



# INNOVATOR



States improve site characterization and design confidence with advanced geotechnical exploration methods.

Credit: Florida Department of Transportation

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# States Boost Their A-GaME

**Advanced geotechnical methods in exploration** (A-GaME) is a set of technologies promoted by Every Day Counts (EDC) to increase the accuracy of subsurface investigations for improved project design and construction. States are making the most of their site characterization programs by using A-GaME techniques such as measurement while drilling (MWD), cone penetration testing (CPT), and seismic and electrical geophysics.

## New Hampshire and Florida Advance MWD

As part of a project to widen and improve a major corridor, the New Hampshire Department of Transportation (NHDOT) instrumented a rig to use MWD to better understand the engineering properties of the soil and rock.

MWD can be used in any type of soil or rock, records continuously, and does not require additional effort from the driller. A relative advantage of MWD is that it can distinguish boundaries and material changes with greater precision and accuracy than intermittent sampling methods, as measurements are taken continuously.

NHDOT used MWD on this project to enhance geotechnical site characterization and provide continuous monitoring and recording of data during the drilling process. This technique allowed NHDOT to add information between standard penetration tests and get real-time information in between the traditional 5-foot samples. This helped with site characterization and enabled the driller to know, in real time, how the drill was responding to the subsurface materials.

The Florida Department of Transportation (FDOT) used MWD at a site near Dowling Park as part of ongoing research investigating the benefits of MWD for drilled shaft quality assurance and quality control (QA/QC) applications.

The Ocala Limestone formation at the site has historically been challenging for site investigation as the bedrock is soft-porous, often highly weathered, and possesses a high degree of strength variability and spatial uncertainty. FDOT conducted MWD on test shafts to assess the measured drilling resistance compared to the load-tested shaft side shear capacity. The relationship between drilling resistance and shaft side shear capacity was then used to estimate performance on untested production shafts.

Because MWD was conducted in the footprint of the future production shafts, spatial uncertainty was eliminated, and the strength variability and side shear capacity of each shaft were directly assessed. This application of MWD helped confirm the engineering design was appropriate at each production shaft location. FDOT is continuing its development of MWD as a QA/QC tool for drilled shafts and developing a new protocol for MWD that will improve and speed-up decision-making when encountering problematic shafts.



Florida DOT geotechnical engineers use measurement while drilling to gain more accurate and precise subsurface readings.

Credit: Florida Department of Transportation

## Michigan and New Mexico Learn from User Groups

The A-GaME team continues to reach, assist, and grow a community of practice through three user groups. Each of the three groups represents an area promoted by A-GaME—**CPT**, **MWD**, and **geophysics**. Groups have member support from, but are not formally affiliated with, American Society of Civil Engineers Geo-Institute committees, Deep Foundation Institute committees, Transportation Research Board geotechnical committees, and FHWA.

These technical transfer and discussion forums enable efficient cross-organizational communication and exchange of thoughts and ideas. Members discuss best practices, lessons learned, and application of technologies in novel situations; answer questions; and collaborate. “The user groups are guided directly by user interests and needs,” said Benjamin Rivers, FHWA A-GaME team lead.

The Michigan DOT (MDOT), which has more recently adopted CPT, participates in the CPT user group.


“The presentation and discussion topics in the group have covered the full range of CPT from planning and performing CPT, collecting good data, interpreting CPT data, and designing with CPT data while using real project experiences,” said Erron Peuse of MDOT. “As a newer CPT user, being involved with the CPT user group has been a way to connect with more experienced users, which has been very helpful for us as we get started using and continue to further develop our CPT program. We have implemented several best practices learned from the group and the topics covered in the group give us confidence in the results that we are getting.”

The ability to learn both benefits and challenges of using a particular technology can be valuable to States as they grow their areas of practice around specific geophysical exploration techniques.

“Attending the MWD user group allows me to hear about the successes as well as challenges that others have run into while trying to implement MWD,” said Melissa Bates of the New Mexico DOT. “Prior to attending the webinars, I realized that these methods had some

advantages; however, applying the methods in a practical way could be difficult. Without these presentations, it was sometimes difficult to find practical technical resources meant for geotechnical engineers that were up-to-date and had the appropriate level of technical background. The user group makes using these methods feel less intimidating.”

Derrick Dasenbrock, FHWA geotechnical engineer and A-GaME team member, said they encourage participation from those willing to share their A-GaME experiences and those looking to learn more. “These user groups are for anyone interested in, or curious about, advanced geotechnical exploration methods,” he said. “Individuals are welcome to join and help continue to build these robust, interactive communities of practice.”



**EDC Outtakes**  
**A-GaME**

U.S. Department of Transportation  
Federal Highway Administration

**DERRICK DASENBROCK**  
Federal Highway Administration

*In this EDC Outtake, Derrick Dasenbrock, FHWA geotechnical engineer, discusses the benefits of A-GaME and some of the techniques used in this toolbox approach.*

Credit: FHWA

## MORE INFORMATION

- 🎙 Listen to the **A-GaME webinar series** to hear more State DOT experiences with A-GaME.
- @ To join the **CPT**, **MWD**, or **geophysics** user groups, contact **Benjamin Rivers** or **Derrick Dasenbrock** of the FHWA Resource Center or **Silas Nichols** of the FHWA Office of Infrastructure for more information.



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# MassDOT Incorporates Equity Factors into Pedestrian Safety Analysis

The Massachusetts Department of Transportation (MassDOT) wanted to identify safety improvements to help produce more equitable outcomes for pedestrian safety and mobility. The agency began by using traditional data elements that are known to correlate with risk of pedestrian deaths, such as roadway and infrastructure factors like speed limit and number of lanes. MassDOT then went a step further in its safety analysis and included equity and environmental justice (EJ) factors to consider the needs of vulnerable populations based on socioeconomic data.

The study, funded through a grant by the U.S. DOT under its Safety Data Initiative competition, confirmed that socioeconomic characteristics can be related to pedestrian safety.

“We’ve heard that socioeconomic characteristics can correlate with severe pedestrian crashes,” said MassDOT safety engineer Bonnie Polin. “This study helped us highlight that this correlation is present in Massachusetts—we’re actually seeing the data and saying ‘yes, these data can point to risk.’”

Traditional risk factors were also analyzed. MassDOT found the majority of fatal and serious injury pedestrian crashes occurred on roads that had posted speed limits of 35 miles per hour and less and were two-way with an undivided configuration. These roads also had an annual average daily traffic of 9,000 vehicles per day for some functional classes and 15,000 vehicles per day for others; were principal arterial, minor arterial, and major collector roads; and had two travel lanes.

Adding the equity and EJ factors via socioeconomic data gave a more complete picture. That data showed fatal and serious injury crash risks

were higher in communities with at least one EJ factor present.

“If the road segment is located within an area that has a high percentage of low-income households, a higher percentage of non-English speakers, or lower employment rates, the road segment has an elevated risk and is therefore assigned a higher score,” Polin said.

The value of this type of **systemic analysis** is that, by identifying more risk factors, agencies can prioritize and apply countermeasures proactively, likely preventing some crashes from happening.

“The systemic approach is one of our strongest safety strategies,” said Jerry Roche, **data-driven safety analysis** program manager for FHWA. “It is exciting to see States incorporate more and more factors into their analysis. That means more lives saved.”

Polin said considering this wider spectrum of risk factors can help MassDOT address pedestrian safety from even more fronts.

“We look at both ways of solving the problem. If we’re seeing high crash locations—high crash intersections, locations where there are a lot of run-off-the-road crashes—we can address those with projects,” she said. “But we also want to know where the risks are. So, not only the crashes that are occurring, but where the crashes *could* occur so we can address those and be proactive.”

MassDOT used the results of the study to develop a safety analysis tool that uses these data to pinpoint the top 5 percent of Massachusetts road segments that have the highest risk for fatal or serious injury crashes. The tool uses a broad base of factors, including roadway conditions like traffic volume and whether a median is present,

as well as socioeconomic variables like employment density and ratio of population living in poverty.

The data inform the investments—which projects to prioritize, how much and what kind of funding may be applied to projects, and agency evaluation of whether project processes are equitable.

“A lot has come out now with bringing equity into the equation. Are our funds being distributed in a way that promotes equitable outcomes for all users? We have to look at this from the lens of equity,” Polin said, emphasizing the analysis considered all the data, not just equity. “The data are telling us where to focus our resources and our funds. It happens to be the needs are elevated in environmental justice communities, which guides us to improve safety for all road users.”

The result is agencies investing safety dollars with more confidence.

“The data are driving this home,” Polin concluded. “We try to use data-driven processes to get to safety enhancements, and the data are directing us here. That, to me, is the step we need to take.”

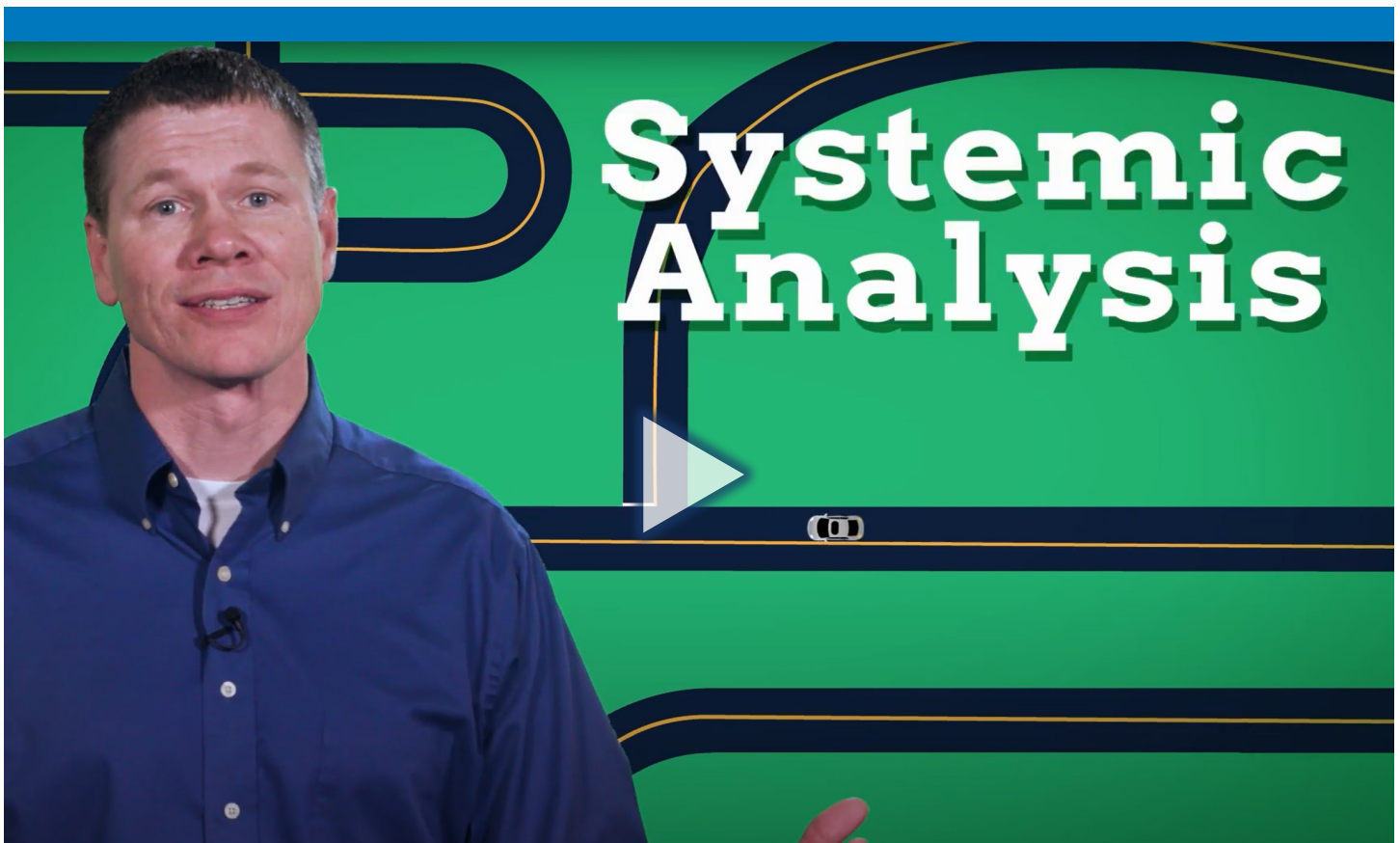
## MORE INFORMATION

📄 Read the **MassDOT report** summarizing the socioeconomic and demographic risk factor analysis performed for pedestrian crashes.

@ Contact **Jerry Roche**, FHWA Office of Safety, for more information on data-driven safety analysis.



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Credit: FHWA

Systemic analysis identifies roadway locations that are at highest risk for severe crashes, allowing agencies to prioritize and apply countermeasures proactively. Watch a [video](#) from the FHWA Office of Safety to learn the concepts behind this type of **data-driven safety analysis**.

# Weathering the Storm

## States describe strategies for managing Hurricane Ida's effects on infrastructure.

When Hurricane Ida made landfall in Louisiana as a Category 4 storm in August 2021, extensive flooding and wind damage caused hundreds of road closures from New Orleans to Baton Rouge. Ida then moved inland and brought flash floods and tornadoes to parts of the Northeastern United States.

The first session of FHWA's new **Road Weather Spotlight** monthly webinar series focused on Hurricane Ida's effects on the transportation network and **weather-responsive management strategies** (WRMS). Presentations by the Louisiana Department of Transportation and Development (LADOTD), the Pennsylvania DOT (PennDOT), and the New Jersey DOT (NJDOT) as well as the National Weather Service (NWS) described the strategies used to mitigate storm damage and accelerate the recovery process.

### Louisiana

Hurricanes can change quickly in intensity as they move through the Gulf of Mexico, so the LADOTD modifies preparations to adapt to those changes as the storms move closer. In Ida's case, its late strengthening resulted in officials ordering evacuations in several areas, so LADOTD used dynamic message signs and public service announcements to notify travelers of alternate routes.

David Miller, LADOTD's chief maintenance engineer, said Ida was on track to hit the State's two largest cities, so the agency requested aid from districts in other parts of the State to support the large response effort. They were also able to bring in signal and sign repair personnel from the Texas DOT.

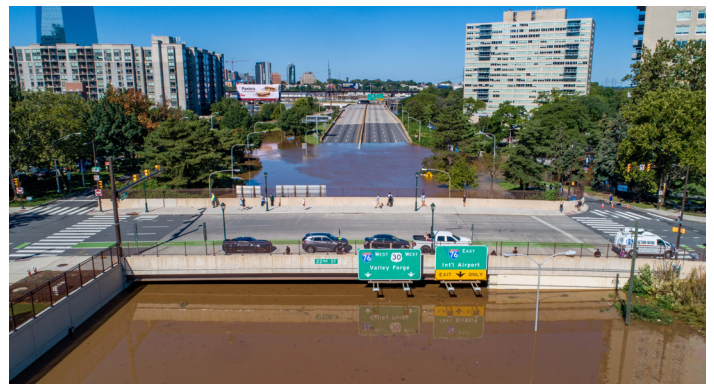
Once Ida's winds subsided, the LADOTD began clearing more than 11,500 shoulder miles of mud and debris. The agency used **crowdsourced data** to populate its **debris operations dashboard**, conserving staff resources by allowing the public to input debris locations and type.



Louisiana's debris operations dashboard allowed residents to report locations for roadway debris removal.

### Pennsylvania

As the flooding and tornadoes of Ida arrived in Pennsylvania, PennDOT kept traveler information such as road closures and weather advisories up-to-date on its **511PA.com** website.



After a river flooded a portion of interstate in Philadelphia during Ida, the Pennsylvania DOT contracted with a private company to help remove 30 million gallons of water.

Dan Whetzel, PennDOT's section chief for emergency incident management, reported that Ida caused the Schuylkill River to overrun its banks onto Interstate 676, which runs below ground at a point in downtown Philadelphia. Once the river receded, it left PennDOT with about 30 million gallons of water on the interstate.

"With the pumps we typically use, it would have taken 20 or more days to pump that much water out," he said, "so we worked through our command structure and found a company working in the Marcellus Shale area that could bring multiple pumps. They were able to pump the 30 million gallons of water back into the Schuylkill River in a day and a half."

Although the company had not worked for PennDOT before, it was able to mobilize and begin pumping within 24 hours. Whetzel said that having executive staff at a centrally located command center during the storm helped streamline the response to this and other challenges.

## New Jersey

When Ida moved into New Jersey, it brought 11 inches of rain in about 6 hours, as well as an EF-3 tornado. Chris Feintheil, NJDOT's senior director of operations, said that the agency activated its 511 NJConnect system six times during Ida, directly communicating with motorists stuck on its road networks.

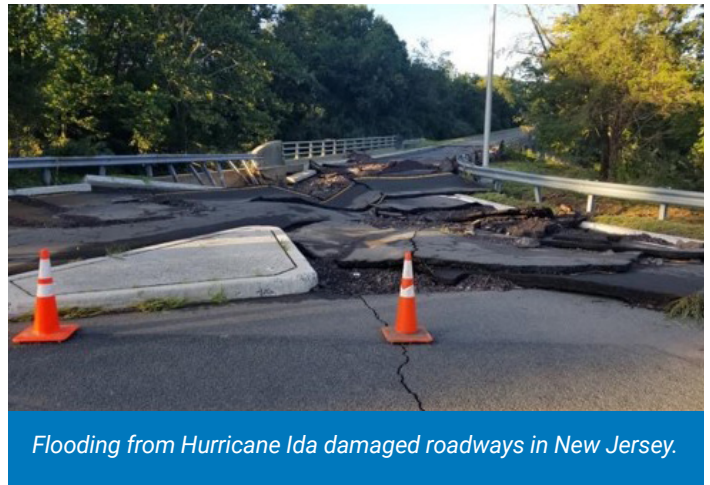
Following the storm, one challenge was removing the hundreds of abandoned vehicles on roadways. The agency has partnerships with the state police and various towing contractors throughout New Jersey, and Feintheil said that the towing contractors ended up being some of their busiest vendors. "There were cars everywhere that we had to at least get to the shoulder. We worked with local and state police to move them safely off the roadway so we could start to go to work ourselves," he said.

## National Weather Service

The National Weather Service (NWS) provides data to different DOTs ahead of and during severe weather events. Roham Abtahi explained that for hurricanes, coordination originates from the National Hurricane Center and then through the field offices to the DOTs.

"We've got 122 field offices across the country," said Abtahi. "Some areas have several offices, so in some cases, you may want to coordinate with our regional operations centers. They can bring all the information together and condense it during an event like Ida where you wouldn't want to be dealing with several different offices as a storm moves in."

He also described the [Pathfinder program](#), which encourages the DOTs, NWS, and weather service contractors to share and translate weather forecasts and road conditions into consistent, actionable transportation messages for the public. "At these meetings, we try to facilitate a better relationship between the DOTs and the



Flooding from Hurricane Ida damaged roadways in New Jersey.

National Weather Service," said Abthai, "so that when a big event happens, you can work closely with the person who is able to serve you."

Tony Coventry, transportation specialist for FHWA's Road Weather Management Program, said that while WRMS tools and Pathfinder are often associated with winter operations, they can greatly benefit preparations and response to any severe weather event, including hurricanes, wildfires, and even dust storms.

"While severe weather presents numerous challenges to our roadways," said Coventry, "agencies can use WRMS to mitigate its impacts through preparation efforts that leave them better equipped to overcome whatever impacts occur on our Nation's infrastructure."

## MORE INFORMATION

- ▶ Watch the video recording of the [Road Weather Spotlight webinar](#) on Hurricane Ida.
- 📄 Sign up for future [Road Weather Spotlight webinars](#).
- 📄 Read a fact sheet on [Pathfinder implementation](#).
- @ Contact [David Johnson](#) or [Tony Coventry](#) of FHWA's Road Weather Management Program.



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# STICs Open Roadways to Innovation

The **State Transportation Innovation Council (STIC) Incentive program** provides resources to help STICs make proven innovations standard practice in their States. The program offers funding of up to \$100,000 a year per STIC to offset some of the costs of these efforts. Recently completed STIC Incentive projects demonstrate how far this funding can go in helping to improve safety and efficiency and accelerate construction. These include a Kansas coordinate mapping system that minimizes distortion, new uses for **unmanned aerial systems (UAS)** in New Jersey, a Missouri system for improving **traffic incident management** data collection, and the development of **design-build** documentation in Vermont.

## Kansas Improves Statewide Mapping System

The Kansas DOT (KDOT) used STIC funds to design the **Kansas Regional Coordinate System (KRCS)**, a statewide mapping system made up of low-distortion projections (LDPs).

Map distance does not equal ground distance in the real world due to topographical features. The difference between the map (grid) and horizontal surface (ground) is called linear distortion. This linear distortion must be accounted for, for example, when developing construction plans and surveys. LDP systems are one tool for minimizing this “**grid versus ground**” distance problem.

Traditionally, KDOT scaled State Plane Coordinate System coordinates to ground measurements to reduce linear distortion. However, this approach was not ideal for large land areas and often required a new coordinate system be created and managed for every project. The results were also not fully compatible with spatial software platforms such as a geographic information system (GIS).

The KRCS divided Kansas into 20 zones that optimally minimize distortion, especially over large areas. The system eliminates the need to keep creating new coordinate systems and is compatible with a wide range of commonly used commercial surveying, engineering, and GIS software.

LDP systems such as the KRCS can also simplify data management and facilitate data transfer between internal groups and outside organizations. Learn more on the **KRCS website**.

## Missouri Advances Traffic Data Collection

The Missouri DOT (MoDOT) used STIC funds to combine incident and work zone data with probe data in one system that enables better analysis, reporting, and situational awareness.

Probe data is data generated by monitoring the position of individual vehicles (probes) over a certain space and time. These measurements can then be converted into performance measures. MoDOT uses the Regional Integrated Transportation Information System (RITIS) to access third-party probe data as well as the National Performance Management Research Data Set.

With this project, MoDOT added to RITIS all work zone and incident data generated by the Advanced Traffic Management Systems in three of its Transportation Management Centers (TMCs) as well as its Traveler Information Map.

MoDOT worked with University of Maryland to transfer the data to RITIS in a usable format. Data is directly transferred once per minute by the TMCs. It is then incorporated into existing tools, including tools that are newly accessible due to the increase in data and access. MoDOT utilizes the combined data on performance measures in the “Operating a Reliable Transportation System” section of its **statewide tracker**.



MoDOT staff in its Southwest District are using the RITIS tools as part of their **traffic incident management** strategies. After-action reviews for incidents now include visualizations of congestion from crashes, which helps illustrate the impact of lane closures and lane clearance to both MoDOT personnel and external partners.

### New Jersey Expands UAS Capabilities

The New Jersey DOT (NJDOT) used STIC funds to purchase equipment for field operations and provide training for UAS remote pilots. These efforts helped launch the NJDOT Bureau of Aeronautics UAS Program.



This [video on drone technology at the New Jersey DOT](#) highlights the agency's efforts to integrate UAS into its operations and the role of STIC funding in supporting that mission.

NJDOT has pursued a variety of UAS applications to improve safety and efficiency. Its program has demonstrated UAS feasibility for structural inspections, real-time construction project monitoring, **traffic incident management**, aerial three-dimensional (3D) mapping, traffic congestion assessments, and more. An agency video, **Drone Technology at NJDOT**, highlights these efforts to integrate UAS into its operations.

An NJDOT report, **Unmanned Aircraft System (UAS): Purchase and Training**, describes the use of STIC funding to help establish the UAS program as well as current and planned UAS applications and benefits. The report describes the pilot training curriculum and two applications—high mast light pole (HMLP) inspection and **traffic incident management**—and offers lessons learned and best practices.

### Vermont Develops Design-Build Documentation

The Vermont Agency of Transportation (VTrans) used STIC Incentive funds for its **design-build** documentation effort. Design-build is an alternative contracting method that combines the design and construction phases of a project into a single contract, potentially saving time and cost compared to traditional design-bid-build delivery. VTrans developed standard processes and documents that program managers and groups could use to properly implement this innovative contracting method.

VTrans formed a small working group, consisting of two VTrans staff members and a consultant, to spearhead the effort. The documents developed include design-build definitions for VTrans' standard specification book, a sample request for qualifications (RFQ), and a process for using alternative technical concepts with design-build. The tools produced include RFQ scoring criteria, an example design-build schedule, and an Alternative Delivery Decision Matrix—a tool that allows project managers to determine which alternative contracting method (between design-build or **construction manager/general contractor**) is appropriate for a proposed project.

All of the materials developed can be found on the [VTrans design-build resources website](#).

### MORE INFORMATION

- Check out the **State Innovation Accomplishments map** to see what tools and practices STICs in other States are advancing.
- 📄 Download a list of State and local **Homegrown Innovations** from the 2020 National STIC Showcase.
- @ Contact **Sara Lowry** of the Federal Highway Administration for information on the STIC Incentive program.



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# States **innovate!**

## Delaware Uses CM/GC to Restore the Corridor

The Delaware Department of Transportation (DelDOT) is using the **construction manager/general contractor** (CM/GC) project delivery method for its Interstate 95 **Restore the Corridor** project in Wilmington. The project includes repair of 19 bridges, pavement, and ramps on a critical corridor with an estimated annual average daily traffic of 110,000 vehicles per day. DelDOT's **project website** states that the agency expects the CM/GC process to improve the project by lowering construction risk and offering engineering innovations to enhance the efficiency of construction and project quality.



Credit: Delaware Department of Transportation

*Delaware is using the construction manager/general contractor method to deliver a major Interstate 95 corridor project that involves repair of 19 bridges, pavement, and ramps.*

## States Use Crowdsourced Data to Alert Commercial Vehicles

The **New Jersey** and **Colorado DOTs** are using **crowdsourced data** and private sector partnerships to deliver real-time information to commercial vehicles and improve the safety of all road users. Because commercial vehicles have far greater stopping distances, unexpected slowdowns on roadways pose a significant safety threat, particularly at the back of queues. Transportation agencies can now deliver in-cab alerts about road conditions through connected truck service providers to help commercial vehicle drivers approach and react more quickly

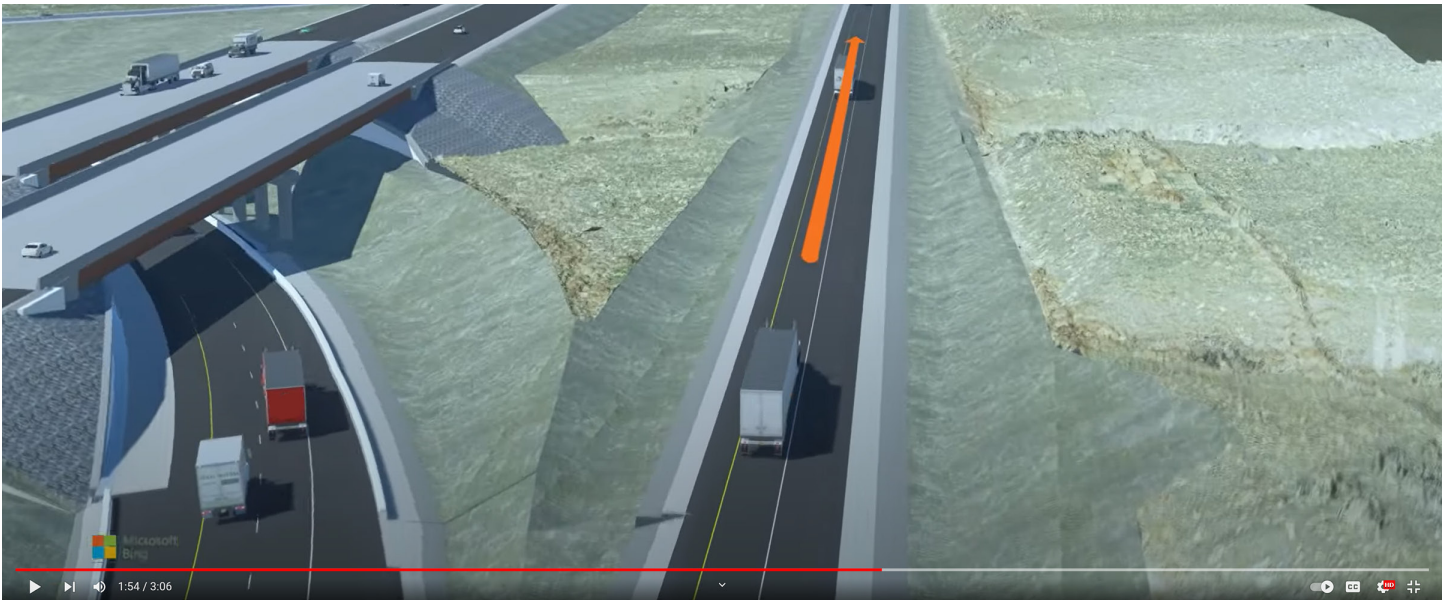
to roadway incidents, work zones, and adverse weather conditions. Learn more from the **Crowdsourced Data for Commercial Vehicles** webinar, part of the **Adventures in Crowdsourcing** webinar series.

## Georgia and North Carolina Use Texts to Boost Outreach

The **Georgia Department of Transportation** (GDOT) uses text messaging as a **virtual public involvement** (VPI) strategy for outreach to communities with low broadband access, where residents may face barriers to participating in other VPI formats such as online meetings. The text messages provide information about upcoming meetings or other opportunities to engage in transportation planning and project development. GDOT pairs text messaging and other VPI techniques with in-person outreach and physical mailings to try to reach all members of the community. The **North Carolina Department of Transportation** (NCDOT) has also had success using text messaging in its public involvement program. NCDOT often conducts online surveys to engage the community and uses text messaging as part of a multifaceted outreach approach that includes social and traditional media promotion, email, and in-person engagement. Texting surveys gives the public another option to get engaged using the method of their choosing.

## Idaho Integrates Public Input on Pocatello Interchange

The Idaho Transportation Department's (ITD) **I-86/I-15 System Interchange** project will replace aging and obsolete bridges built in the mid-1960s and address traffic congestion resulting from significant population growth in the area. Also, as a result of public feedback gathered in 2018 and 2021, ITD will build a new, separated pedestrian/bicycle pathway. "Bicycle and pedestrian access to the Highland area was something the community saw as very important," Co-Project Manager Greg Roberts said



Credit: Idaho Transportation Department

The Idaho Transportation Department created a [video animation](#) to inform and engage public comment on its I-86/I-15 system interchange project.

in an [ITD news release](#). ITD used [virtual public involvement](#) strategies to support public participation in the decision-making process, including an [interactive GIS map](#) of the project area with a comments portal and a [digital visualization](#) of the planned improvements.

### Rhode Island STEPs Up Safety at Midblock Crossings

The Rhode Island Department of Transportation (RIDOT) developed an uncontrolled midblock crossing evaluation tool that is enabling it to address safety at more than 900 State-owned midblock crosswalks. RIDOT used an app to streamline data collection and developed a dashboard to automate crash countermeasure selection for each inventoried crosswalk. Treatments included countermeasures promoted by FHWA's [Safe Transportation for Every Pedestrian](#) initiative such as [rectangular rapid flashing beacons](#) and [pedestrian hybrid beacons](#). RIDOT applied [State Transportation Innovation Council](#) funds toward developing the app and an FHWA [Accelerated Innovation Deployment \(AID\) Demonstration](#) program grant toward installing some of these enhancements. Read about RIDOT's effort in FHWA's [Safety Compass](#) newsletter.

### Oklahoma DOT's Project Bundling Creates Bidding Options

In 2021, the Oklahoma Department of Transportation (ODOT) used a unique approach to [project bundling](#) when it advertised six sets of optionally bundled projects, saving an estimated \$1.4 million. This bundling method provided contractors with options to address factors that may hinder some from bidding on typically bundled projects. According to ODOT, contractors most often prefer larger bundles of projects, but there are factors that may make smaller bundles, or even separate contracts more attractive at times. For example, bonding capacity may limit the contractor's ability to bid a large bundle of projects. Also, bidding smaller separate contracts can give the contractor more flexibility over the construction schedule. Optional ties provide contractors flexibility to bid on individual contracts or in bundles because one size doesn't fit all situations. This approach also makes it easier for an agency to demonstrate the cost savings of project bundling by comparing the bids for separate projects to bids for combined projects, rather than comparing bids to engineer estimates.



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# INNOVATOR

INNOVATOR, published by the FHWA's Office of Innovation Management, Education, and Partnerships, advances the implementation of innovative technologies and accelerated project delivery methods in highway transportation.

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

## Taking the Systemic Approach to Safety

The **systemic approach** to safety identifies locations based on high-risk roadway features correlated to particular crash types, rather than crash frequency, to proactively improve locations based on risk. To help practitioners implement this approach, FHWA developed the **Systemic Safety Project Selection Tool**, which presents a process for incorporating systemic safety planning into traditional safety management processes.

Crash trees can also be used as part of systemic analysis to identify focus crash types and facilities. FHWA developed a **Crash Tree Maker** that automates the process and makes it easier to try different combinations. Learn more from this **tutorial video**.

**How Healthy is Your Road System?**  
Find out with systemic analysis

Systemic analysis is like a health screening for your road system. Just as your doctor identifies risk factors for illness, systemic analysis identifies locations that are at highest risk for severe crashes. Practitioners can then prioritize projects based on risk and apply low-cost safety treatments to reduce severe crashes across the whole at-risk system.

**Symptoms**  
Severe roadway departure crashes on curves.

**Possible Risk Factors:**

- ⚡ Avg. Daily Traffic > 1,000 vehicles
- ⚡ Curve Radius < 1,000 feet
- + Intersection within Curve
- ⚡ Visual Trap within Curve
- ⚡ Severe Crash within Curve

**Diagnosis**  
11% of all curves have 3 or more risk factors.

**Lab Results:**

- Curve A ⚡ ⚡ ⚡
- Curve B ⚡ ⚡ ⚡ +
- Curve C ⚡ + +
- Curve D ⚡ +
- Curve E ⚡ ⚡ +

**Treatment**  
Prioritize highest risk sites and treat with low-cost countermeasures such as chevron signs or rumble strips.

**Follow-Up**  
Track and evaluate safety improvements. Further remediation can be implemented as needed.

**Systemic vs. Systemwide**  
Systemic does not mean treating all locations. It allows agencies to treat the highest-risk sites within limited budgets.

CURVE COUNTY - X-RAY RESULTS

Credit: FHWA

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