funding sources include FTA formula funding (Sections 5310 and 5311); state department of transportation (DOT) funding; community initiatives; and other national, state, and local grants.

Rural communities have rolled out a variety of innovations. In the ride-sourcing category, for instance, popular ride-share companies have been providing nonemergency medical transportation in rural communities across the United States, facilitating better health care by making trips to the doctor or regional clinic affordable and convenient. While national ride-hailing companies traditionally have struggled to provide conventional services to the general public in rural communities, nonemergency medical transportation and other community-initiated ride-sourcing programs have flourished.

Jess Betts-Nelson, Waupaca County Catch-A-Ride

Local Feonix microtransit drivers pose against a backdrop of sunflowers along a county road south of Waupaca, Wisconsin. Like their colleagues in other rural communities, these county Catch-A-Ride drivers undergo rigorous training that includes certifications in defensive driving, CPR, and nonemergency medical transportation. The drivers are (*left to right*) MaryKay Burr, Frannie Packingham, Heather Willette, Rhonda Giauque, Reyna Kilty, Melissa Soerens, Connie Brenneman, and Jacque Mohawk.

These rural ride-sourcing programs often engage specialized private mobility providers to offer transportation options tailored to the needs of local residents. Many also adjust staffing and scheduling practices to increase the pool of potential drivers. Instead of relying on contract drivers, for instance, successful rural ride-sourcing initiatives operate with volunteer as well as hired drivers and ensure that service is available for fixed hours during weekdays and weekends. The Winnebago Catch-A-Ride program, developed to provide flexible transportation options in Winnebago County, Wisconsin, is a case in point. The service, which uses the Feonix–Mobility Rising platform, aims to fill rural mobility gaps unaddressed by existing public transit services. Catch-A-Ride's drivers are volunteers who undergo mandatory screening and background checks to ensure passenger safety.[1]

Bike-sharing programs—which abound in urban areas—can be expensive to implement, with high start-up costs for bikes with tracking abilities, docking stations, other infrastructure, and maintenance. However, rural communities have embraced low-cost bike-share business models to better meet demand on small budgets. Consider the library bike-share program that Allen County, Kansas, launched in 2017. Like checking out a book or movie, the public can borrow a bike for free from the local library. Similar


Becca Lachman, Athens County Public Libraries

A collection of bicycles attracts borrowers to the Nelsonville Public Library in rural Athens County, Ohio. The bike-lending program, one of the nation's first when it wheeled out in 2013, now features electric bikes, child seats, and other options.

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[1] Jeremy Mattson, Ipek Nese Sener, and Jill Hough describe this nonprofit mobility-as-a-service initiative in Breaking Down Barriers to Healthy Food and Healthcare. *TR News 346*, July–August 2023. To learn more, visit the program's website at https://feonix.org.

programs have sprouted in rural communities throughout the United States.

While car-share services remain scarce in rural communities, subsidized programs could bolster mobility options for low-income residents who lack access to or don't own vehicles. Southern California's Needles Car Share program, which serves a remote Mojave Desert community on the Arizona border, is a successful example. Subsidized by the regional transit agency, members pay $5 per hour to use a car, a rate that includes insurance and fuel.

Microtransit services operate similarly to on-demand ride-hailing services but convey multiple passengers traveling in the same direction in larger vehicles. These services initially sputtered in the urban areas where they were launched. Over the years, different companies tried various business models and eventually some proved able to successfully operate microtransit services in both urban and rural areas. The business model is well suited to providing on-demand transportation services, and in recent years rural microtransit services have become more popular. A recent FTA Integrated Mobility Innovation grant has further advanced the countywide transformation of conventional dial-a-ride services typically found in rural areas. In rural Baldwin County, Alabama, for example, microtransit services provided by Via have improved ridership, passengers' experience, efficiency, and flexibility (*2*). Similar implementations are underway in rural areas and small cities in North Carolina and in the Boston suburb of Newton, Massachusetts, among other places.

## Lessons Learned and Best Practices

While shared-use mobility could prove beneficial for some rural communities, it is important to understand what type of service is relevant for residents and the potential implementation challenges. The NCHRP Project 20-65/Task 76 study, "Opportunities for State DOTs (and Others) to Encourage Shared-Use Mobility Practices in Rural Areas," consisted of a comprehensive analysis of rural shared-use mobility implementations and presented guidance


Courtesy of Baldwin Regional Area Transit Systems

A steadying hand supports a passenger boarding a bus in rural Baldwin County on Alabama's Gulf Coast. The regional transit system, which provides affordable, door-to-door public transportation on a fleet of wheelchair-accessible vehicles, used a federal grant to launch on-demand scheduling in 2020.

and best practices for rural communities aspiring to adopt some type of shared-use mobility practices. Findings include the need for leadership from community partners to form planning committees or advisory groups to identify existing mobility gaps and transportation needs. The study also stressed the importance of not only determining the category of shared-use mobility service—such as ridesourcing, car- and bike-sharing, or microtransit—that could best suit the community's specific transportation needs but also understanding the challenges associated with implementing and operating a shared-use mobility service in a rural setting. Partnerships between rural government entities and private mobility providers could help reduce costs and supply technology, software, and mobility apps on phones or other platforms for the community's transportation needs. Another key step is identifying a variety of funding agencies to sponsor implementation efforts.

For shared-use mobility programs to succeed in rural areas, it is essential to have reliable broadband Internet service. Connectivity allows users to make reservations; request, manage, and pay for rides and trips; and receive notifications and alerts. However, ensuring sufficient coverage remains a major hurdle for many rural communities. Moreover, some residents may lack access to smartphones or bank accounts, both of which are required for making reservations and payments. Providing alternatives, such as telephone support lines and cash payment options, is critical to the equitable introduction and expansion of shared-use mobility services—as is gaining the trust of rural users in these new forms of transportation.

## Conclusions

FTA grants and other federal, state, and local support have helped to spur innovative rural shared-use mobility initiatives, such as ride-sourcing services for medical appointments, community-based bike-sharing programs, and the transformation of existing dial-a-ride programs into microtransit services. Multiple rural implementations and comprehensive studies also have documented the barriers, providing valuable guidance for localities considering similar programs. In addition, the NCHRP 20-65/Task 76 final report (*3*) contains a toolkit that not only outlines the various steps, tasks, and best practices involved in planning and piloting shared-use mobility solutions in rural communities but also highlights specific funding opportunities.[2] Since shared-use mobility services tend to be capital-light businesses (which require relatively little money to launch), and initial deployments have shown they can operate efficiently and economically, rural communities probably will see more shared-use mobility services deploy successfully in the next five years.

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[2] Explore the toolkit, which begins on Page 59 of the report, at https://onlinepubs.trb.org/onlinepubs/nchrp/2065/Task76Report.pdf.

# Ready to Roll

## Technology for Rural Transportation

Brandon Frie, Unsplash

KEVIN CHAMBERS AND BLAKE HANSEN

Chambers is a principal at Full Path in Portland, Oregon, and Hansen is a transportation technology subject matter expert at Olsson in Overland Park, Kansas.

Whether traversing the misty green of the Great Smoky Mountains or quietly passing through whistle-stop towns and unincorporated areas, rural roads are an integral part of the U.S. landscape, and technology is making them safer.

It's 1995. Driving along a rural highway on a frigid January night, your eyelids are getting heavy, and that warm motel bed in the town 40 miles ahead is calling your name. You're jarred awake by the exploding airbag punching you in the face. Ears ringing, you slowly come out of a daze and realize that you nodded off for an instant, ran off the road, and hit a tree.

In 1995, this scenario could easily have ended in tragedy. Now, almost 30 years later, technological advancements have improved protection for the people inside the vehicle, shortened emergency response time, and helped prevent crashes from occurring in the first place. Ongoing developments in microprocessors, wireless communications, vehicle technology, and artificial intelligence will continue to fuel advancements that improve safety, mobility, and the rural transportation network.

## Unique Challenges

Even with recent progress, rural traffic fatalities in the United States still account for nearly 50 percent of the total (*1*). Some technologies developed in urban areas, such as those for transit, traffic control, and traveler information, can be extended into rural communities. Technologies that need to be installed along the roadway at regular intervals—such as speed sensors—are prohibitively expensive or impractical in rural areas. While the key objectives of safety, access, and efficiency are the same in both urban and rural settings, the barriers of distance, speed, terrain, and access to power and communications provide unique challenges in rural areas.

## Rural Roads

Technological developments affecting rural highways are often focused on safety, such as improving vehicle safety and driver performance (*2*). Other advances leverage the data produced by vehicles through ever-expanding connectivity to identify areas for infrastructure and operational improvements. The increasing quality and availability of this mobile data means that roadside technology can be deployed more strategically. Some examples follow.

### VEHICLES

Advanced driver assistance systems have matured as an early benefit of automated vehicle research and development. These systems are available in many new vehicles to help keep drivers focused, in their lanes, following at a safe distance, and alert to potential hazards.

### MOBILE DATA

As cellular and broadband networks extend their reach into rural areas, a variety of mobile data sources—coupled with advanced data analytics—are providing increasingly fast and accurate insights into operational and infrastructure conditions.

### ROAD WEATHER

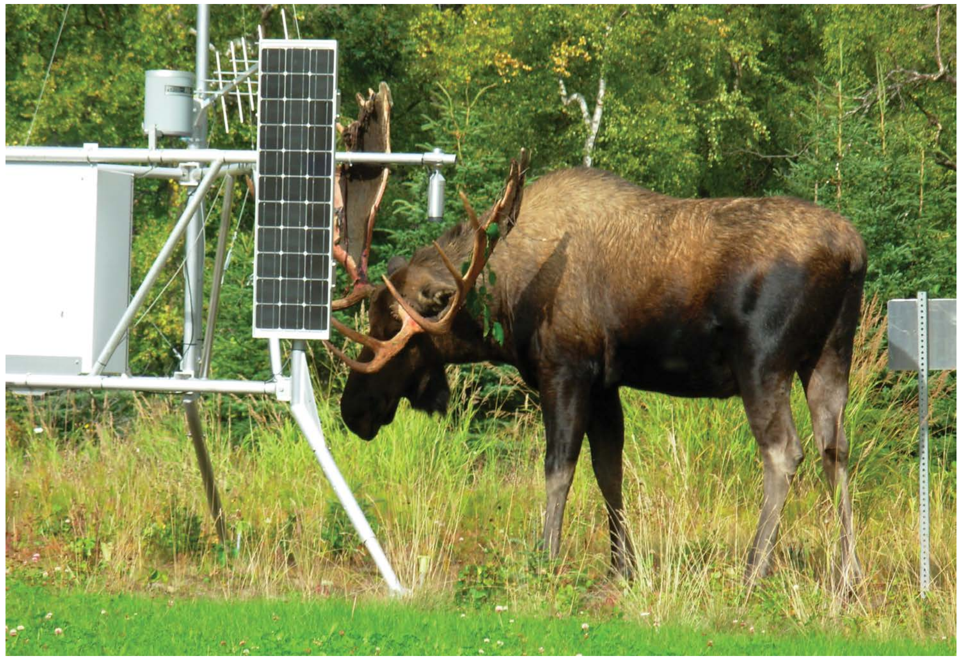
Weather-specific road-condition technology adds critical specifics to general atmospheric data. This helps optimize agency weather operations and provides real-time advisories to travelers in wet, windy, dusty, or icy conditions.

### FREIGHT

Many technology efforts, such as freight-specific routing systems that account for weather conditions, size and weight restrictions, and parking availability, are focused on keeping freight networks running smoothly. For example, the Wyoming Department of Transportation's Commercial Vehicle Operator Portal is focused on weather information that may affect freight vehicles.

### SPECIALTY APPLICATIONS

Many new technological applications help address specific challenges, such as warnings for low-speed curves, wildlife crossings, falling rocks, at-grade highway crossings, visibility, variable speed limits, and work zone safety systems.



Dan Peterson, NOAA, Flickr, CC BY 2.0

Weather station equipment in Anchorage, Alaska, is a convenient surface for a moose to rub its felted antlers. Such remote weather information systems can be fully automated and provide travelers with real-time information about rural road conditions.

## Rural Transit

One of the catalysts for rural transit technology advancements is the rise of rural cellular and broadband networks that allow riders, for example, to locate a bus easily, reducing the feelings of risk and doubt that can limit transit use. A combination of real-time scheduling, GPS, and enhanced transit data specifications have made it possible to show customers flexible and fixed-route service options. This advance is allowing some larger, rural dial-a-ride services to reinvent themselves by providing more dynamic dispatch services and making it easier for travelers to stay informed about their trip status after


Courtesy of Southeast Vermont Transit

An accessible, cowhide-patterned MOOver bus takes a wooded route through southeastern Vermont. Even in rural areas, advances in technology are making it more convenient for those with mobility issues to use transit on demand or through a fixed-route scheme. The same technology improvements may make it more affordable for providers to get transportation closer to those in need when they need it.

requesting a ride. The continued improvement and expansion of these solutions is contingent on the increasing expansion of rural broadband and cellular networks.

Digital connectivity and interoperability also are expanding to benefit even the smallest rural transit agencies. Some rural transit providers are exploring partnerships with transportation network companies for last-mile services. Others, such as the Virginia Department of Rail and Public Transportation, through its Statewide Integrated Mobility Initiative, are exploring technology-enabled services (*3*). With the recent development of open data standards to manage trip request and fulfillment data between agencies, rural communities are working to link together a wide spectrum of providers into a single mesh of transportation services ranging from intercity fixed routes to small volunteer driver programs (*4*).

## Organizing First

Although the rapid increase in rural digital connectivity and transportation technology is far from complete, it provides opportunities to maximize the effectiveness of existing physical infrastructure. Organizations also recognize that whether technology is a good fit depends greatly on the specific context; it may be an effective tool in the toolbox but not a fix-all.

For this reason, many state agencies have developed transportation systems management and operations plans that consider technology within the context of overall system operations (*5*). These plans help ensure that agencies have the necessary organizational capabilities before they deploy and maintain technology in the field. This approach is consistent with the German maxim "organization before electronics before concrete" (*6, 7*), which originated in rail planning. This approach has helped agencies set up the organization, funding, and processes needed to ensure long-term operational effectiveness of their deployed rural transportation technology.

## Ongoing Advancements

The application of technology is a critical step in eliminating fatalities and strengthening mobility in rural areas. Although technological advancements in areas such as data science, communications, and machine learning provide a myriad of possibilities, other concepts—like fully autonomous vehicles—still need significant progress before being ready for rural applications.

A concerted focus on rural transportation technology research and application development that goes beyond simple retooling of urban-focused solutions is needed. This will help technology developments overcome barriers of distance and weather. It will also continue to turn these developments into reliable, affordable, scalable, and impactful solutions that can save lives and improve efficiency for all who rely on rural transportation.[1]

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[1] Visit the 2023 National Rural ITS Conference website at https://www.nationalruralitsconference.org/.

"The barriers of distance, speed, terrain, and access to power and communications provide unique challenges in rural areas."

# Wheels Up!

## Alaska's Rural Air Service


Mark Hanten, Alaska Air Transporters


REBECCA DOUGLAS AND DYLAN BLANKENSHIP

Douglas is the statewide aviation system planner and Blankenship is a development specialist at the Alaska Department of Transportation and Public Facilities in Anchorage.


Tethered to the shore of Upper Twin Lakes in Alaska's Southwest region, a de Havilland Canada DHC-2 Mk1 Beaver awaits its next flight. Such aircraft play a significant—and necessary—role in the state's rural air network, serving passengers as air taxis, recreational transport, and more in remote outreaches where roads are few.

Alaska's extraordinary and remote landscape presents significant transportation challenges because of a lack of roads connecting its rural communities. Instead, the traveling public relies on the state's vast network of more than 230 publicly owned and operated airports and many smaller airstrips. This includes 60 airports with scheduled commercial service, making it the largest aviation network in North America. Rural aviation plays a crucial role in providing access to essential services such as health care, education, and even grocery shopping. It contributes to a unique way of life. In addition to aviation, Alaskan communities utilize all manner of transit, including aircraft equipped with skis and floats, barges, four-wheelers and snow machines, fan boats, and even dogsleds. They also use ice roads and runways. However, aviation is the only year-round method to reliably connect to more than 80 percent of the state's communities. In most states, cities and counties are commonly responsible for airports. However, the State of Alaska is responsible for most of the rural airport system.

## State of Alaska's Rural Airport System

Alaska's rural airport system consists of 235 public airports. This count excludes hubs such as Ted Stevens Anchorage International Airport, Lake Hood Seaplane Base, and Fairbanks International Airport, all of which make up the Alaska International Airport System. The rural system has two main operators: The Alaska Department of Transportation and Public Facilities (DOT&PF), which owns, operates, and maintains most rural airport infrastructure, and the air carriers and operators that provide aviation services for all communities on and off the contiguous road system.

Aviation provides essential services that include mail delivery, cargo shipment, and passenger transportation—often referred to as the "three-legged stool." The system depends on federally funded programs such as Bypass Mail and the


A Bobcat takes care of the heavy lifting for a baggage handler, who offloads the last of the cargo from a Ryan Air Alaska CASA C212. Alaska's air network keeps the supply chain moving for residents as well as businesses.

Ryan Air Alaska, Wikimedia Commons, CC BY-SA 4.0

Essential Air Service Program. Bypass Mail provides funding incentives to airlines that deliver parcel post packages to remote communities that otherwise are not economically viable to serve, while the Essential Air Service subsidizes the cost of transporting passengers to designated smaller airports around larger hubs. Together, these programs make it financially feasible for carriers to offer services and routes to remote areas. However, the Rural Service Improvement Act of 2002 (RSIA) recognized that "a class of carriers had developed and focused on mail to the exclusion of passengers and freight. RSIA compared air service in Alaska to a three-legged stool that supports passengers, freight, and mail service. And it recognized that if there was focus by any party on only one leg of the stool, such as mail, the overall stool would be weakened" (*1*).

The current state of rural Alaskan aviation infrastructure is often substandard compared with other systems within the country. This is because of a variety of reasons, such as extensive and diverse landscapes that cover hundreds of miles, difficult access to many places, extreme weather, and lack of sufficient funding for improvements. A 2021 FAA report identified weaknesses throughout the state and offered 11 recommendations to improve the safety of the aviation system (*2*). Researchers found that many areas lack reliable navigational aids and vital information such as current certified weather and cellular service, especially in locations with extreme weather conditions and rough terrain. These factors contribute to Alaska's high aviation accident rate, which makes up 7 percent of all aviation accidents in the United States—despite being home to less than 1 percent of the population (*3*).

The Alaska DOT&PF is responsible for managing and ensuring compliance for rural aviation infrastructure across the state. It oversees airport planning, design and construction, and maintenance of existing infrastructure. It also ensures that airports meet FAA safety standards. This is a huge challenge with the large number of assets and personnel to stay operational, but the department provides opportunities to create resilient infrastructure and build a safer system for everyone involved.

## Challenges of Rural Aviation in Alaska

One of the most challenging aspects of managing the largest aviation system in North America is the isolation, remoteness, and extreme weather in many areas. This was recently highlighted by the Aviation Advisory Board's Resolution 2022-2, which supported the state's plan for the Western Alaska Resiliency Study. This study will identify risks and provide recommendations for many airports in western Alaska that are affected by environmental factors such as erosion, permafrost, freeze–thaw cycles, and sea-level rise. For example, the western portion of Alaska faced Typhoon Merbok's extreme wind, rain, and flooding in the fall of 2022. Many communities experienced extensive damage to infrastructure, although most airports sustained the event well and ensured that access remained viable for emergency response. More studies and better technology will be required to combat the effects of weather and the environment, but the high cost of building in remote areas will likely remain.

Funding is also a significant challenge facing all airports in Alaska, which have far more needs than funding available. Alaska DOT&PF must balance the need for maintenance versus system expansion. It must also balance planned and ongoing projects with personnel challenges and a reduced workforce. However, due to safety concerns and required grant assurances, the state more commonly funds projects related to rehabilitation or resurfacing rather than large projects that create additional infrastructure beyond what exists today. The funding challenges are also compounded by the high cost of construction in remote communities. For example, the community of Kongiganak sits along the coast of western Alaska. Like many Alaskan communities—including Juneau, the state capital—it is not connected to the contiguous road system, meaning all access in and out is by air. A capital improvement project is underway that includes resurfacing the runway, taxiway, and apron at Kongiganak Airport. The only way to secure the needed materials and equipment for this—and any—construction project in Kongiganak is to transport them by barge. Gravel for projects like this can cost up to $400 per cubic yard to purchase and deliver, while the average cost of gravel across the state is generally $10–$50 per cubic yard. The resultant cost of reconstruction is prohibitive, so Alaska DOT&PF must often repair and maintain older infrastructure beyond its useful life and until funding is available for replacement. This frequently causes

U.S. Coast Guard

Rushing floodwaters from 2022's Typhoon Merbok wash a building off its foundation and trap it beneath a bridge in Nome, Alaska. Such extreme weather conditions and the damage they bring are among the major factors that can stall the state's aviation system.

Dave Wilson, Aviation Risk Solutions

Bright as a beacon, a yellow building marks Kongiganak Airport—part of an isolated western Alaska community disconnected from the state's main highway system. Water surrounds the nearby village of Kongiganak, just two miles from the Bering Sea. When residents need to venture farther, they head to the outdoor airport terminal and catch a flight.

frustration statewide, as economic development–related projects are often shelved as the rehabilitations and safety needs take priority and receive funding first. This results in a cycle where communities must rely on federal dollars to make repairs rather than build a self-sufficient airport that can generate income.

## Benefits of Alaska's Rural Aviation

Air transportation is essential for rural communities in Alaska, with more than 80 percent of communities disconnected from roads. The Alaska Aviation System Plan summarizes this point: "While many villages have clinics, there are few hospitals and trauma centers. Residents also travel by air for routine medical care, often traveling to larger hub cities to see general physicians, dentists, or specialists" (*4*). Logistics and maintenance are crucial issues, but community vitality is an equally important though less tangible policy goal that contributes to fostering rural communities.

Additionally, rural aviation supports economic development opportunities in areas that otherwise would have none. Jobs ranging from equipment operators to rural contractors and tourism professionals are created in these systematically divested communities. Airports provide access to subsistence resources, such as hunting and fishing grounds, as well as to national parks and the remote outdoors (*4*).

Further, airport infrastructure in rural Alaska has proved more resilient in extreme conditions than traditional road and rail networks. This is especially true for infrastructure with well-designed and constructed runways. In many cases, the first response to disaster events in a community is via airplane.

## Conclusions

Rural aviation in Alaska is critical for providing access to essential services and supporting the state's mostly rural way of life. However, current airport infrastructure is not where it needs to be, and there are significant challenges to its continuous operation and maintenance. As the state's geographical environment calls for Alaska DOT&PF to be not only resilient but also creative in problem solving, there is hope in future developments and improvements in its airport infrastructure.

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# GETTING WIRED

## Providing Broadband and Cellular Access

Courtesy of Jon Staveny, Northwest Colorado Council of Governments


BRANDY REITTER

The author is executive director of the Colorado Broadband Office in Denver.


Workers install fiber optic cable along miles of Interstate 70 through Colorado. Using highways to carry communication services helps to get connectivity to rural areas where broadband and cellular service is a need—not a want—for work, play, education, telemedicine, emergency services, and more.

The Internet provides an information superhighway that continues to evolve, becoming integral to everyday life. Some of this evolution has linked broadband networks and transportation infrastructure; broadband and cellular networks may share transportation system infrastructure to provide middle- and last-mile connectivity for high-speed Internet. This connectivity contributes to the well-being of rural communities, areas that can otherwise be isolated.

Rural access to transportation and broadband services share similar barriers and impacts, resulting in underserved populations. To address these limitations, rural communities can leverage transportation and broadband infrastructure through regionalism and public–private partnerships to improve access, affordability, digital equity, and inclusion.

Barriers to broadband adoption in rural areas include a lack of physical infrastructure, affordability, digital literacy, and devices. Devices include personal computers, tablets, routers, modems, and hotspots. In Colorado, infrastructure and digital inequity make up 55 percent and 45 percent, respectively, of the adoption gaps. The lack of private investment in rural broadband infrastructure has contributed to disparities in access to health care, education, public services, and economic growth. Of 3 million locations (areas or specific addresses where broadband Internet services are available for installation and use), 360,000 (12 percent) lack adequate access to high-speed Internet. This includes 166,000 households (14 percent) in mostly rural areas (*1*).

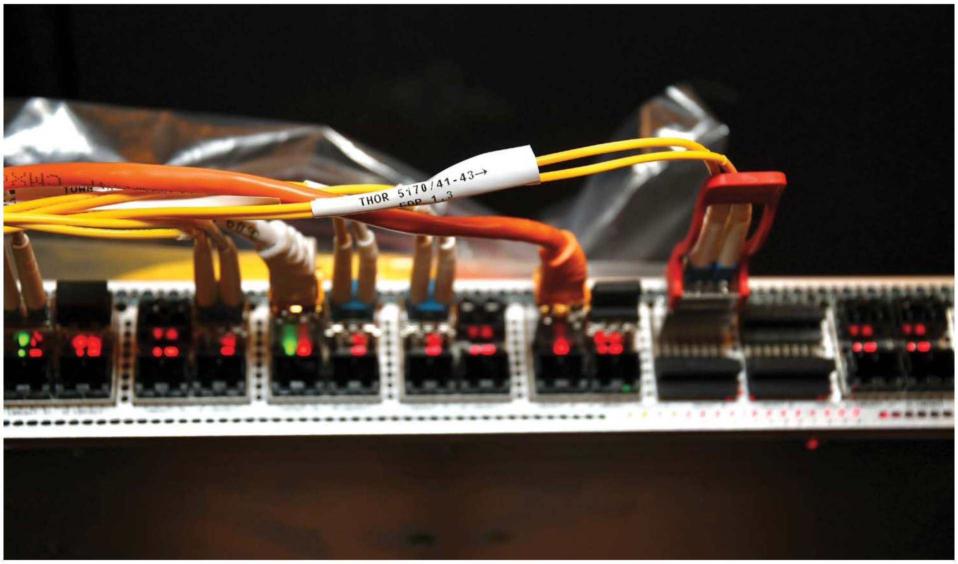
### Leveraging Transportation

In Colorado, collaborative public–private partnership models show the benefits of leveraging transportation infrastructure to bridge the digital divide. Public roads are valuable assets that can be used to reduce deployment costs by establishing rights-of-way, streamlining permitting processes, and leasing dark fiber to partners to expand broadband infrastructure in hard-to-serve areas. Dark fiber is unused or unlit optical fiber cable laid underground or strung along utility poles that are activated for the use of optical signals or data transmission.

For example, Project THOR is a regional model of a public–private partnership that includes the Northwest Colorado Council of Governments, 14 rural communities, Internet service providers, and the Colorado Department of Transportation (DOT). Project THOR used Interstate 70 to construct 400 miles of affordable, middle-mile fiber optic network carrier-class infrastructure to northwest Colorado (*2*). A middle-mile network is a portion of a telecommunications network that connects local access networks to a wider Internet backbone.

In southwest Colorado, Region 10 is another model that includes communities, rural electrical cooperatives, and Internet service providers. Region 10 used a network of state highways and conduit investments to construct more than 200 miles of middle-mile infrastructure to serve the most unserved (*3*).

Public–private partnerships are proving to be a local solution that expands access to broadband for rural communities in Colorado. The town of Breckenridge created a partnership called Fiber 960, which provided $8 million to construct a middle-mile loop to lease to a private Internet service provider to get last-mile service to customers. Breckenridge took advantage of local and state transportation infrastructure to complete the project (*4*). Public–private partnerships also may include utility providers. La Plata County Electric Association constructed 125 miles of fiber optic cable that is leased exclusively to an Internet service provider to deliver last-mile connectivity to towns, tribal communities, and nonprofits located in La Plata, San Juan, and Archuleta counties. The association uses rights-of-way and utility easements to bring critical infrastructure to rural southwestern Colorado (*5*).



Courtesy of Jon Staveny, Northwest Colorado Council of Governments

**A circuit board represents the connectivity that Colorado has provided in diverse rural areas from the affluent ski resort town of Breckenridge to the remote southwestern part of the state.**

## Taking Ownership

Using existing utilities, locally owned and operated networks become innovative solutions that allow rural communities in Colorado to expand broadband access. Glenwood Springs was the first rural community in Colorado to own and operate a municipal broadband utility. In 2020, the city financed a major expansion of the network to expedite service delivery to the whole community (*6*). Yampa Valley Electric Association, located in the state's central mountains, created Luminate Broadband. Their locally owned and operated broadband network includes 325 miles of fiber optics that provide access to 1,658 customers (*7*). A similar example is Trailblazer Broadband, a $28 million town-owned fiber-based broadband utility located in Estes Park, Colorado, that will service up to 4,500 rural customers over the next three to five years. Trailblazer Broadband uses a power and communications utility for infrastructure financing (*8*).

Leveraging transportation infrastructure for broadband enables the expansion of cellular access for rural communities in Colorado. Cellular access not only supports mobile devices, but it is critical infrastructure for public safety, emergency management, and transportation. Colorado DOT and Crown Castle, a telecommunications company, partnered with First Net Authority to construct a system of fiber optics, a 32-foot-tall cell tower, and poles or nodes that will enable parties to use the new fiber system for cameras to address traffic issues and improve public safety. The project will increase connectivity along a 20-mile stretch of US-36 between the towns of Estes Park and Lyons, which are rural with geographical challenges ranging from mountainous terrain to their distance from broadband infrastructure (*9*).

## Advantages

Improved Internet access has a positive effect on digital equity as well as on economic development. Through infrastructure deployment in rural communities, the Colorado Broadband Office is working with the Colorado Department of Labor and Employment's Office of the Future of Work to create a statewide Digital Equity Plan. Part of this plan includes a digital navigator program that focuses on providing digital education, apprenticeships, and low-cost devices to increase digital adoption rates in rural Colorado. The goals are to help residents learn new skills or improve existing skills, prepare them for employment

Wally Gobetz, Flickr, CC BY-NC-ND 2.0

Steep and sometimes heavily forested terrain in locations like Lyons, Colorado, can be challenging for utility installation. With the Rocky Mountains—North America's largest mountain system—dividing Colorado between the plains in the east and the Western Slope, geographic obstructions are common.

opportunities that rely on broadband connectivity, and improve digital inclusion for rural communities.

## Highways to the Future

Transportation infrastructure has evolved to be more than automobiles on roads. Transportation systems have become the foundation of successful rural broadband solutions in Colorado, representing a critical path for connecting rural communities to high-speed Internet. While the lack of private investment in rural broadband and cellular infrastructure results in digital exclusion, innovative solutions address the limitations of connectivity.

When transportation and broadband infrastructure are used by public–private partnerships, rural communities can participate in the modern world. These solutions enable public and private actors to realize the economies of scale that are critical to broadband and cellular investment, expand access to broadband infrastructure, and improve digital equity and inclusion.

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# Jurisdictional Challenges in Tribal Transportation


Christine Gerencher

**RONALD HALL**

The author is the tribal transportation program manager at the Upper Great Plains Transportation Institute and co-director of the Northern Tribal Technical Assistance Program at North Dakota State University in Fargo.

A solitary butte marks the road to the Acoma Pueblo's Sky City Cultural Center, approximately 60 miles west of Albuquerque, New Mexico—the closest large city. On tribal land, road jurisdiction is complex. Whether for maintenance or traffic stops on routes leading to cultural sites, campgrounds, or casinos, who governs the roads is up for debate.

The term *jurisdiction* is referenced in forums ranging from courtroom arguments to coffee shop conversations. As a legal concept, jurisdiction is the focus of entire law school courses. And for much of the United States, the concept is left to lawyers. But for transportation officials, law enforcement, and emergency responders across Indian Country, jurisdiction is an issue that must be recognized and accounted for daily.

Jurisdictional authority derives from sovereign powers established at nationhood. Tribal governments are sovereign nations with inherent powers of self-government that exist outside of and predate the U.S. Constitution. These powers are limited only by Acts of Congress or U.S. Supreme Court decisions. The law regarding jurisdiction on tribal land is complex and constantly shifting with new cases and situations. Within tribal lands, decisions regarding jurisdiction can have life-or-death consequences, as they affect who will have the authority to maintain a road, replace a stop sign, or arrest a suspected criminal.

The baseline definition of jurisdiction is the authority of a government to enact and enforce laws. There are three general categories of jurisdiction (*1*).

1. Jurisdiction to prescribe—to make law applicable to the activities, relations, or status of persons, or the interests of persons in things, whether by legislation, executive act or order, administrative rule or regulation, or determination of a court.
2. Jurisdiction to adjudicate—to subject persons or things to the processes of courts or administrative tribunals, whether in civil or criminal proceedings, whether the state is a party to the proceedings or not.

Joe Ravi, Wikimedia, CC BY-SA 3.0

The U.S. Supreme Court building glows in the twilight of a Washington, DC, evening. The inscription above the columns, *Equal Justice Under Law*, and recent court rulings give hope to tribal authorities that they may retain or gain additional jurisdiction on tribal land, including roadways and transportation infrastructure.

3. Jurisdiction to enforce—to induce or compel compliance or to punish noncompliance with laws or regulations, whether through the courts or by use of executive, administrative, police, or other nonjudicial action.

Tribal governments administer and operate transportation programs in a jurisdictional environment that touches each of these categories. The following discussion applies to public roads on tribal land.

## Public Roads Jurisdiction

Indian Country is a web of roads with different owners. Of the 157,000 miles of road in the National Tribal Transportation Facilities Inventory, about 31,400 miles are owned by the Bureau of Indian Affairs, 26,000 miles are owned by tribes, and 101,000 miles are under state or local ownership (*2*). These figures vastly understate all but the miles owned by the Bureau of Indian Affairs.

Tribes lack jurisdiction to perform maintenance or make improvements on—or establish regulatory rules for—state and local roads and bridges without first receiving permission.[1] Tribal and county road maintenance agreements can be negotiated and enforced. Liability for injuries resulting from improper maintenance is one issue that must be addressed in intergovernmental agreements.

## Enforcement of Criminal Laws

Tribal criminal jurisdiction within tribal lands is evolving. The reservation of land to tribes under treaties with the United States was intended to establish exclusive homelands. However, those treaties were not honored, resulting in non-Native land ownership within tribal boundaries.

This situation was compounded in 1978 when the U.S. Supreme Court decided *Oliphant v. Suquamish Indian Tribe*. The Court ruled that tribes do not have criminal jurisdiction over non-Native people for crimes committed within reservation boundaries. As a result, tribal law enforcement officers may not arrest non-Native people for criminal conduct, including impaired driving, speeding, possession of illegal substances, and other crimes. In 2013, changes to the Violence Against Women Act included recognition of the inherent authority of "participating tribes" to exercise "special domestic violence criminal jurisdiction" over certain defendants, regardless of their status as Native or non-Native people.[2]

However, in 2021, in *United States v. Cooley*, the Supreme Court held that tribal governments—and thus their police officers—retain the power to temporarily stop and, if necessary, search non-Native people traveling on public rights-of-way (highways) through reservations for suspected violations of federal or state laws. The Cooley decision is the first time the Court has ever found that a tribe's interest in addressing a threat to its political integrity, economic security, health, or welfare was strong enough for the tribe to exert governmental authority over a non-Native people.

This authority of a tribal officer to detain and transport criminal suspects to proper nontribal authorities was recognized as rooted in the tribe's inherent sovereign powers. At oral argument, Justice Brett Kavanaugh commented that law enforcement experts describe "the laws created by the Court and Congress to govern authority over criminal conduct on reservations as so complex, conflicting, and illogical that they are nothing short of an 'indefensible morass.'"

## Public Safety

Many state and local governments are establishing effective communication and collaboration with tribal governments to address coordinated long-range planning, project development, law enforcement, and substance abuse treatment. Safety planning is supported through data and equipment sharing, joint road safety assessments, and other forms of mode-specific planning. Law enforcement has been improved by cross-deputizing tribal officers to enforce state and federal law.

Public transportation on tribal lands presents parallel but different issues and opportunities for a wide range of stakeholders. Law and policies regarding tribal government authority to manage transportation infrastructure, regulate emerging modes and technologies, and interact with other government and private entities are evolving fields.

The TRB Standing Committee on Native American Transportation Issues is interested in collaborating with other committees and organizations to further research and analyze these challenging issues.[3]

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[1] Local roads include rights-of-way owned by a county, municipal, township, or parish.

[2] See 25 U.S. Code Section 1304—Tribal Jurisdiction Over Covered Crimes. https://www.law.cornell.edu/uscode/text/25/1304.

[3] Learn more about this TRB committee at https://sites.google.com/view/trbame30.

# Geofoam

## Colorado's Innovative Answer to an Emergency Highway Repair

STEPHEN HARELSON

The author is president of Dyer Mountain Ltd. Civil and Mechanical Engineering in Denver, Colorado, and former chief engineer of the Colorado Department of Transportation, also in Denver.

When an emergency strikes, the time is ripe for innovation. Sometimes, however, the best innovations are with techniques and technologies that are unknown or unproven to the decision makers addressing the emergency. In these instances, TRB's published research can help reassure these decision makers and provide justification to allow them to stick their necks out and implement these seemingly cutting-edge techniques.

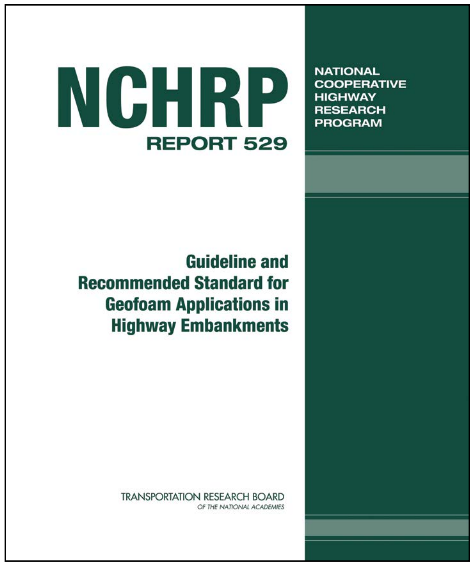
### Problem

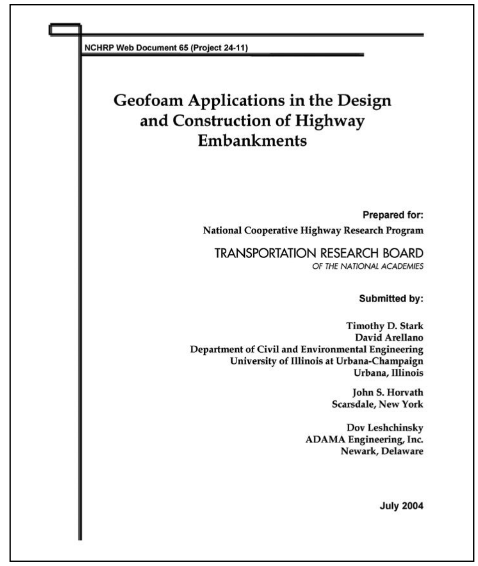
On July 12, 2019, the Colorado Department of Transportation (DOT) was faced with an emergency. A mechanically stabilized earth (MSE) bridge abutment failed catastrophically, closing US 36 that connected Denver and Boulder. After two days of troubleshooting, engineers on the scene determined that the abutment had been constructed on an ancient lake bed. The lake bed consisted of fat clay: Clay with a high liquid limit and plasticity index that cause it to lose strength when wet. In this case, the fat clay lost much of its bearing capacity when moist. As the MSE abutment weighed on the moist fat clay, it triggered a rotational failure at the toe of the MSE wall and the entire embankment came tumbling down. Engineers at the scene were faced with a dilemma: how to remove 120,000 cubic yards of failed embankment, address the foundational issues in the lake bed, and return the 120,000 cubic yards of material to the way it was. More than 100,000 drivers who rely on the road every day waited anxiously for the solution.

### The Answer

Five days later on July 17, 2019, Colorado DOT selected Kraemer North America to construct the repairs under a construction manager–general contractor (CM–GC) project delivery arrangement. David Evans and Associates was hired to assist Colorado DOT in the repair design. The design consulting team also included RJ Consulting as the geotechnical design subconsultant. Under Colorado's CM–GC contracting protocol, the contractor provides input on the design, while the Colorado DOT engineers and the engineering consultants maintain control over final design decisions.

The first design meeting of the reconstruction team—Colorado DOT, the CM–GC contractor, and design consulting team—took place a day later on July 18. Colorado DOT, the contractor, and the engineering consulting team worked tirelessly to design the repair. Quickly, it became obvious that removing the failed embankment, constructing a foundation through the lake bed to bedrock, and reconstructing the MSE wall would take eight or nine months. Recognizing that much of that construction would occur in the Colorado winter, harsh weather could delay it even further. The geotechnical design subconsultants suggested the use of Geofoam blocks to fast-track the project and get the embankment reconstructed prior to winter.




The project team followed best practices outlined in *NCHRP Report 529* and *NCHRP Web Document 65* to design a novel use of Geofoam expanded polystyrene blocks to repair a section of US 36 in Colorado.

## Benefits

Geofoam is an expanded polystyrene product that is specially designed to replace earthen embankments. A lay person would describe it as Styrofoam because it looks and feels very similar to the Styrofoam packing material seen in most every package. It weighs about 1 percent to 2 percent of normal soil fill, so its use would essentially unload the fat clays that had failed (i.e., remove the excess weight that had led to failure). With the use of Geofoam, the structure would weigh less than 10,000 tons instead of 120,000 tons. This was well within the bearing capacity of the lake bed clays, and it would allow reconstruction of the fill quickly and without the need to construct foundation structures through the clay to the more substantial bedrock below.

The contractor had used the product on a 2005–2006 project in Utah and, therefore, was also heavily involved in the design of the emergency project for Colorado DOT. Based on the Utah experience, the contractor was confident that the use of Geofoam would be a solution for the emergency project and that it would accelerate the delivery by at least six months.

## Application

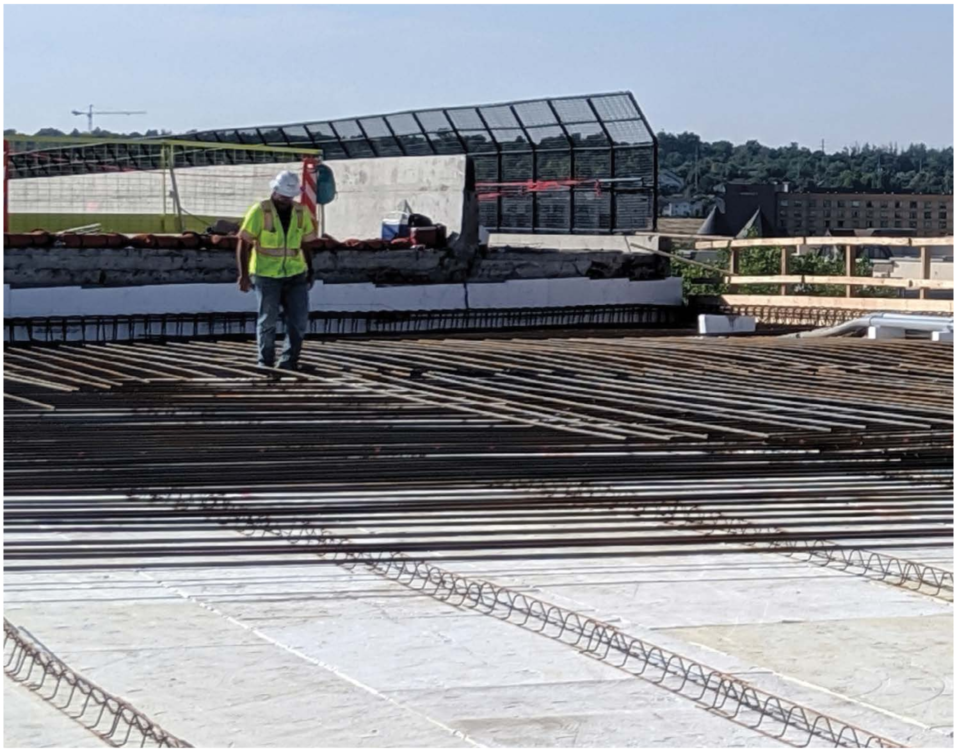
Colorado DOT, however, had very limited experience with Geofoam—with only two examples of its use and on a much smaller scale than was envisioned on this project. However, the contractor had used the material on several previous projects, and the geotechnical experts at RJ Consulting were also convinced of its advantages. A quick literature review showed that two National Cooperative Highway Research Program (NCHRP) publications discussed its use in highway embankments: *NCHRP Report 529: Guideline and Recommended Standard for Geofoam Applications in Highway Embankments* and *NCHRP Web Document 65: Geofoam Applications in the Design and Construction of Highway Embankments* (*1*, *2*). Both documents were prepared under NCHRP Project 24-11, "Guidelines for Geofoam Applications in Embankment Projects". *NCHRP Report 529* provided detailed and well-thought-out design suggestions for the use of the material, while *NCHRP Web Document 65* provided several case examples that convinced Colorado DOT staff that they were traveling down a feasible path.

The geotechnical design subconsultant relied heavily on the NCHRP design guidelines. Early in the deliberations with the contractor, the geotechnical designers knew conceptually that the Geofoam product would work as a solution and found that *NCHRP Report 529* was invaluable in getting the design right and modeling the expected compression of the material under final load.

While the CM–GC contractor removed the failed embankment from July 19 to August 13, the design team worked on the design of the Geofoam embankment—using the suggestions outlined in *NCHRP Report 529*. One of the greater challenges was procuring the necessary 6,000 Geofoam blocks in the narrow construction window available to avoid winter weather conditions. The contractor worked with the Geofoam manufacturer to deliver the material from multiple plants throughout the country to keep the project on track.

Foam material compresses under load, so settlement of the material as it was loaded with the roadway slab was another important consideration. This compression occurs over several days, but then it stabilizes. The amount of the compression must be considered in the design of the embankment so that the roadway is at the proper grade once the compression stabilizes. Other issues addressed included protecting the Geofoam from rodent infestation, as well as any solvents that might be spilled from highway traffic and attack the expanded polystyrene.

Embankment construction during September 2019 went smoothly. The refrigerator-size Geofoam blocks replaced the earthen embankment by being stacked in an interlocking pattern. It was critical that the blocks be fitted tightly together to minimize the compression of the structure. When stacking was complete, the Geofoam was protected with a membrane and a concrete panel wall. The roadway deck was placed on the Geofoam, while the Colorado DOT engineers carefully measured the compression



Courtesy of Colorado DOT

**Crews assemble the rebar mat that will reinforce the concrete slab that rests on top of the Geofoam structure.**

of the structure as it was loaded. The compressed Geofoam stabilized exactly as the NCHRP report indicated. The roadway was reopened to traffic on October 4, 2019, less than three months after the failure and less than half the time of a more traditional fix, saving Denver–Boulder commuters an entire winter's worth of construction detours.

The availability of the NCHRP research provided design guidelines and material and construction suggestions, as well as the engineering properties of the geofoam material and a summary of successful case histories (*3*). This research provided design tools, established methods of design, reassured Colorado DOT staff that the approach would work, and confirmed that the product was proven and reliable. It also documented use in other regions of the country and, although it was cutting edge and innovative to the project team, the research demonstrated that Geofoam had been used successfully elsewhere and provided an engineering basis for its use in Colorado.


Courtesy of Colorado DOT

**Precisely stacked Geofoam blocks form the face of the new structure. A steel-reinforced concrete caisson is one in a series that will support the precast concrete panels that protect the Geofoam wall.**

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# Karen K. Dixon

*Associate Agency Director, Texas A&M Transportation Institute*

**Karen Dixon** is a nationally recognized highway safety expert who focuses on the safe and efficient design of streets and highways. Whether chairing a major national effort that culminated in the creation of the first *Highway Safety Manual* published by AASHTO or drilling down into the roadway design details required at the local level, she employs a holistic view and thinks of safety first. "Often academic research focuses on fundamental scientific concepts," she notes, "but many common concerns for the traveling public can be evaluated and then addressed at the local level."

With expertise in geometric design, transportation safety, access management, and consideration of transportation suitable for all users, Dixon recognizes that there is a danger in evaluating many of these focus areas independently, based on the scope of research. "Often, we need to better understand the performance of each of these elements as part of a more comprehensive systemwide effort that explicitly considers their interactions."

During more than a decade with Texas A&M Transportation Institute (TTI), Dixon has tackled in many high-profile projects, but she also pursues work she feels "will provide meaningful, application-oriented information." With a trail of successes that included co-authoring TRB's *Access Management Manual*, she was promoted to TTI associate agency director in 2022.

As a member of the graduate faculty, Dixon contributes to the Texas A&M University School of Civil and Environmental Engineering. Having served on masters and doctoral thesis committees, she often includes students in her research efforts and notes, "I may continue to mentor these students after they graduate and start their careers." Her local community involvement extends to serving in officer positions—including president—of the Institute of Transportation Engineers' College Station Chapter.

Dixon, who received her bachelor's degree in civil engineering from Texas A&M, earned a master's degree and a PhD, both in civil engineering, from North Carolina State University in Raleigh. She worked in the private sector as a site development, highway, and interchange designer for eight years before returning to academia in 1995 to teach at the Georgia Institute of Technology's College of Engineering in Atlanta. Starting in 2005, she taught at Oregon State University in Corvallis until 2012, when she left as a full professor. Her decision to return to Texas and TTI reflected a desire to "best use my experience to effectively contribute to the needs of the transportation community and to increase the impact I was having on transportation research and the deployment of that research," Dixon recalls.

"Many common concerns for the traveling public can be evaluated and then addressed at the local level."

A well-respected author and co-author of more than 80 technical papers and research reports, she is the recipient of the Institute of Transportation Engineers' 2021 Transportation Safety Council Edmund R. Ricker Award and the 2023 Texas A&M Regents Award, the highest honor awarded to a Texas A&M researcher. As a member of the joint TTI and Texas Department of Transportation (DOT) team effort that culminated in Texas DOT's Safer by Design Safety Scoring Tools, Dixon also received the U.S. Department of Transportation's 2021 National Roadway Safety Award as well as the 2022 Francis B. Francois Award for Innovation. She quickly points to the efficiency of this joint research effort. "TTI conducted a national safety study focused on the impact of elevating speed limits and how this change influenced crash frequency and severity. At the same time," Dixon notes, "Texas DOT was challenged by how to prioritize benefits based on safety and fiscal needs for higher speed road projects and how to compare projects equitably. The objectives were different, but the distinct linkages between the two projects enabled the State of Texas to benefit from the national study and Texas DOT to adopt the tool with a requirement that every maintenance or construction project would use the tool on roads they maintain."

A TRB member since 1997 and a frequent National Cooperative Highway Research Program panel member, Dixon chaired the Subcommittee on Crash Modification Factors from 2011 to 2014 and is the chair of the Standing Committee on Safety Performance and Analysis, for which she also previously served as co-chair.

When asked to pick a standout career moment, Dixon describes listening to the assigned TRB contact announce her to the committee as the new chair of the *Highway Safety Manual* Research Task Force. "There was an instantaneous standing ovation," she adds. "The audible respect from my peers was one of the most humbling—and memorable—experiences." This event set the bar for Dixon, who continues to meet or exceed the bar through practice-based research efforts that incorporate design and operational components into safety research whenever possible.

# Frederic D. Fravel

*Vice President, KFH Group*

**Fred Fravel** is a team player who believes in the synergy of collaborating with others. Perhaps his most impactful early collaboration is one he credits to his graduate school advisor. "In the hall one day, my advisor handed me a lot of Interstate Commerce Commission data on intercity bus companies. 'Go see what you can do with this,' he suggested. No instructions, just a well-aimed directive." Diving down the data rabbit hole, Fravel and his collaborators soon published a paper on economies of scale in the intercity bus industry and touched on the potential effect of deregulation—trendsetting thoughts in the 1970s.

With a bachelor's degree in interdisciplinary social science from Duke University in Durham, North Carolina, and a master's degree in regional planning from the University of North Carolina at Chapel Hill, Fravel began his professional career as an intercity program manager for the North Carolina Department of Transportation (DOT) in 1978. "After a summer backpacking around Europe on a rail pass, I realized that at home in the States, I really had very limited mobility unless I had a car—and this was something to work on changing." Fravel concentrated on projects to maintain rural intercity bus service and expand Amtrak service in North Carolina. He seized an opportunity to assist the Motor Carrier Ratemaking Study Commission as a consultant, concentrating on two legislatively mandated studies involving antitrust immunity for collective ratemaking and the effect of deregulation on rural and older adult populations. Soon after, he joined a private firm where he would spend the next 11 years addressing options for maintaining rural bus, air, and rail services; studying Interstate Commerce Commission antitrust immunity policies for collective ratemaking and bus terminal control; and writing congressional Office of Technology Assessment feasibility studies that addressed the feasibility of wheelchair access on intercity buses.

"There is a significant link between research and practice and between policy and outcomes."

In 1995, Fravel took on a new type of collaboration when he and two colleagues formed KFH Group (the *F* in the company name stands for Fravel). "Often, we work on teams with other transit planning consultants," he notes. The firm focuses on assisting local, state, and federal authorities looking to improve public transportation services.

Since starting KFH, "most of my projects have been with state transportation departments, local governments (usually the transit system), and some private transportation firms," Fravel explains. From an assessment of rural intercity bus needs in Nebraska to an update of the Ohio Intercity Bus Study for the Ohio DOT, projects have him crisscrossing the nation.

Fravel's work is grounded in research, and his TRB involvement is second generation. "My father was a highway engineer who attended Highway Research Board meetings in the 1950s and 1960s when I was growing up," he recalls. Despite the organization's name change, TRB was not new to Fravel when he and fellow graduate students started going to the TRB Annual Meeting in the 1970s.

"There is a significant link between research and practice and between policy and outcomes," Fravel notes. "My work began by—and still relies on—looking at data, doing research, identifying research results, and providing this information to policy makers who create policies that need to be evaluated through research and so on." Fravel sees the research community as part of an ongoing feedback process that begins with asking questions to be researched, collecting data that can address them, and performing analysis to understand the relationships—all of which lead to plans to put that research into action. His advice to young colleagues is to "get involved in the entire process. That includes the development of research questions, as well as the more defined planning tasks."

A member of Transit Cooperative Research Program and National Cooperative Highway Research Program project panels, Fravel is past chair of TRB's Intercity Bus Committee, now part of the Rural, Intercity Bus, and Specialized Transportation Committee, which he co-chaired from 2019 to 2022. Above all of his TRB involvement, however, he considers one of his most significant achievements to be "receiving the Roger Tate Is Smiling Award—recognizing my ongoing work in rural public and intercity bus transportation." Like Tate, who was known for his passionate, innovative, and unswerving commitment to improving transportation services in rural America, Fravel has been a champion of people who are underserved, especially those in rural communities.

Always the collaborator, he adds a reminder for those starting out: "In an industry where your competitors today are your team members or clients tomorrow, it is important to develop and maintain good relationships with everyone. It's a small industry."

# TRANSPORTATION INFLUENCER

## Stacey Kulesza

*is an associate professor of civil engineering in the Ingram School of Engineering at Texas State University in San Marcos. She is also the director of the Coastal Research and Education Actions for Transportation Equity (CREATE) University Transportation Center, a research-focused consortium of universities led by Texas State University. Since 2020, she has served as committee communications coordinator for TRB's Standing Committee on Transportation Earthworks.*

**What do you do in your role as committee communications coordinator for the Standing Committee on Transportation Earthworks?**
Mainly, I manage our committee LinkedIn page. This means I also do a lot of reminding members that we have a page, and it's the best place to find up-to-date committee information as well as relevant technical content shared in our group.

**What helps you be successful in this role?**
By sitting in on other meetings at TRB and just listening, I've learned a lot about what other committee communications coordinators do. I've also led or helped with the last three Triennial Strategic Plans. Knowing some of the requirements helped me to recognize where to focus communication—and recordkeeping—efforts.

**What might you change if you had an opportunity to go back in time before taking on this role?**
I'm not much for going back in time. Can I leap forward a few years instead? I'm fully onboard with our committee revolutionizing the communication coordinator role by adopting technology of the future.

**What do you find most helpful about TRB?**
The networking opportunities at TRB have easily been the most helpful in my career. Where else but the TRB Annual Meeting can I gather with thousands of colleagues to talk about their transportation geotech needs and how our research team can help?

*Keep up with the Standing Committee on Transportation Earthworks at https://www.linkedin.com/groups/13892417/.*

Transportation Influencer highlights the journey of young professionals active in TRB. Have someone to nominate? Send an e-mail to TRNews@nas.edu.

# MEMBERS *ON THE MOVE*

**Anne Marie Turner** joined TRB as a senior program officer for the National Cooperative Highway Research Program (NCHRP). Previously, she was a project manager with Sam Schwartz, a consultancy focused on transportation and engineering.

**Yi Zhao,** formerly a traffic engineering branch manager at the District Department of Transportation in Washington, DC, joined TRB as an NCHRP senior program officer.

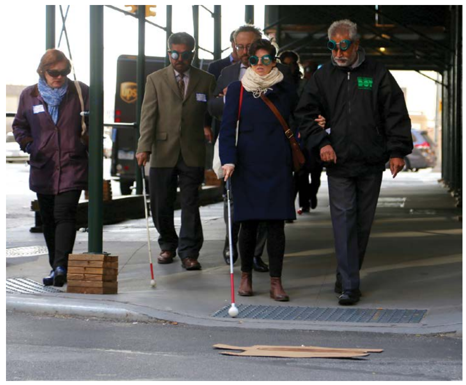
# Creating Connections and Facilitating Equity Through Transportation


TRB hosted Transportation Equity: Community Building in Action on March 22, 2023. This webinar reviewed policies and practices that address inequities and injustices caused and contributed to by transportation. Discussions also considered the role of transportation careers in community building, as well as equity-centered and sustainable outcomes. Tanisha Hall, Fairpointe Planning chief executive officer and principal, as well as chair of TRB's Special Committee on Diversity, Equity, and Inclusion, was the moderator. This was the third webinar in a series that focused on advancing workforce diversity and employee development.

### Fair-Share Transportation Planning

Todd Litman, executive director of the Victoria Transport Policy Institute, spoke about integrating public health and social equity into transportation. He discussed how transportation planning was once only focused on issues like reducing congestion, speed, and accident rates. Now, priorities have shifted to include affordability, social equity, public health, and the environment. He believes that for transportation planners, it's an exciting time to become a local expert on these emerging issues.

Litman also explained that fair-share transportation planning is based on ensuring that all receive an equitable distribution of resources. For example, the majority of transportation funding needs to shift away from driving-related infrastructure because, in a typical community, 20 percent to 40 percent of travelers cannot drive. Reasons may include being too young, past the age of safe driving, or unable to drive because of a disability.



New York City DOT, Flickr, CC BY-NC-ND 2.0

Conducting a hands-on accessibility tour, New York City Department of Transportation staff walk in the shoes of people with visual disabilities—down to wearing special glasses that limit sight. In stressing the need for social equity in transportation, webinar presenters encouraged just such exercises.

### Transit Agency and Community Collaboration

Jamaal Schoby, senior managing associate at CHPlanning, focused on transit and stressed the need to use a bigger lens: Equity is not sameness. He outlined the four dimensions of transit equity as being structural, procedural, geographic, and modal. In creating a transit equity framework, Schoby stressed that the transit agency and the community need to collaboratively develop best practices in areas including safety, affordability, workforce investment, and innovation. He cautioned that it is essential for community members to be at the table, as is encouraging underrepresented and nontraditional stakeholder participation, as well as building a coalition of diverse champions in the community who can act as liaisons.

Schoby indicated that some outcomes include agencies getting a better understanding of community needs, new and improved performance metrics, the community's improved perception of the transit system, and transit routes that are more aligned with the community's travel patterns.

### Access to Transportation Is Critical

Anna Zivarts, director of the Disability Mobility Initiative Program for Disability Rights Washington—a private nonprofit organization—spoke about transportation access for everyone and cited that 31 of every 100 U.S. residents is a nondriver. She added that 18 percent of those over age 65 do not drive. She also discussed a project in which she documented stories of nondrivers to inform policies for which she advocates. She shared a story about a woman who must use her wheelchair on the road because the sidewalks in her community are uneven and do not offer smooth transitions to the road.

An overarching theme of Zivarts' presentation was that people need networks to get to where they need to go. Prioritizing those connections is important because it's not just one accessible sidewalk that provides nondrivers with access to different forms of transportation. It is many that connect to transportation options.

*Access the presenters' slides at https://onlinepubs.trb.org/onlinepubs/webinars/230322.pdf and a recording of the webinar at https://vimeo.com/811004064.*

*—Karen Febey,*
*TRB senior report review officer*

NCHRP RESEARCH REPORT 988

# Mapping a Path for Rural Transportation Research

JOHN W. SHAW

The author is a road-safety research scientist at Iowa State University in Ames.

Transportation practitioners in every state face myriad challenges as they work to meet the needs of rural communities. To explore ways that research can contribute to those efforts, the National Cooperative Highway Research Program (NCHRP) established a project panel and commissioned the development of a Rural Transportation Issues Research Roadmap, published as *NCHRP Research Report 988* in 2022.

The panel—chaired by Charles Carr, director of Intermodal Planning at the Mississippi Department of Transportation (DOT)—selected Montana State University and Iowa State University to conduct the fast-tracked project. Through a series of in-depth workshops, the team completed a multimodal analysis of existing rural transportation research, identified research gaps, compiled more than 900 rural transportation research needs, and developed a set of early-action research needs statements—several of which have come to fruition as NCHRP and Transit Cooperative Research Program projects.

*NCHRP Research Report 988*, which includes hundreds of research ideas suitable for implementation by state DOTs, industry coalitions, individual researchers, and students, draws attention to the unique circumstances and diversity of rural communities. For example, it acknowledges that the issues faced by rural communities on the fringes of metropolitan areas are likely to differ considerably from those in remote areas. Similarly, the transportation needs of rural resort towns are distinct from those of communities that produce agricultural or mineral commodities.

U.S. Department of Agriculture

Cattle bred for coast-to-coast markets graze the autumn range at Van Dyke Angus Ranch in Montana's scenic Gallatin Valley. The transportation needs of rural agricultural communities differ markedly from countryside towns close to suburbs.

For simplicity, research needs were organized into 15 themes ranging from active transportation, aviation, and rural public transit to economic development, infrastructure, and safety. Special categories were included for the many cross-cutting issues identified by project participants. For example, rural economic development, infrastructure, and safety are often intertwined. The roadmap's intent is to assist state DOTs and other public agencies with setting research priorities that help inform policies and investment decisions.

*Read NCHRP Research Report 988 at https://doi.org/10.17226/26343.*

# Aviation Symposium Lands in California

KATIE TURNBULL AND DAVID BALLARD

Turnbull, a senior research fellow at the Texas A&M Transportation Institute in College Station, served as chair of the TRB Executive Committee in 2018. Ballard is a retired transportation and aviation economist who lives in Jenkintown, Pennsylvania.

TRB's 11th National Aviation System Planning Symposium touched down at the National Academies' Arnold and Mabel Beckman Center in Irvine, California, on May 15, 2023. Over three days and with more than 140 participants from the public and private sectors, the symposium featured a mix of general and breakout sessions, interactive poster discussions, and networking opportunities.

After an optional tour of the Lyon Air Museum in Santa Ana, California, and an Airport Cooperative Research Program strategic planning workshop, the symposium began with keynote presentations on advanced air mobility and supersonic aircraft. "A lot has changed since the last symposium in 2018," noted Fin Bonset, chair of the Symposium Planning Committee. "Participants discussed current activities related to advanced air mobility involving the use of electric vertical takeoff and landing aircraft to move freight and people, innovative air transport technologies, equitable mobility, and climate adaptability and sustainability."

The concurrent breakout sessions provided details on modeling aviation activity, integrating new air transport technologies with aviation system planning, workforce development needs, and airport project selection and funding. The interactive poster session highlighted recent aviation system planning research.

"The interaction among participants was fantastic," noted Leah Whitfield, chair of the TRB Standing Committee on Aviation System Planning. "Sharing experiences and lessons learned encouraged creative and innovative ideas to take flight."

That creativity continued during standing committee meetings on the final day of the symposium. In addition to the Aviation System Planning Committee, the other symposium co-sponsoring committees—Aviation Administration and Policy, Airport Terminals and Ground Access, and New Users of Shared Airspace—also met.

Symposium participants departed with an enhanced understanding of current trends and future opportunities, as well as new contacts and innovative ideas to ensure the future of safe, equitable, resilient, and sustainable air transportation.

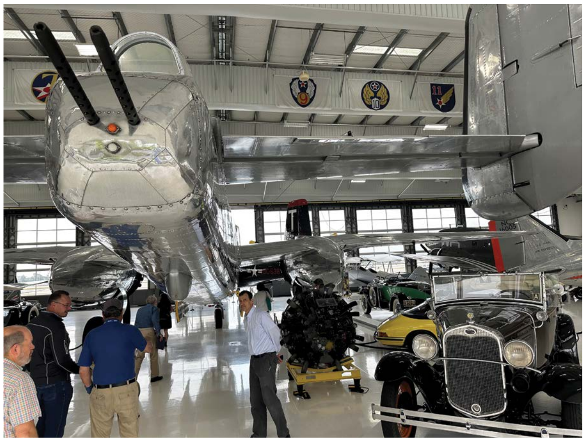
## Catching Up with the Rural Transportation Issues Coordinating Council

One of the four TRB coordinating councils created in April 2020 is the Rural Transportation Issues Coordinating Council, which is the center for coordination on rural transportation issues, conversation, and research. The council considers all aspects of rural transportation, and the list of issues under their purview includes—but is not limited to—planning, design, construction, operations, service provision, training, maintenance, economics, sustainability, safety, equity, and preparing for the next generation of technologies and trends in transportation and the environment affecting rural areas. This relates to the transportation of people as well as goods and services to rural communities, destinations, and markets.

### ONE STOP FOR ALL THINGS RURAL

The goals of the council are to raise awareness of rural transportation issues and increase coordination across TRB by providing a way to network, offering opportunities for peer exchange, serving as a resource to accelerate the inclusion of rural issues and opportunities in the TRB structure, and establishing a robust rural program for the TRB Annual Meeting.

The council is designed to help committees with all things rural. This may



Jennifer Martin

The high-polished body of a B-25 bomber gets close inspection from symposium attendees at the Lyon Air Museum in Santa Ana, California, part of a transportation exhibit that includes a black Model A Ford.

include the following:

- Providing support for rural-focused research needs statements;
- Co-sponsoring a committee’s call for papers, lectern sessions, workshops, poster sessions, or TRB-sponsored conferences;
- Assisting in committees’ marketing of rural resources and events through the council’s website, distribution list, and meetings; and
- Supporting traditionally underrepresented communities’ participation in rural issues and opportunities at TRB events.


Jaime Sullivan

Completed in 1836, Taftsville Covered Bridge in rural Woodstock, Vermont, carries an unexpected steady flow of traffic. Despite that commonality with urban areas, rural regions face issues that may bear little resemblance to urban problems and their solutions.

### HOW TO PARTICIPATE

Anyone interested in getting involved may become a friend of the Rural Transportation Issues Coordinating Council by signing up at MyTRB.org, browsing the council's website (in progress) at https://www.trba0040c.com/, or contacting council chair Jaime Sullivan at jaime.sullivan2@montana.edu or Anusha Jayasinghe, the council’s TRB staff liaison, at AJayasinghe@nas.edu.

**Rural Transportation Issues Coordinating Council Mission**

**To promote rural transportation research needs and opportunities across all modes and disciplines within the entire TRB committee structure and other TRB activities to improve the well-being of rural communities and transportation users.**

## COOPERATIVE RESEARCH PROGRAMS NEWS

### EVALUATION OF MOTORCYCLE LICENSING AND TRAINING REQUIREMENTS

Texas A&M Transportation Institute received a $400,000, 36-month contract [Behavioral Traffic Safety Cooperative Research Program (BTSCRP) Project BTS-27] to evaluate the current state of the practice for motorcycle licensing in the United States and develop recommendations for improvement based on the latest empirical data.

*For further information, contact Richard Retting, TRB, at 202-334-2418 or RRetting@nas.edu.*

mitch055233, Flickr, CC BY-SA 2.0 DEED

Motorcyclists account for a disproportionate number of overall traffic fatalities. A new BTSCRP project is examining whether more restrictive licensing elements, such as requiring a skills test to obtain a permit, may be needed.

### COST–BENEFIT EVALUATIONS OF DETECTION METHODS FOR DRIVING UNDER THE INFLUENCE OF DRUGS

The Pacific Institute for Research and Evaluation received a $500,000, 24-month contract (BTSCRP Project BTS-25) to perform a comparative cost–benefit analysis of three methods—oral fluids, drug-recognition experts, and advanced roadside impaired driving enforcement—used for the detection of driving while under the influence of drugs.

*For further information, contact Richard Retting, TRB, at 202-334-2418 or RRetting@nas.edu.*

### ADVANCED DRIVER ASSISTANCE SYSTEMS EDUCATION AND OUTREACH

The University of Iowa received a $250,000, 24-month contract (BTSCRP Project BTS-26) to characterize the current state of advanced driver assistance systems education, training materials, and methods of delivery; identify populations in need of advanced driver assistance systems education and training; identify gaps in existing educational materials and methods of delivery; and identify effective methods of delivering advanced driver assistance systems information and educational materials to target populations.

*For further information, contact Richard Retting, TRB, at 202-334-2418 or RRetting@nas.edu.*

### RESEARCH ROADMAP FOR INSTITUTIONALIZING TRANSPORTATION EQUITY

Portland State University received a $250,000, 18-month contract [National Cooperative Highway Research Program (NCHRP) Project 20-123(19)] to develop a research roadmap to be used by AASHTO, state departments of transportation (DOTs), and partners responsible for—or interested in—institutionalizing transportation equity: from transportation project development through preliminary design. The AASHTO Strategic Plan includes a goal of promoting diversity in all AASHTO activities, collaborating with traditional and nontraditional partners to support equity and social justice objectives, and ensuring that transportation policies provide safety, mobility, and access to everyone.

*For further information, contact Camille Crichton-Sumners, TRB, 202-334-1695 or CCrichton-Sumners@nas.edu.*

### REVENUE-RELATED STRATEGIES FOR NEW MOBILITY OPTIONS

ECONorthwest received a $450,000, 24-month contract (NCHRP Project 19-23) to develop a toolkit for transportation agencies that addresses how revenue-related strategies—such as taxes, fees, and subsidies—support policy objectives and shape the deployment of new mobility options. The toolkit is envisioned to assist agencies in developing, evaluating, implementing, and administering revenue-related strategies for new mobility options that transport people and goods.

*For further information, contact Dianne Schwager, TRB, at 202-334-2969 or DSchwager@nas.edu.*

### COUNTERING HUMAN TRAFFICKING: A TOOLKIT FOR STATE DOTS

Texas A&M Transportation Institute received a $450,000, 22-month contract (NCHRP Project 20-121A) to develop a suite of tools that support effective training, policy, and collaboration practices related to combating human trafficking. The products from this project will be tailored to employees of state DOTs, as well as their contractors and collaborative partners engaged in countering human trafficking operations. However, the results will also likely benefit other transportation agencies.

*For further information, contact Michael Brooks, TRB, at 202-334-2863 or MBrooks@nas.edu.*

### PLANNING FOR 4.9 GIGAHERTZ SPECTRUM CHANGES

Blue Wing Services received a $250,000, 16-month contract (NCHRP Project 23-28) to evaluate anticipated regulatory changes to the 4.9 gigahertz spectrum so that state DOTs are prepared to adapt and preserve the ability to continue essential communications for critical transportation functions. The objective of this research is to develop plausible scenarios that describe how the spectrum might be managed; create a guide with strategies for state DOTs to align current and future projects, communications system processes, and programs to use the spectrum under each scenario; and design a portfolio of training and communications materials to support the implementation of the strategies and explain the value of the spectrum for transportation-related uses.

*For further information, contact Michael Brooks, TRB, at 202-334-2863 or MBrooks@nas.edu.*

### LITHIUM-ION BATTERY TRANSIT BUS FIRE PREVENTION AND RISK MANAGEMENT

The Fire Protection Research Foundation received a $350,000, 24-month contract [Transit Cooperative Research Program (TCRP) Project E-14] to develop a guide to lithium-ion battery transit bus fire prevention and risk management with recommended practices for original equipment manufacturers, battery companies, transit agency facilities, and vehicle maintenance. The research team will review the potential root causes of zero-emission bus lithium-ion battery fires, including an analysis of the potential of such fires to spread to other vehicles or reignite after suppression; evaluate risk mitigation options; identify, evaluate, and summarize effective practices for fire risk mitigation and suppression, focusing on agencies that store and charge their buses in indoor facilities; identify quantitative and qualitative metrics that can be used to evaluate vehicle and battery performance as they relate to fire and life safety; and address the technical, economic, and institutional barriers to implementing identified solutions.

*For further information, contact Stephan A. Parker, TRB, at 202-334-2554 or SAParker@nas.edu.*

Marc A. Hermann, Metropolitan Transportation Authority, Wikimedia, CC BY 2.0 DEED

A TCRP project will develop a guide to fire prevention and risk management for electric buses powered by lithium-ion batteries.

### INTEGRATING TRANSPORTATION SYSTEMS MANAGEMENT AND OPERATIONS INTO TRANSPORTATION ASSET MANAGEMENT

WSP USA received a $500,000, 28-month contract (NCHRP Project 08-138) to develop a guide for state DOTs and other agencies on integrating transportation systems management (TAM) and operations assets into transportation asset management plan processes. The research should identify the anticipated benefits of transportation systems management operations (TSMO) and TAM integration, as well as provide practical instruction on the application of proven and emerging methods, policies, and processes for identifying and integrating appropriate TSMO assets into TAM processes. The guide should include appropriate tools, techniques, and applications with clear instructions on how to use them.

*For further information, contact Jennifer L. Weeks, TRB, at 202-334-2122 or JLWeeks@nas.edu.*

### DEVELOPMENT OF GUIDANCE FOR NONSTANDARD ROADSIDE HARDWARE INSTALLATIONS

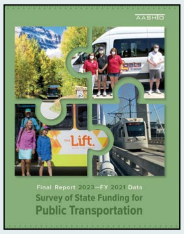
Texas A&M Transportation Institute received a $400,000, 30-month contract (NCHRP Project 15-79) to develop guidelines for nonstandard roadside safety hardware applications where standard practices for crash-tested roadside safety hardware cannot be used.

*For further information, contact Anne-Marie Turner, TRB, at 202-334-2966 or ATurner@nas.edu.*

## VOLUNTEER VOICES

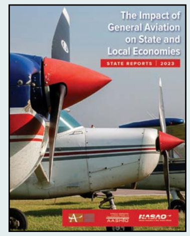
At a future TRB Annual Meeting, I would like to hear more about the potential applications and impact of artificial intelligence on all aspects of the transportation industry. I would also like to hear opinions on this topic from a wide spectrum of professionals and perspectives, including those from fields that are off the beaten path—such as IT, archaeology, and health.

**—CASEY EMOTO**
Civil Engineering and Program Delivery Officer
Santa Clara Valley Transportation Authority
San Jose, California



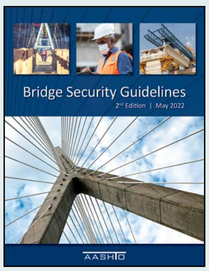

**Survey of State Funding for Public Transportation**
*AASHTO. Get the downloadable PDF file at https://store.transportation.org/Item/CollectionDetail?ID=247.*

Using survey results from FY 2021 data, this 2023 annual report provides a snapshot of each state's investment in public transportation from federal, state, and local funding sources. The report's tables and charts show how different funding and tax mechanisms are used to support transit operations and capital projects. The COVID-19 pandemic's impact on state transit programs—including solutions to help transit agencies overcome pandemic-related obstacles—are also addressed.




**The Impact of General Aviation on State and Local Economies: State Reports 2023**
*AASHTO. Download the free online report at https://store.transportation.org/Item/PublicationDetail/5056.*

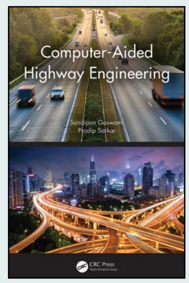
This report updates the 2014 edition and was developed to help communicate the importance of general aviation to state and local communities, as well as to illustrate aviation's link to our national economy. Considered are the latest general aviation economic data, key issues that general aviation supports, and emerging aviation technologies.




**Bridge Security Guidelines, 2nd Edition**
*AASHTO. Purchase a downloadable PDF at https://store.transportation.org/Item/CollectionDetail?ID=232.*

This volume offers guidance on bridge design for human-induced extreme events. Included is information on the response of concrete bridge columns subjected to blast loads, blast-resistant design and detailing guidelines, and analytical models of blast load distribution.

How to potentially reduce risk to other structural bridge components is discussed, as are other intentional hazards (such as nonexplosive cutting devices, collisions or impacts, and fire), which are subject to threat vulnerability risk assessments. Additional resources for identifying potential solutions also are provided.

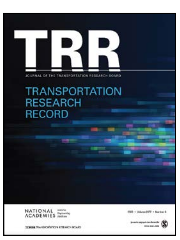



**Computer-Aided Highway Engineering**
*Sandipan Goswami and Pradip Sarkar, Nova Science Publishers. ISBN 978-1-00304-583-0. Purchase this publication at https://doi.org/10.1201/9781003045830.*

This e-book aims to develop highway engineering professional knowledge by examining project preparation using hands-on training on computer software in the design of worldwide road infrastructure. Using satellite data—including highway geometric, pavement, and tunnel design supported by relevant tutorials—it discusses the digital terrain model. Quantity and cost estimation, as well as the production of various types of sophisticated construction drawings are described in detail with theory and tutorials backed by real project data.

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

## TRB PUBLICATIONS



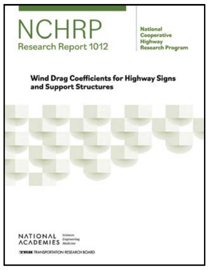

**Transportation Research Record 2677, Issue 3**

In addition to other research, this issue discusses the field performance of salt brine applications, a methodology for conflating large-scale roadway networks, accelerating mixture design for cement-treated base material, and big data and discrete optimization for electric urban bus operations.

**Transportation Research Record 2677, Issue 4**

This COVID-19 theme issue discusses changes to crash type, timing, and severity from COVID-19 stay-at-home policies; COVID-19 effects on telework and commuting; transportation as a disease vector; and vehicle design strategies to reduce COVID-19 transmission risk in shared and pooled travel.

SAGE is the publisher of the *Transportation Research Record: Journal of the Transportation Research Board* (TRR) series. To search for TRR articles, visit http://journals.sagepub.com/home/trr. To subscribe to the TRR, visit https://us.sagepub.com/en-us/nam/transportation-research-record/journal203503#subscribe.




**Wind Drag Coefficients for Highway Signs and Support Structures**
NCHRP Research Report 1012

This report develops comprehensive methods for estimating wind loads and the associated drag coefficients for highway signs and overhead support structures.

*2023; 178 pp.; TRB affiliates, $75.75; TRB nonaffiliates, $101. Subscriber categories: bridges and other structures, design, highways.*

**Developing a Highway Framework to Conduct an All-Hazards Risk and Resilience Analysis**
NCHRP Research Report 1014

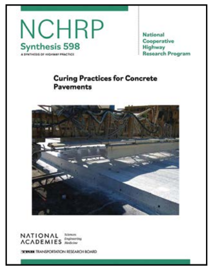
This report presents a research roadmap for developing a comprehensive manual, tools, training, and implementation guidelines for quantitative risk and resilience assessments that satisfy federal requirements, such as the Moving Ahead for Progress in the 21st Century Act, FHWA Order 5520, and the Infrastructure Investment and Jobs Act.

*2023; 222 pp.; TRB affiliates, $78.75; TRB nonaffiliates, $105. Subscriber categories: operations and traffic management, planning and forecasting, security and emergencies.*

**Replacement of Highway Operations Equipment: Formulation of Long-Range Plans and Budgets**
NCHRP Research Report 1017

This report is a handbook on concepts that state highway agencies can use to make long-range investments in equipment and a guide for agencies to formulate cost-effective, long-range plans for replacing equipment.

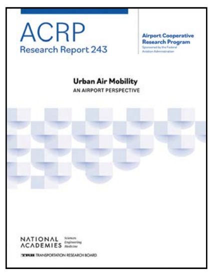
*2023; 108 pp.; TRB affiliates, $62.25; TRB nonaffiliates, $83. Subscriber categories: maintenance and preservation, vehicles and equipment.*




**Curing Practices for Concrete Pavements**
NCHRP Synthesis 598

This synthesis documents state department of transportation practices for curing concrete pavement, including curing procedures, curing material types used, application rates, the timing of curing, and specific measures adopted when paving under adverse weather conditions.

*2023; 94 pp.; TRB affiliates, $59.25; TRB nonaffiliates, $79. Subscriber categories: highways, materials, pavements.*




**Urban Air Mobility: An Airport Perspective**
ACRP Research Report 243

This research provides a comprehensive examination of the emerging urban air mobility industry with a particular focus on its impacts and opportunities for airports. Urban air mobility is a new and rapidly evolving market, broadly characterized as the local, on-demand movement of people and goods by air using a range of piloted, semiautonomous, and fully autonomous systems.

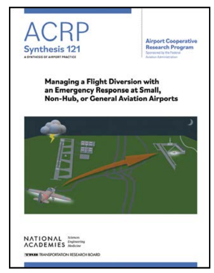
*2023; 114 pp.; TRB affiliates, $62.25; TRB nonaffiliates, $83. Subscriber categories: aviation, passenger transportation, planning and forecasting.*

**To order the TRB titles described in Bookshelf, visit the TRB online bookstore, https://www.mytrb.org/MyTRB/Store, or contact the Business Office at 202-334-3213.**

**Advancing the Practice of State Aviation System Planning**
ACRP Research Report 244

This report offers practitioners guidelines on how to make system plans better reflect emerging trends, optimize increasingly limited resources, identify roles and responsibilities in managing state aviation systems, and scope system plans that meet the unique needs of each state. It is intended to serve as a companion to the existing FAA guidance on system planning.

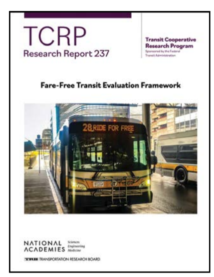
*2023; 210 pp.; TRB affiliates, $75; TRB nonaffiliates, $100. Subscriber categories: aviation, administration and management, policy.*




**Managing a Flight Diversion with an Emergency Response at Small, Non-Hub, or General Aviation Airports**
ACRP Synthesis 121

This synthesis compiles practices that small, non-hub, and general aviation airports use when planning for and responding to flight diversions that involve an incident or an emergency.

*2023; 168 pp.; TRB affiliates, $70.50; TRB nonaffiliates, $94. Subscriber categories: aviation, security and emergencies.*




**Fare-Free Transit Evaluation Framework**
TCRP Research Report 237

This report presents a framework that can be used by public transit practitioners to evaluate the potential benefits, costs, and trade-offs of implementing fare-free transit.

*2023; 130 pp.; TRB affiliates, $66; TRB nonaffiliates, $88. Subscriber categories: public transportation, finance.*

# Let's Hear from You!


In each issue, we pose a sometimes light and fun transportation-related question that allows you to share your thoughts with other readers. To answer, **click here** or e-mail us at **TRNews@nas.edu** and follow these simple steps:

1. In the subject line, include **"Volunteer Voices: [the question you're answering]";**
2. Answer the question thoughtfully, but keep it brief—up to about 150 words;
3. Add whether you are a TRB member or volunteer, and list the committees you are involved with; and
4. Add TRNews@nas.edu to your contacts so we avoid your spam folder when we tell you you're going to be published.

**That's it!** Like all *TR News* content, your response may be edited for grammar, length, and TRB style. When the issue with your quote is published, you'll get a PDF of the page featuring your response and photo.

**Now that you have the details, here's the question:**

**What technology or infrastructure would be most useful in improving transportation in rural communities?**

Scan the QR code to answer our online survey question.

## VOLUNTEER VOICES

My favorite transportation mode for visiting a state or national park—other than the Grand Canyon—is on foot, leaving my vehicle for the day as soon as I secure a parking spot. Walking is healthy and enjoyable. It lets me plan my day flexibly and get closer to nature. Plus, pedestrians do not pollute the air or disturb wildlife! By walking, I get to experience the breadth of our natural resources and document geological wonders by taking pictures whenever I want.

**—KOHINOOR KAR**
Research Center Lead
Arizona Department of Transportation
Phoenix, Arizona

# INFORMATION FOR CONTRIBUTORS TO TR NEWS

*TR News* welcomes the submission of articles for possible publication in the categories listed below. All articles submitted are subject to review by the Editorial Board and other reviewers to determine suitability for *TR News*; authors will be advised of acceptance of articles with or without revision. All articles accepted for publication are subject to editing for conciseness and appropriate language and style. Authors review and approve the edited version of the article before publication. All authors are asked to review our policy to prevent discrimination, harassment, and bullying behavior, available at https://www.nationalacademies.org/about/institutional-policies-and-procedures/policy-of-harrassment.

## ARTICLES

**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, technology, etc.). Manuscripts should be no longer than 3,000 words. Authors also should provide tables and graphics with corresponding captions (see Submission Requirements). Prospective authors are encouraged to submit a summary or outline of a proposed article for preliminary review.

**MINIFEATURES** are concise feature articles, typically 1,500 words in length. These can accompany feature articles as a supporting or related topic or can address a standalone topic.

**SIDEBARS** generally are embedded in a feature or minifeature article, going into additional detail on a topic addressed in the main article or highlighting important additional information related to that article. Sidebars are usually up to 750 words in length.

**POINT OF VIEW** is an occasional series of authored opinions on current transportation issues. Articles (1,000 to 2,000 words) may be submitted with appropriate, high-quality graphics, and are subject to review and editing.

**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. Research Pays Off 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 the logo of the agency or organization submitting the article, as well as one or two photos or graphics. Research Pays Off topics must be approved by the RPO Task Force; to submit a topic for consideration, contact Nancy Whiting at 202-334-2956 or nwhiting@nas.edu.

## OTHER CONTENT

**TRB HIGHLIGHTS** are short (500- to 750-word) articles about TRB-specific news, initiatives, deliverables, or projects. Cooperative Research Programs project announcements and write-ups are welcomed, as are news from other divisions of the National Academies of Sciences, Engineering, and Medicine.

**BOOKSHELF** announces publications in the transportation field. Abstracts (100 to 200 words) should include title, author, publisher, address at which publication may be obtained, number of pages, price, Web link, and DOI or ISBN. Publishers are invited to submit copies of new publications for announcement (see contact information below).

### SUBMISSION REQUIREMENTS:

- **Articles** submitted for possible publication in *TR News* and any correspondence on editorial matters should be sent to the *TR News* Senior Editor, Cassandra Franklin-Barbajosa, cfranklin-barbajosa@nas.edu, 202-334-2278.
- Submit **graphic** elements—photos, illustrations, tables, and figures—to complement the text. Photos must be submitted as JPEG or TIFF files and must be at least 3 in. by 5 in. and 2 megabytes with a resolution of 300 dpi. Large photos (8 in. by 11 in. with a minimum of 4 megabytes at 300 dpi) are welcome for possible use as magazine cover images. A detailed caption must be supplied for each graphic element.

Note: Authors are responsible for the authenticity and accuracy of their articles and for obtaining written permissions from publishers or persons who own the copyright to any previously published or copyrighted material used in the articles, **as well as any copyrighted images** submitted as graphics.

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