



# INNOVATOR



*Unmanned aerial systems provide new perspectives for environmental projects.*

*Credit: Washington State Department of Transportation*

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# UAS Improve Environmental Data Collection

No longer do transportation agency staff have to spend days walking through difficult terrain to reach often expansive environmental areas such as wetlands. **Unmanned aerial systems (UAS)** are elevating perspectives on these areas while saving agencies' critical resources.

State departments of transportation (DOTs) are reporting that the abundance and quality of data collected by UAS far exceed that of traditional methods.

## Agencies Are Flying High With UAS

The North Carolina DOT (NCDOT) has used UAS on wetland modeling for a corridor development. They found that when UAS was paired with airborne LiDAR (light detection and ranging) sensors, the modeling data returned rapidly and with relative accuracy and certainty.

NCDOT used the modeling to delineate wetlands from 3 to 4 acres to nearly 100 acres in size.



Credit: Western Federal Lands Highway Division

*UAS expedited the inventory of 9,500 linear feet of historic rock walls in Crater Lake National Park, Oregon.*

The larger sites would have required at least 10 people on foot. However, NCDOT Environmental Specialist Wesley Cartner says his team of four expedited the process considerably using UAS.


"We did it in an afternoon," Cartner said. "We were able to acquire the data within a day and then post-process it within a day or two. We have the same type of results without the additional 2 to 3 weeks and without having to have people actually traverse the terrain."

The Washington State DOT (WSDOT) used UAS for a post-construction wetland mitigation monitoring project. WSDOT replaced ground-based permanent photo points, locations from which photos are taken over time and compared to detect changes in the landscape, with UAS-based permanent photo points acquired by automated software. The photos collected for the monitoring project were then housed on a web-based network, allowing regulators to review them as needed.

WSDOT reports that using UAS allows its Environmental Services Office to capture much more useful imagery of sites than is possible with ground-based photography both for tracking site development and communicating results to regulators.

For the Water Quality Unit at the Vermont Agency of Transportation (VTrans), UAS allowed stakeholders to get a different view of the conditions at VTrans' facilities. Agency staff used UAS imagery to identify and map out pervious and impervious surfaces. The data collected by UAS was processed into a stormwater pollution prevention plan.

"Originally, they were creating these plans on-site and with the use of Google imagery," said VTrans UAS Program Manager Evan Robinson, noting that UAS-based imagery is up to 10 times more detailed than satellite-based imagery. "Now we get a crew to go out and fly one of these sites and generally within an hour we have taken



## Unmanned Aerial Systems to Improve the Transportation System

View this [UAS storyboard](#) to see how States such as North Carolina and Utah are using UAS to collect environmental data and perform inspections.

pictures of the whole facility. Then we're able to create our own high-resolution imagery."

When 9,500 linear feet of historic rock guard wall at Crater Lake National Park in Oregon had to be inventoried in 2020, the FHWA Western Federal Lands Highway Division (WFLHD) relied on UAS to document the boundaries of the stonework along East Rim Drive, a scenic highway on the lake's rim. The report would help with rehabilitation and rockfall mitigation at one of the park's most unique and beautiful historic features.

Choosing UAS over traditional methods, the agency avoided the human risk and costs involved with hanging a camera from a crane near the edge of the scenic overlook or hiring a helicopter to collect the images at a dangerously close proximity to the wall.

"UAS was really the clear winner in terms of efficiency, cost, and data quality," said Zekial Rios, land services manager at WFLHD.

Rios referenced the inventory previously done on the park's historic stone wall on West Rim Drive. It took about seven people to do the crane work and the entire summer.\*

"With UAS, we did it with three people in about 3 weeks," Rios said.

Also, using UAS significantly reduced the noise disturbance for visitors and wildlife compared with using a helicopter to capture the data.

"If you're in one of the most scenic national parks in the country, and you're feeling the wind and looking at this deep blue water but you're hearing helicopters rolling overhead—that's really going to ruin somebody's experience," Rios said.

All-in-all, UAS helped WFLHD get "the best look at the walls since they were constructed in the 1940s," Rios said.

### Safer, Quicker, Better

UAS are changing the game for transportation agencies, making their work quicker, safer, and more efficient.

"This is one of a hundred or a thousand applications highlighting the versatility of the tool and how it's able to be used and applied across the board," Robinson said. "It's so helpful in increasing efficiency and in creating a safe work environment."

*\*These flights were conducted under the Department of Interior UAS policy in place during 2019. Currently the use of UAS in the park remains limited to emergency operations.*

## MORE INFORMATION

@ Contact **James Gray** of FHWA's Office of Infrastructure.

➤ Visit the **FHWA UAS website**.



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# Agencies Share Positive Experiences with TOPS

Pavement overlays represent a significant portion of highway infrastructure dollars. State and local agencies can maximize this investment and help ensure safer, longer-lasting roadways by employing innovative overlay procedures that improve pavement performance, lessen traffic impacts (fewer work zones), and reduce the cost of pavement ownership.

Many transportation agencies report having positive experiences using an asphalt or concrete overlay promoted as part of the FHWA **Targeted Overlay Pavement Solutions** (TOPS) Every Day Counts initiative. This article highlights successful applications of four different TOPS overlays.

## Highly Modified Asphalt Mixture Overlay

Highly modified asphalt (HiMA) mixtures are having a big impact in Florida. The Florida Department of Transportation (FDOT) began researching HiMA 7 years ago and found that it prevents rutting twice as well as the control mix.

“We get excellent rutting resistance with the HiMA binder,” said FDOT State Bituminous Materials Engineer Howie Moseley. Studies also show HiMA significantly improves the performance of FDOT’s open-graded friction course mixtures, can increase structural capacity up to 20 percent, and is more cost-effective compared to the conventional mixture.

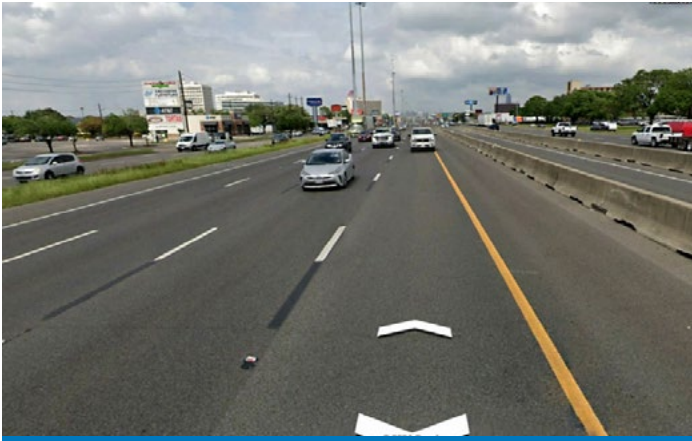
FDOT uses HiMA to address severe rutting in high-stress locations, such as truck weigh stations, agricultural inspection stations, and high-volume intersections and interchanges. Since 2017, the agency has placed more than 600,000 tons of HiMA mixtures on over 50 projects across the State.

One of the first HiMA projects built by FDOT was on Interstate 10 between two large truck stops where the combination of heavy axle loads and slow-moving traffic had resulted in severe rutting, exceeding 2 inches in some areas. FDOT had planned to reconstruct the highway section



Credit: Gary Fitts

The Florida DOT has monitored and evaluated the performance of HiMA overlays on this roadway since 2017.



The 18-year-old CAM interlayer on I-69 in Houston, TX, is still performing well today.

using a Portland cement concrete pavement to address these failures, but as an interim measure, FDOT milled the section to a depth of 2.5 inches and replaced it with a dense-graded HiMA mixture. “The project has performed so well that the reconstruction project was canceled,” said Moseley. After 6 years of service, rutting remains minimal.

### Crack Attenuating Mixture Overlay

The Texas DOT (TxDOT) is having success with crack attenuating mixture (CAM). **Research** has shown that properly designed CAM interlayers may reduce the number of reflective cracks and slow the rate of reflective cracking by up to 50 percent without jeopardizing rutting resistance.

The Houston District’s first overlay project with a CAM interlayer was in 2014 on a stretch of Interstate 69. It was designed to support an annual average daily traffic of 300,000 vehicles per day. Cracks were spaced 10 to 20 feet apart on the original continuously reinforced concrete pavement. The Houston District worked with the Texas A&M Transportation Institute to design CAM as a fine-graded mixture with high-binder content applied in thin 0.5- to 1-inch lifts between the existing pavement and a thin asphalt layer.

According to TxDOT Project Manager Ashwaq Mohammed, the CAM overlay system has performed well on I-69. “The Houston District has several hundred lane miles of continuously reinforced concrete pavements at or near the end of their designed service life with varying levels of surface distress,” said Mohammed. “Many of these old pavements are heavily

trafficked and unsuitable for reconstruction due to lane closures and high costs. These are good candidates for CAM interlayers.”

### Concrete on Asphalt Overlay

More than two decades since it was installed, a concrete overlay added to the asphalt surface of County Highway 9 in Richland County, IL, is performing exceptionally well and has no failures, according to the county engineer.

“This project provided Richland County with competitive bids, rapid construction, minimum inconvenience to residents, and a smooth-riding, long-lasting pavement,” said Richland County Engineer Danny Colwell.

In 2010, Richland County chose to place a thin concrete overlay over a 22-foot-wide asphalt road that serves as a trucking route servicing oil fields and grain elevators. At the time, pavement distress included transverse cracks due to shrinkage of the soil-cement base, with no rutting or ride issues.

Richland County decided to place the overlay for several reasons. The county had previous experience with premature oxidation of asphalt overlays, and unbonded concrete overlays had proven successful in nearby counties. Specifying a concrete overlay also enabled more competition for the work—past projects indicated that only one contractor typically bid on county asphalt projects while multiple concrete contractors were available. Crews milled the existing asphalt/seal coat pavement to a 1-inch depth and constructed a 5.5-inch concrete overlay with macrofibers.

### Concrete on Concrete Overlay

Concrete on concrete-unbonded overlays allow the existing pavement to be retained as a base layer, even when the existing concrete is affected by **alkali-silica reactivity** (ASR)—a materials-related distress that results in premature concrete deterioration. The Delaware DOT (DelDOT) used this technique on a 9-mile section of Interstate 495 originally opened to traffic in 1978.

In 1990, DelDOT initiated a comprehensive study to evaluate rehabilitation strategies. Major concerns included extensive deterioration due to ASR. The potential for ASR distress was not well known at the time I-495 was constructed. After a review of several strategies, DelDOT selected

*Continued on page 6*



an unbonded jointed plain concrete overlay that allowed the use of the existing pavement structure, retained the ASR-affected concrete at the project site, and considerably reduced construction time, resulting in less disruption to traffic.

At different points on the highway, traffic volumes increased 12 to 22 percent over the 2010 projected traffic. But according to DelDOT, the project has maintained the as-constructed smooth ride and has received only minor maintenance repairs in nearly 30 years in service. DelDOT's Director of Transportation Resiliency and Sustainability Jim Pappas said, "The key to a successful project such as this one is proper planning, coordination, and preliminary site investigation."

### New TOPS Resources

The TOPS team developed case study brochures on the use of **HiMA in Florida** and **CAM in Texas**, as well as **stone matrix asphalt in Georgia** and **high-performance thin overlays in New Jersey**.



Credit: Delaware Department of Transportation

*This concrete overlay on I-495 in Delaware was placed more than 30 years ago and still provides a smooth ride today.*



Credit: Illinois Chapter, American Concrete Pavement Association

*This concrete overlay was placed on County Highway 9 in Richland County, IL, in 2010.*

Longer, more detailed case studies and how-to documents will be released later this year.

An updated concrete overlay resource is also now available. The fourth edition of the **Guide to Concrete Overlays** presents the basic principles that a pavement engineer needs to design and construct concrete overlays on existing asphalt, composite, and concrete pavements.

The new edition includes current information on continuously reinforced concrete pavement overlays, geotextile separation layers, fiber reinforcement, concrete overlay design procedures, and lessons learned from the experiences of numerous State highway agency engineers.

## MORE INFORMATION

@ Contact **Tim Aschenbrener** (asphalt) or **Robert Conway** (concrete) of the FHWA Office of Infrastructure Pavement Materials team.

➤ Learn how various States are using TOPS in this Every Day Counts **storyboard**.

➤ Visit the **TOPS webpage** for information on additional overlay technologies.



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# States Innovate!

## Arizona Accelerates Bridge Construction on Route 66

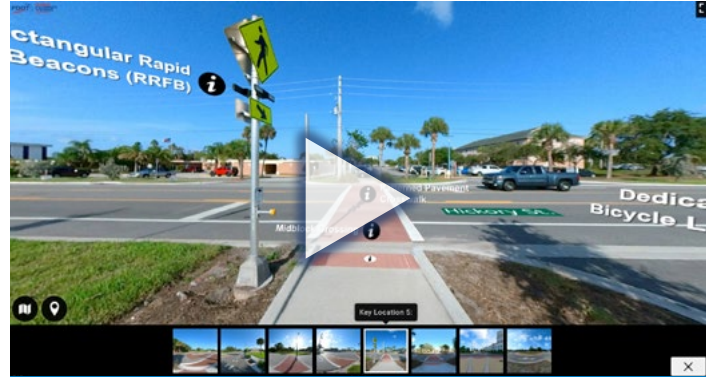
The Arizona Department of Transportation (ADOT) replaced the 1930s-era Rio de Flag bridge on Route 66 in downtown Flagstaff using **accelerated bridge construction** with precast girders and slabs. In this method, the precast components are built offsite or adjacent to the alignment and include features that reduce the onsite construction time and mobility impact versus conventional construction. ADOT reports that it saved 6 months of construction impacts to travelers. Read more on ADOT's [Rio de Flag project webpage](#).



This [time-lapse video](#) shows Arizona DOT's use of prefabricated elements to accelerate replacement of a 1930s-era bridge on Route 66.

## Florida Launches Complete Streets Website

The Florida Department of Transportation (FDOT) created a new, immersive **complete streets website** that explains complete streets principles and how they benefit the State. In addition to offering resources such as manuals, videos, and webinars, the website highlights complete streets projects across the State and allows users to visualize design alternatives. Interactive, 360-degree views allow users to explore project features such as rectangular



The Florida DOT's [interactive complete streets website](#) provides 360-degree views of pedestrian safety features on projects statewide.

rapid flashing beacons, pedestrian refuge islands, midblock refuge islands, and midblock traffic control signals. More information on these safety features is available on the Every Day Counts [Safe Transportation for Every Pedestrian \(STEP\) webpage](#).

## States Offer Online Resources for Traffic Incident Management

States are developing new web-based resources to advance traffic incident management (TIM) training. Minnesota's State Fire Marshall, a Division of Minnesota's Department of Public Safety, created a repository called **SceneSafe**. The website includes a **30-minute video** of best practices and safety measures for addressing roadway incidents, along with other resources to improve responder safety. The New Jersey Department of Transportation developed a **Traffic Incident Management Resource Portal** to provide ongoing support and guidance for TIM training that provides videos, diversion routes, and access to working groups. Hear about additional ways in which States are advancing TIM Training from the [Talking TIM webinar series](#).



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# Connecticut Takes a GIS-Based Approach to Digital As-Builts

Agencies have traditionally created as-built drawings by recording design and construction changes on paper plan sheets or PDFs and filing them away—which captures some details at the time of construction, but does not communicate them efficiently for maintenance, operations, and asset management. Many agencies are moving toward digital as-builts, which are created with the digital data collected in real time as the project is designed and constructed. Digital as-builts allow data to be contributed by various partners during project delivery, validated by agencies as part of an enterprise data management system, and easily used by others.

The Connecticut Department of Transportation (CTDOT) is developing integrated applications and workflows to enhance its digital as-builts by leveraging geographic information system (GIS) data. In using this approach, important infrastructure elements (assets) are inventoried, maintained, and replaced. CTDOT's plan is that all highway infrastructure elements will be inventoried, maintained, identified, and programmed for replacement, removal, or rehabilitation using project development and asset management principles in a GIS-based system.

## GIS in lieu of Plans

CTDOT is currently using GIS for spatially challenged projects such as highway signs. Prior to 2016, signing projects were developed within a computer-aided design (CAD) environment that was time consuming and outdated for the designer, contractor, and inspector. CTDOT's sign as-builts were done with PDF markups, which did not contain any data on location or sign removal. In 2016, CTDOT started requiring installation contractors to submit GPS installation data. "The intent was to put the installation data in our inventory as part of the as-built process," said Barry Schilling, CTDOT transportation supervising engineer. "But we struggled to capture 10 percent of the projects."

Recently CTDOT employed an app called ArcGIS Field Maps to capture all sign data location and attribution, including sign removals. The sign data now gets de-commissioned and commissioned during the project workflow. Contractors are no longer required to submit GPS installation data because the app verifies the location is as designed, or the contractor can adjust the location as required. The app allows CTDOT to quickly check project status at different locations.

## Transforming CAD Features to GIS Features

CTDOT is also developing CAD to GIS data transformations for traffic signal capital project models. Prior to 2015, its traffic signal plan storage consisted of paper copies stored in flat files and CAD files stored on a network drive. After 2015, CTDOT moved to cloud storage of PDF plans and CAD files, but there was no connection between the cloud storage and the agency's databases. In collaboration with the University of Connecticut, CTDOT began developing an Esri-based solution for managing the traffic signals inventory.

Once the data model (schema) was developed, CTDOT began developing the item types attribution for the CAD signal features using Bentley OpenRoads™ Designer. This underlying CAD feature intelligence will be packaged into a traffic signal workspace for CTDOT and consultant engineers, who will benefit from the auto harvesting of contract item quantities. This information will then be extracted, transformed, and loaded (ETL) into the Esri signal inventory by CTDOT using Safe Software's FME® (Feature Manipulation Engine). A quality assurance process developed in FME by CTDOT is then performed.

"This is going to remove those silos," said Elaine Richard, CTDOT civil applications and CAD coordinator. "We're going to be able to create a seamless flow of information from design to construction, to inventory. Using item types, we'll





Connecticut DOT uses an app for collecting and updating sign data in the field.

be able to provide project information, attribution on the graphical elements and geolocation of each component.”

### GIS-Based Project Management

Over the past 3 years, the Bureau of Engineering and Construction developed a Microsoft Azure cloud-based SharePoint™ project management solution. In parallel, CTDOT is developing a new Esri Azure cloud-based GIS infrastructure.

CTDOT’s SharePoint solution, COMPASS, was scoped to manage all project submittals and transmittals so that completed document reviews and approvals are automatically passed to the next reviewer. The agency said the application has been very successful and is standardizing the project management environment while also becoming a common data environment for project

data, including models for both CAD and Building Information Modeling (BIM). Bruce Bourgoin, CTDOT supervising engineer, said COMPASS is basically a one-stop-shop giving users access to CTDOT’s project data and documents.

The Esri build out has developed a robust portal environment along with internal enterprise data governance, change management, and distributed subject matter experts across the agency. Within this new environment, CTDOT worked with a GIS developer to create an application named ATLAS 2.0.

ATLAS 2.0 is built in a progressive Esri Experience Builder™ environment that allows users to identify proposed project work area(s) and hands out unique project identifiers that get joined with contract project numbers once available. The application allows the configuration of underlying asset inventories including linear referencing system routes, bridges, traffic signals, and others. These configured asset inventories are then available for automated scans for project inclusion. ATLAS 2.0 is being integrated with COMPASS so that the results of these scans get pushed to the SharePoint project site.

This ATLAS/COMPASS integration will provide information to asset inventories on decommissioning, rehabilitation, or preservation of each asset within a project. It also provides a draft permit needs determination and any spatial connections with active and historical projects. The CAD to GIS data transformations will drive commissioning of new or replaced assets. “This direct collaboration with our asset inventories is CTDOT’s vision for digital as-builts” said Bill Pratt, who is managing CTDOT’s digital as-built initiative.

## MORE INFORMATION

- @ Contact FHWA’s **Bryan Cawley** or **David Unkefer** for digital as-built resources and technical assistance.
- Visit FHWA’s Every Day Counts **e-Ticketing and Digital As-Builts** webpage.



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# STIC Incentives Drive Innovation

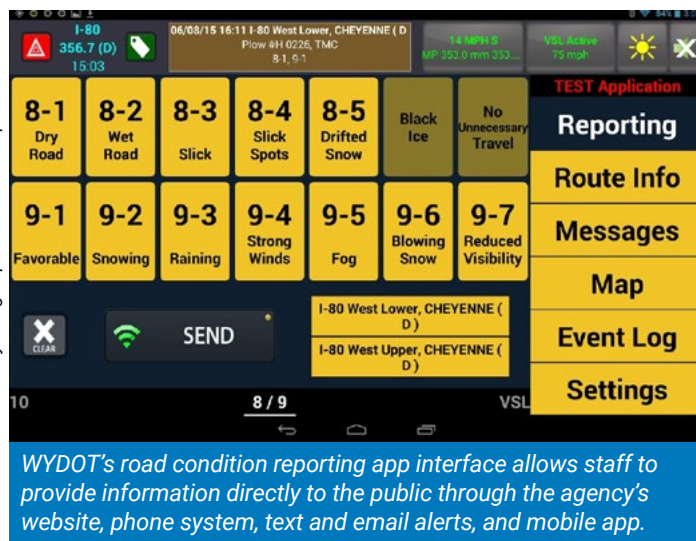
Agencies are solving highway transportation challenges with help from funds offered through the [State Transportation Innovation Council \(STIC\) Incentive program](#).

“STIC Incentive funds empower agencies to advance innovations that best fit their program needs,” said FHWA STIC Program Coordinator Sara Lowry. “The funds help get good ideas into statewide practice, and the projects often result in resources that can be shared or used as models by other agencies with similar challenges.”

The funding may support innovations from a variety of sources in addition to FHWA’s Every Day Counts program. Past projects include an automated system that improves road condition reporting in Wyoming, a wildlife fencing method for reducing deer-vehicle crashes in Virginia, and a tool for producing standardized plans for local roadway bridges in Wisconsin.

## Wyoming Automates Road Condition Reporting

Travelers rely on the Wyoming Department of Transportation (WYDOT) to provide accurate and timely road information so they can make informed decisions. To improve its reporting capabilities for [weather-responsive](#)



[traffic management](#), WYDOT developed a Road Condition Reporting app. The agency later used STIC Incentive funds to expand the app’s deployment through additional software development and hardware purchases and installation.

WYDOT maintenance employees use the application to report road conditions directly to the public through the agency’s website; phone, text, and email alerts; and mobile app without requiring intervention by the agency’s Transportation Management Center (TMC). Staff can also use it to recommend variable speed limits and report common traffic hazards and infrastructure damage.

Employees interface with the app via a computer tablet mounted in vehicles. The system works in locations where cell coverage is not available by using both Wi-Fi hotspots and the State’s WyoLink radio network to send and receive information.

An initial WYDOT study indicated the automated reporting system saves the equivalent of one full-time staff position. The result is that TMC operators can focus on more critical tasks, such as updating roadside devices, while drivers receive more accurate and timely information.

A user survey showed about 80 percent of maintenance personnel and TMC operators believe the agency should continue using the app. WYDOT attributed this deployment success primarily to early efforts to give end users a voice during the development process.

## Virginia Evaluates Wildlife Fencing

The Virginia Transportation Research Council (VTRC) applied STIC funds toward a goal of substantially reducing deer-vehicle collisions (DVC) along a busy interstate corridor.

A 2015 VTRC study of two unfenced underpasses along Interstate 64 discovered that, despite frequent use of the unfenced underpasses by deer, there was still a high degree of deer activity along the adjacent roadside and an associated high frequency of DVCs.





The Virginia Transportation Research Council used STIC funds on a [wildlife fencing project](#) that is improving safety by substantially lowering deer-vehicle crashes.

The VTRC used STIC funding to install wildlife fencing designed to guide wildlife into the two underpasses, as well as trail cameras to verify the system's effectiveness. The project installed 8-foot-high fencing extending a half mile east and west of each underpass. Jump-outs were placed approximately every quarter mile to give animals trapped within the roadway a safe exit.

In previous years, VTRC recorded an average of seven crashes annually at both underpass sites. In the first year after installation, the new fencing decreased that number to just one crash at each site—a 90-percent reduction.

In a [Virginia DOT video on the project](#), VTRC Associate Principal Research Scientist Bridget Donaldson said the fencing had proven so far to be a low-cost, effective solution for making two problematic stretches of highway safer. After monitoring the sites for 2 years, [VTRC reported](#) that the benefits from crash reduction exceeded the fencing costs in 1.8 years, and the fencing resulted in an average savings of over \$2.3 million per site.

### Wisconsin Develops Bridge Plan Design Tool

The Wisconsin DOT (WisDOT) used STIC funding to develop and implement its [Standard Bridge Design Tool](#) (SBDT), which produces standardized plans for the single-span slab bridges most typically used on local roadways. By automating a large portion of the design and drafting work for this type of structure, the SBDT decreases the

monetary resources needed within the design phase of relatively simple bridge projects. The agency's goal is to deliver more bridge replacement projects under the same funding through the overall cost savings.

The WisDOT SBDT functions from a website user interface where the bridge designer inputs seven bridge parameters (span length, bridge width, skew, etc.) based on their preliminary type, size, and location design. Users are then provided with approximately 85-percent designed and detailed final bridge plans. WisDOT reports that relatively minor editing is required of the final plans output by the SBDT, and this is where the design phase savings occur.

The main focus of the SBDT's use is on local roadways, but WisDOT is leveraging the tool on the State system as well. View the process for using the SBDT in WisDOT's [Standard Bridge Design Tool User Guide](#).

## MORE INFORMATION

- Learn about more projects on the [STIC Incentive](#) webpage.
- @ Contact [Sara Lowry](#) of the Federal Highway Administration for information on the STIC Incentive program.



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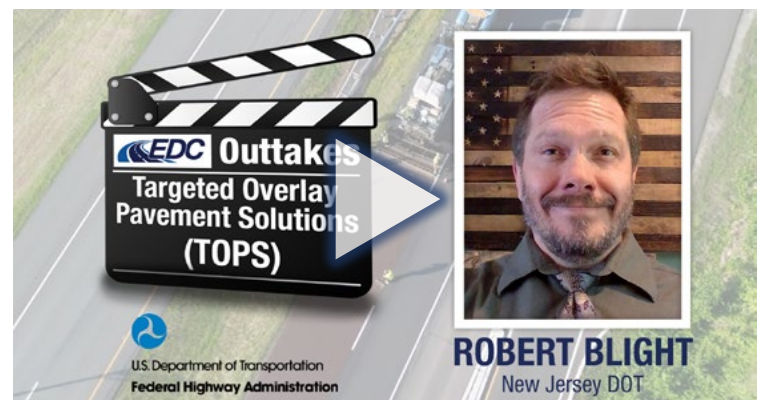
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U.S. Department of Transportation  
**Federal Highway Administration**

## EDC Outtakes

Listen to your peers share insights on Every Day Counts (EDC) **Targeted Overlay Pavement Solutions (TOPS)**. In these two editions of EDC Outtakes, Angela Folkestad, Executive Director of the Colorado and Wyoming Chapter of the American Concrete Pavement Association, talks about Colorado's success with placing concrete overlays on existing asphalt, and Robert Blight of the New Jersey Department of Transportation explains how his agency overcame funding challenges to create a strong pavement program that incorporates TOPS.



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