Pennsylvania
Department of Transportation
Local Technical Assistance Program

Providing FREE training, technical support, and resources to municipalities for over 40 years.

moving FORWARD

WINTER 2026

A quarterly review of news and information about Pennsylvania local roads.

Key Construction Threats to Green Stormwater Infrastructure Success

By Altje Macy, PE, LEED AP

Green Stormwater Infrastructure (GSI) encompasses a range of practices designed to manage stormwater runoff by replicating the natural water cycle. These systems capture and filter rainwater using engineered soils, native vegetation, and clean stone beds, encouraging infiltration close to where runoff originates. By allowing water to soak into the ground, GSI helps recharge groundwater supplies while reducing downstream flooding and erosion. Common examples of GSI include rain gardens (also known as bioinfiltration basins), porous pavements such as pavers and porous asphalt, underground infiltration beds, and green roofs.

Despite being an established concept, GSI remains underutilized in many development projects. This limited adoption often stems from a reliance on conventional stormwater practices — such as piping runoff to detention basins — which are familiar and perceived as easier to design and maintain. GSI is also frequently viewed as costly and labor-intensive, deterring some stakeholders. While these concerns can be addressed with proper planning and education, visible signs of system failure — like persistent ponding — can reinforce doubts. When GSI doesn't perform as expected, it can quickly shift public perception from innovation to inconvenience.

Failure of a GSI system can occur due to design errors or poor maintenance, but there are also several things that can happen during construction that could prevent success. Key construction-related threats to GSI success include clogging, poor soils, and compaction.

One of the ways GSI is differentiated from traditional stormwater management practices is that it is, as the name implies, *green*. Soil is one of the most important and overlooked components of a surface GSI system, like a stormwater street bumpout or rain garden. Not just any soil can be placed in a GSI system if it is to function properly. Soils with too many fine particles can clog the bottom of a system where infiltration is meant to occur. Silts washing into a system with side slopes, or offsite runoff, may also clog the surface of a GSI system.

The best soil for a successful GSI system will be free of fine particles and consist of a mixture of sand and compost, providing both structural stability and organic matter to support healthy vegetation. Specifications from a proven soil mix that is intended for GSI systems and procuring these soils from a reputable source

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A GSI Street Bumpout to provide traffic calming and stormwater management with uncompacted, engineered soils. Photo: Cedarville Engineering Group

ALSO IN THIS ISSUE

Self-Contained Skin Patching Truck Yields Efficiencies

The Self-Contained Skin Patching Truck is a single, truck-mounted unit that does the work of five tandem-axle dump trucks, a chipper spreader, and two oil distributors.

The truck is a highly mobile, computer-controlled unit, operated from the cab by one person. The unit can target and seal distressed roadway areas, preserve roads in a cost-effective manner, quickly move through the road network, and prevent the formation of potholes. For example, being able to drive the unit from location to location without it needing to be transported by a larger truck greatly increases production and decreases staff hours.

"PennDOT's Berks County Manager Rick Stone and I discovered this unit that makes skin patching operations more efficient," PennDOT District 5 Assistant District Executive for Maintenance Bruce Bubser said. "We received the go-ahead to pilot the truck, and so far, we are very satisfied with it."

PennDOT Engineering District 5, based in Allentown, rented the unit for 10 days at a cost of $38,625, which included the cost of an operator provided by the rental company. District 5 only needed to provide the safety set up and the rubber tire roller due to current specifications.

A typical skin patch operation has between 13 and 15 workers, a chipper spreader, oil distributors, and multiple dump trucks, so the Self-Contained Skin Patching Truck significantly reduces the number of workers and pieces of equipment necessary to patch a road.

The district plans to monitor the patched areas repaired by the truck for longevity and if the results are positive, it may expand its use.

"Bruce and Rick are outstanding employees dedicated to providing the best transportation system possible," PennDOT District 5 Executive Christopher Kufro said. "The innovation they are piloting will help to increase efficiency, while reducing the cost of maintaining our roadway network."

The Self-Contained Skin Patching Truck is a single, truck-mounted unit that does the work of five tandem-axle dump trucks, a chipper, spreader and two oil distributors. Photo: PennDOT

What are your peers saying about LTAP?

A roadmaster in South-Central Pennsylvania relayed how Pat Wright guided them on the completion of a traffic study and updating an ordinance to slow speed along a township roadway. The work included reposting distinct sections of road in compliance with the safe running speeds. Things are working out well. "**We've seen a reduction in speeding and the residents have stopped complaining**, which is a good thing! Pat did a great job and really helped us out." He added that LTAP is an excellent program, saving the township money and time in successfully addressing community concerns.

LTAP Tech Assist participant

Peer Exchange on Rural Road Safety

The United States Department of Transportation (USDOT) invited the Pennsylvania Local Technical Assistance Program (LTAP) to participate in a peer exchange on Rural Road Safety. The event was hosted in August 2025 by the Ohio Department of Transportation LTAP at its Central Office in Columbus, Ohio. Representing Pennsylvania LTAP was LTAP Instructor Chris Zivkovich, PE and Austin Erhard, Hempfield Township, Westmoreland County.

In addition to Pennsylvania, there were over 40 attendees representing Indiana, Illinois, Wisconsin, Minnesota, Ohio, multiple tribes, the Federal Railroad Administration, and the Federal Highway Administration.

Per nationwide crash statistics, the most common type of fatal crash on rural roads is the roadway-departure crash, with speed and alcohol-impaired driving related crashes also causing a significant number of fatal crashes on rural roadway networks.

The peer exchange agenda focused on discussing rural safety challenges, highlighting best practices, and sharing strategies to strengthen the knowledge base of state, local, and tribal stakeholders. This knowledge empowers them to implement proven safety measures for rural roads that can reduce transportation fatalities in their jurisdictions and communities at home. The peer exchange was a collaborative opportunity where LTAP attendees could share challenges, knowledge, experiences, and successful practices to improve rural road safety with others of a similar background and expertise.

Throughout the two-day peer exchange, there were discussions and breakout sessions on topics that first looked at existing data and what roadway owners were experiencing on their rural road network. Sessions included: Rural Road Safety Data, Emergency Response Times to Rural Crashes, Safety & Mobility of People and Goods in Rural Areas, and User Behavior in Rural Areas. Secondly, there were sessions focused on improving safety on rural roads and presentation of effective strategies participants were using in their states, including Integrating the Safe System Approach into Rural Road Safety Programs, Deployment of Proven Countermeasures on Rural Roads, and Communicating Safety in Rural Areas.

Chris Zivkovich, PE an LTAP Instructor, and Austin Erhard, Hempfield Township, Westmoreland County, collaborating with peers at the USDOT peer exchange on Rural Road Safety. Photo: PennDOT LTAP

The Safe System Approach aims to eliminate fatal crashes and reduce serious injury crashes. The FHWA website https://highways.dot.gov/safety has more information and resources. Graphic: FHWA

FHWA's Safe System Approach (SSA) outlines a holistic approach to achieving Vision Zero, which aims to eliminate fatal and serious injuries for all road users (motorists, cyclists, pedestrians, etc.) through six key principles:

- Death & Serious Injury is Unacceptable.
- Humans Make Mistakes.
- Humans Are Vulnerable.
- Responsibility is Shared.
- Safety is Proactive.
- Redundancy is Crucial.

The SSA was the focus point for many of the discussion topics throughout the two days. To achieve Vision Zero, safety assessments cannot be completed using data from only the macro level but rather must be conducted at the micro level. From a local level it may not seem like much, but if every rural road owner embraces the SSA and sets achievable goals of eliminating one fatal or serious crash a year on their roads, the cumulative impact would be significant. Once you zoom out and think about that approach occurring in every state, county, city, township, or borough, the overall reduction in fatal crashes and serious injuries nationwide would be impactful. Repeat this process year after year, and Vision Zero is a possibility.

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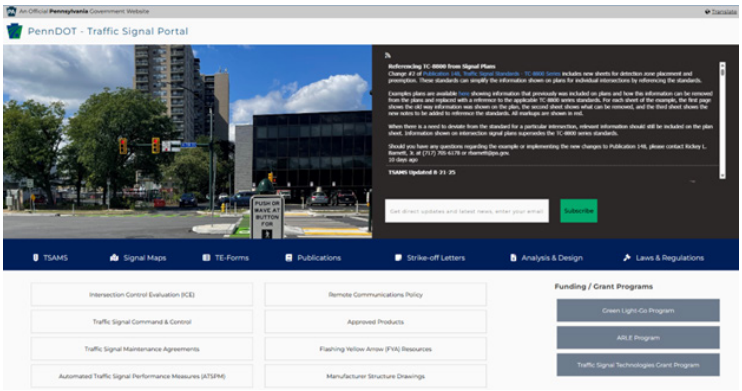
Traffic Signal Portal and LED Signs

Looking for a PennDOT publication, form, or information about project funding opportunities for traffic signals?

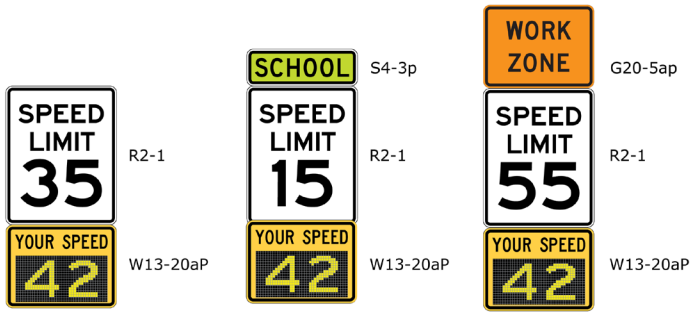
PennDOT's **Traffic Signal Portal** (penndot.pa.gov/signals) is your one-stop shop for all of these resources. The landing page of the portal has a newsfeed providing the latest updates to traffic signal publications, Automated Red Light Enforcement (ARLE), and Green Light-Go (GLG) programs, our Traffic Signal Asset Management System (TSAMS), along with general news. The page also includes helpful links for GLG and ARLE, TSAMS, all PennDOT publications, Traffic Engineering forms, and contacts for your local PennDOT traffic signal group. The portal is a great resource for all municipalities whether or not they own traffic signals.



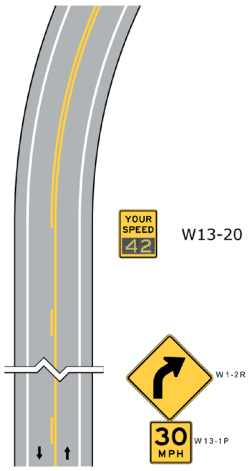
This is the landing page of the PennDOT Traffic Signal Portal.

Municipalities are increasingly looking to implement low-cost safety measures on their roadways by bringing more attention to regulatory and warning signs. One popular safety measure to increase the conspicuity of signs is utilizing LEDs along the border to grab the driver's attention. It's important to note these LED border signs require a flashing warning device permit. Municipalities should work with their local PennDOT district to ensure an approved product listed on PennDOT's Bulletin-15 is used. The same process applies for vehicle speed feedback plaques which are placed under a regulatory speed limit sign and display the speed of approaching vehicles. Permanent installations of these devices must also be permitted by PennDOT and use an approved product listed on Bulletin-15. The only changeable message incorporated into a Vehicle Speed Feedback sign or plaque shall be the numerical speed of the approaching vehicle. No other changeable messages shall be used. Examples of prohibited messages are "Slow Down," "Thank You," and flashing red and blue lights. Other approved ways to increase the conspicuity of signs can be found in section 2A.11 of the Manual on Uniform Traffic Control Devices (MUTCD).

Vehicle Speed Feedback Plaque with Speed Limit Sign



Vehicle Speed Feedback Sign Supplementing Horizontal Curve Warning Advisory Speed



This is the vehicle speed feedback example from Pub 149. Graphic: PennDOT

This is an example of the LED border lit stop sign. Photo: PennDOT

Meet the Expert

One-on-one with Sam Gregory, LTAP Technical Expert

How did you come to be involved with LTAP?

When the LTAP program was established in Pennsylvania in the early 1980s, I was working for PennDOT Bureau of Maintenance and Operations Quality Assurance section. We prepared winter training for operations that needed improvement and shared our training materials with the LTAP personnel. This collaboration continued throughout my career, so when I left PennDOT it was a natural fit to join the LTAP team.

If you could describe LTAP in a few words, how would you do so?

LTAP is a national program established to assist local government public works agencies in efficiently and effectively maintaining their roads and street assets through training, technical assistance, and other resources such as technical bulletins and newsletters.

What are some of the more common questions you get in the field?

Most of the questions center around technical issues dealing with public works maintenance operations. Quite often they center around interpretation of specifications, regulatory issues, and new techniques and technology associated with public works operations.

Talk about your interactions with municipalities and what you've learned.

There is a genuine sense of responsibility to better their community through teamwork. Whether it is the supervisors, workers, or secretaries there is a common goal of improving the lives of their residents. Also, I must give a shout out to the secretaries. They provide an integral part of keeping the municipalities functioning properly. Their work is often behind the scenes, and they might not get the accolades they deserve.

What would you like municipalities to know about LTAP?

It is a valuable asset to help them work smarter and not harder, so take advantage of it. Most municipalities know about the training and tech assists but there are many resources available to them. I would like to see more hands go up when I ask who uses the website so they can take advantage of all the resources that LTAP provides.

What do you like best about working with LTAP?

Interacting with the people. The public works employees that perform the work in the field are truly unsung heroes, maintaining the roads in the summer and making them safe in the winter. It is always enjoyable when they acknowledge they have successfully implemented ideas or suggestions that they have learned through LTAP.

Another benefit of working with LTAP in Pennsylvania is that it has provided me with the opportunity to provide training for other LTAP centers. This has brought me in contact with some outstanding individuals and provided knowledge and resources to share here in Pennsylvania.

You never know who will show up for class — sometimes it's a furry surprise!

Photo: Sam Gregory

Threats to Green Stormwater *continued from page 1*

are critical to project success. It is uncommon for on-site soils to be suitable for use in GSI systems, but in some cases, they can be amended with sand and compost — if they are tested after amendment — to ensure they have the right ratios of sand, silt, and clay. These systems should be planted with native vegetation that can thrive in both saturated and dry conditions — capable of withstanding periodic flooding while also surviving extended dry spells without the need for irrigation. Healthy vegetation is critical to maintain the stability of these soils and to create void spaces to store water.

Another key threat to a successful GSI system is compaction. In either a subsurface storage system or a surface practice, compaction can occur by driving construction equipment over the infiltration area. If the engineered soils designed for the system are compacted during construction, it removes the void spaces critical for GSI success. These void spaces are critical for stormwater storage, and they supply the air that plants need to live.

When infiltration bed soils are compacted and no underdrain is included to gradually release stormwater, the GSI system loses its ability to function. Without adequate pore space, water cannot infiltrate or drain through the soil, causing the system to fill, eliminating the system's storage capacity, and causing surface ponding. Standing water can suffocate plant roots and raise concerns about mosquito breeding, further diminishing the system's effectiveness.

GSI bed bottoms should not be compacted! An exception would be in cases where infiltration is not recommended or possible. Photo: Cedarville Engineering Group

Some GSI systems are installed completely below ground, making construction-related failures harder to detect. Subsurface stone beds rely on a high void ratio — the open spaces between stones — to store and infiltrate stormwater, but it is critical that this stone is *clean*. Clean-washed stone should be specified in the design, and it should be inspected to ensure it is in fact clean when it arrives at the construction site. This stone should be free from dust, and if it is dirty, it should be replaced, or at a minimum, washed on site to remove fine particles. Once clean-washed stone is on site, it is equally important to keep it clean. It should not be stored on bare earth where soils can be picked up with it when it is moved by equipment, and it should be protected from runoff containing sediment. Just as with compaction and silty soils, fine particles on unwashed stone can clog the infiltration surface of a GSI system, causing it to fail.

Stone in GSI systems should be clean-washed and not contain fine particles. If washed stone arrives at a construction site dirty, it should be rejected or washed on site. Photo: Cedarville Engineering Group

Preventable construction-phase failures can undermine the effectiveness of GSI and reinforce negative public perceptions. When GSI systems exhibit issues like standing water, dying vegetation, or mosquito breeding grounds, they are often dismissed as impractical or high maintenance. But these outcomes are not inevitable.

With thoughtful design, proper material selection, and vigilant construction oversight, GSI can deliver powerful environmental benefits. These systems reduce downstream flooding, mitigate erosion, recharge groundwater, and alleviate pressure on sewer networks. More than just a stormwater solution, GSI represents a shift toward resilient, nature-based infrastructure.

By prioritizing construction best practices and educating stakeholders on the value of GSI, we can ensure these systems fulfill their promise — and transform how communities manage water sustainably.

Peer Exchange *continued from page 3*

Are you ready to get started with a plan to reduce crashes and fatalities on your roadways? If yes, reach out to LTAP to learn about the resources available to begin implementing the Safe Systems Approach in your community.

Chris Zivkovich, LTAP Engineer, said "Being able to sit in a room of my peers and listen to discussions on real world safety issues being encountered on rural roads and the countermeasures and programs that have been implemented by people in various states is valuable knowledge that I can bring home and use as a tool in my day-to-day work as an engineer."

Crosswalk Q and A's

What types of crosswalks are approved for use in Pennsylvania?

Pennsylvania has approved both standard and decorative crosswalk markings. These standard crosswalk designs are found in PennDOT's Publication 111 (Pub. 111) https://www.pa.gov/content/dam/copapwp-pagov/en/penndot/documents/public/pubsforms/publications/pub%20111.pdf, *Traffic Control – Pavement Markings and Signing Standards*, (TC-8600, Sheet 6 of 13). There are three standard crosswalk designs: Type A – Parallel, Type B – Diagonal, and Type C – Perpendicular. In addition, three decorative crosswalk designs are approved: Type D – Courtyard, Type E – Herringbone, and Type F – Offset Brick along with six non-reflective decorative pattern colors: white, black, brown, silver-gray, tan, and maroon. These standards help ensure safety, visibility, and uniformity across the state.

Where should crosswalk markings be installed?

Per the *Manual on Uniform Traffic Control Devices* (MUTCD), Section 3C.02, at locations controlled by traffic control signals, crosswalk markings should be installed. On approaches controlled by STOP or YIELD signs, crosswalk markings should be installed where engineering judgment indicates they are needed to direct pedestrians to the proper crossing path(s). At uncontrolled approaches, an engineering study should be performed before a marked crosswalk is installed. The following criteria should be considered:

- Total number of approach lanes
- The presence of a median
- The distance from adjacent signalized intersections or other controlled crossings
- Projected pedestrian and bicyclist volumes
- Pedestrian and bicyclist paths of travel
- Pedestrian ages and abilities
- Pedestrian and bicyclist delays
- Location or frequency of public transit stops
- Average daily traffic (ADT)
- Speed limit or the 85th-percentile speed
- The horizontal and vertical geometry of the crossing location
- The possible consolidation of multiple crossing points
- The availability of street lighting
- Other appropriate factors

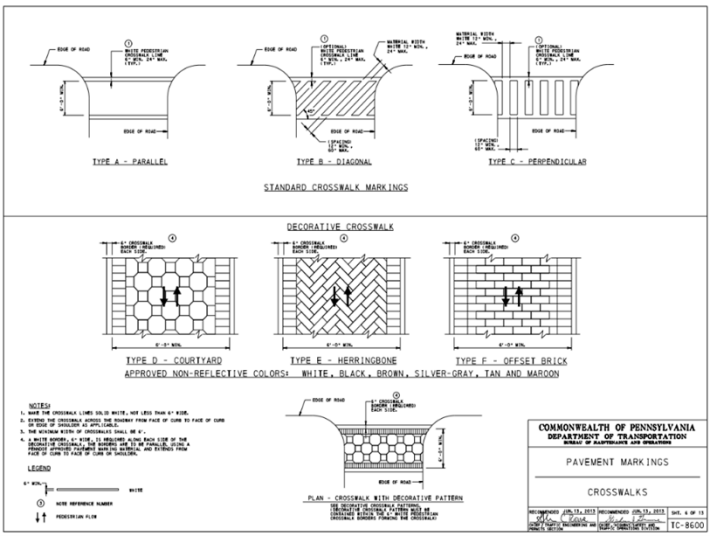
How do you determine the appropriate enhancements to implement at an uncontrolled crossing?

Use Tables 1 and 2 from the new PennDOT SOL 494-25-05, which supplements PennDOT's Publication 46 (Pub. 46), Traffic Engineering Manual: https://docs.penndot.pa.gov/Public/Bureaus/BOO/SOL/494-25-05.pdf. Table 1 is first used to determine whether or not a crosswalk should be marked based on the speed, volume, and roadway configuration. Table 2 is then used to determine additional countermeasures to supplement the marked crosswalk based on the speed, volume, and roadway configuration.

This is a PennDOT Type F – Offset Brick Crosswalk in Mechanicsburg Borough, Cumberland County. Photo PennDOT LTAP

At a minimum, the following treatments shall be installed:

- ADA – all crossings must meet ADA requirements.
- High-Visibility Crosswalks – the crosswalks shall be marked as high-visibility crosswalks per Pub. 111 (TC-8600).
- Warning Signs and Plaques – install a warning sign and plaque immediately prior to the crossing in both directions on the right side of the roadway.



PennDOT's Publication 111, Traffic Control – Pavement Markings and Signing Standards, (TC-8600, Sheet 6 of 13). Graphic: PennDOT

Do you have a question about a crosswalk in your municipality? LTAP can answer questions or provide technical assistance on crosswalks for municipalities.

Upcoming LTAP Training

Classes are being held in person and virtually. Check the website, gis.penndot.pa.gov/ltap, for the latest listing. If you would like to receive email alerts about upcoming training, send a request to ltap@pa.gov. Here is a sampling of upcoming scheduled classes. All classes are free!

Active Transportation for PA Communities
March 24 – Cambria County

Introduction to Traffic Studies
March 12 – Cambria County

Local Road Safety Plans
February 10 – Virtual

Pavement Markings
February 12 – Lancaster County

Road Safety Audit
March 17 – Virtual

Temporary Traffic Control (Works Zones)
February 23 – Adams County

Trucks on Local Roads
March 25 – Lancaster County

Check the website for new classes or reach out to your Planning Partner or LTAP to schedule a class at your facility.

Archived Training: Catch up online!

Recorded sessions and handouts from previously held drop-ins and webinars are available on the LTAP website, gis.penndot.pa.gov/ltap. On the home page, click the "Resources and Technical Information" tile or go to: https://gis.penndot.pa.gov/ltap/Public/LTAP_Resources.aspx. Sessions cover a variety of topics from asset management to truck restrictions. Check out the full list online and take advantage of this free training from the comfort of your home or office.

Course Handouts Are Now Online

Did you misplace a workbook or handout from a course? Do you wish you had the handouts in an electronic format? All the handouts from LTAP courses are now online and available for download. Go to gis.penndot.pa.gov/ltap and under the Training Descriptions tab, click on the course and then scroll to the bottom of the course information to see a list of course handouts.

If the handout for a class is three slides per page, there is a full PowerPoint workbook you can download on the website. These have PowerPoint slides with the workbook content below the slide. They are designed to make it easy to follow the virtual classes and provide all the notes for the in-person classes.

Congratulations to the following Roads Scholars!

The following scholars were certified between September 1 to October 31, 2025.

Roads Scholar II:
- Matt McGough, MPO – Reading City, Berks County
- James Mikucki – Hamburg Borough, Berks County
- Chris B. Nalepa – West Goshen Township, Chester County

Roads Scholar Police:
- Thomas G. Bell Jr. – Lower Swatara Township, Dauphin County
- Andrew Lavenberg – Upper Dublin Township, Montgomery County

What are your peers saying about LTAP?

"It was an **informative presentation with great real-life examples**. Helped me as borough manager to understand how to get this done!"

Introduction to Traffic Studies participant

"We wanted to have **an independent unbiased opinion on the speed limit on the roadway** and Mark was great in doing that, and at showing us what we should do from here on out! Great working with him!"

LTAP Tech Assist participant

Pennsylvania
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Local Technical Assistance Program

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All LTAP services are free to municipalities.