UNIVERSITY OF MINNESOTA
CENTER FOR TRANSPORTATION STUDIES

MINNESOTA LTAP
TECHNOLOGY EXCHANGE

mnltap.umn.edu
Minnesota Local Technical Assistance Program
June 2021 Vol. 29, No. 2

INSIDE:

Pavement markings 101

Pavement markings are an important facet of road safety; they can communicate rules and warnings, often supplementing signage to provide additional visibility and clarity. The "Pavement Markings 101" session at the 2021 City Engineers Association of Minnesota (CEAM) annual conference reviewed the importance of pavement markings and explored

Pavement markings continued on page 6

A long-term approach to green stormwater infrastructure

Strategies for managing stormwater runoff have been steadily undergoing a shift in recent decades toward "green" infrastructure. This is a potentially beneficial change, but transportation professionals are beginning to recognize a need for better information on how to properly design, implement, and maintain these facilities.

The Center for Transportation Studies (CTS) hosted a webinar on April 8 that brought together transportation researchers and professionals to discuss best practices for implementing green infrastructure. Professor John Gulliver of the University of Minnesota's Department of Civil, Environmental, and Geo- Engineering gave a presentation on the subject, after which a panel of local and state government representatives discussed their own practical experiences.

Green infrastructure continued on page 5

Beaver pipe cage improves safety

Beavers looking for a new home threatened the safety of drivers in the Town of Niles, New York. The beavers moved into the area and began packing mud and sticks into a cross culvert along one of the roadways. Their handiwork sometimes stretched 4 to 5 feet into the culvert, causing water to back up and flood the area.

Niles officials needed to find a solution that would keep both the beavers and the roads safe. They came up with an idea to use gabion baskets that they had in stock from another job to block the beavers from turning the cross culvert into a home.

The first few attempts were unsuccessful because the baskets were not secure enough to keep the beavers out. So, the Town of Niles staff took their idea further by consulting with highway workers to build a frame around the basket for improved security and stability around the cross culvert.

Beavers continued on page 4

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READ THE
EXCHANGE
online for links to publications and other resources.

SAFETY

A Minnesota vision for speed limits

How should speed limits be set? With this question in mind and an eye on the future, leadership teams for city and county engineering associations requested that MnDOT's State Aid for Local Transportation (SALT) Division help facilitate a first-of-its-kind effort. The purpose was to develop a consistent and united statewide vision for setting speed limits supported by a diverse group of stakeholders, partners, and users.

For the project, State Aid partnered with consultant Bolton & Menk and set to work last year. The purpose of the project was not to provide guidance on existing state statutes or to provide tools for changing speed limits, but instead to dive deep into the topic through the collaborative engagement of a diverse group.

Across the nation, communities are currently evaluating—and some are modifying—their approach to setting speed limits to incorporate factors such as crash history, roadway context, and the presence of vulnerable road users. A growing number of cities have recently lowered their speed limits systemwide, including Minneapolis. In rural Minnesota, however, pressure grows to increase speed limits.

The project revealed that the engineering community and user groups in Minnesota agree on many aspects of how to set speed limits. The result is a vision for setting speed limits that offers a consistent and unified approach while honoring data-based methods, community environment, and all users. ■

(Condensed from the SALT E-Scene, Feb. 2021.)

Learn more:

- Project website with information about speed limits in Minnesota, answers to frequently asked questions, and links to useful resources: **mnspeedlimitvision.org**

Speed limits: history highlights

1885 Incorporated villages or boroughs are authorized to regulate the rate of speed of engine-powered vehicles.

1911 The first speed limit law in Minnesota references reasonable and proper speeds on public highways, "so as not to endanger the life or limb, or injure the property of any person."

1942 Governor's order implements a wartime speed limit of 40 mph under orders from the USA Office of Defense Transportation, upon the advice of the Wartime National Rubber Director. Repeat offenders will lose their gas ration stamps.

1974 National Maximum Speed Limit 55 mph (NMSL55) on all roads imposed by USDOT for emergency energy conservation, prompted by foreign oil embargoes. USDOT requires substantial compliance to NMSL55 or else funding will be sanctioned. ■

NACE honors Minnesota leaders


Sue Miller

The National Association of County Engineers (NACE) recently honored Sue Miller with the David P. Brand Safety Award. Miller, now a principal with SRF Consulting, was the long-time county engineer of Freeborn County. She was the first woman to serve as NACE president.

A tireless safety advocate, Miller has worked on safety programs, policies, and practices including leading pilot programs on initiatives like the safety edge (the first in the country), road safety audits, and county highway safety plans. Other highlights include initiating federal legislative language for high-risk rural roads and streamlining federal low-cost safety improvement projects.

While serving as NACE president, Miller focused on local road safety and encouraged NACE members to collaborate with their state and federal partners to invest vital federal safety dollars proportionally to the crash rates on local roads using low-cost, proven safety measures.


Stefan Gantert

NACE also named Stefan Gantert the NACE Project Manager of the Year. Gantert, Blue Earth County assistant public works director, was honored for his leadership guiding the County Road 1 (Old Hwy 66 Turnback) reconstruction.

County Road 1 was fraught with sharp 20 mph curves, limited sight distances, narrow shoulders, drainage challenges, and steep slopes adjacent to the roadway. The reconstruction project balanced design standards, impacts, and costs using a variety of elements including Natural Preservation Route design standards, rock excavation, staged reinforced-stabilized slopes construction for access, and stormwater conveyance through the project from the adjacent bluff.

In addition, Washington County Engineer Wayne Sandberg was elected and installed as the North-Central Region vice president of NACE at its recent annual meeting held via videoconference. Sandberg's term will run through April 2023. He served on the board of directors of the Minnesota County Engineers Association from 2017–2018 and as its president in 2019. ■

Steering Committee updates


Jeff Krueger

Jeff Krueger has joined the Minnesota LTAP Steering Committee. He is the new executive director of the Minnesota Association of Townships and a supervisor in New Market Township in Scott County. He succeeds David Hann on our committee.

Welcome, Jeff, and thank you, David, for your service! ■

Technology Exchange

The Minnesota Local Technical Assistance Program is part of the Federal Highway Administration's Local Technical Assistance Program (LTAP). LTAP is a nationwide effort designed to foster and improve information exchange among local practitioners and state and national transportation agencies. Minnesota LTAP is administered by the Center for Transportation Studies at the University of Minnesota, and cosponsored by the Minnesota Local Road Research Board and the Minnesota Department of Transportation.

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Portable stop signs improve response time

When someone reports a stolen or damaged stop or yield sign in Lyon County, Kansas, county highway department employees are immediately called out to replace the sign no matter the time of day. Once workers are on the scene with an abundance of replacement materials and tools, they find the existing hole where the missing sign once stood or remove the remainder of a broken pole and replace it with a new sign.

"This process was time-consuming because of the time it took to gather the tools and equipment needed to replace the sign, which extended the time the intersection was left without safety signs," says Jim Brull with the Lyon County Highway Department.

Highway workers needed an easier solution to quickly replace the signs while restoring safety to the intersections. They found their solution in portable stop and yield signs.

"I brought up the idea for the portable signs during a brainstorm session," Brull says. "Our department promotes change for the better using innovation."

Going portable meant less time spent replacing signs. The portable signs have adjustable height legs with extensions that can be quickly installed in various terrains using fewer tools.

Prior to the portable signs solution, workers would have to guess which tools would be needed to install the new signs. The signs are also easily transported in pickup trucks and SUVs.

Lyon County officials say implementing use of the portable signs improved response times for temporarily replacing the signs and restoring safety at the intersections.

Brull has advice for encouraging creativity to address challenges: "Speak openly about the issues with everyone, especially the front-line workers. Be open to change, encourage innovation for improving job performance, and build a great team!" ■

(Reprinted from the 2020 FHWA Build a Better Mousetrap booklet.)

Learn more:

- Jim Brull, Lyon County Highway Department, 620-340-8220, **jbrull@lyoncounty.org**

DON'T FORGET:
MnLTAP offers an online class: Sign Maintenance and Management for Local Agencies.

Sign maintenance truck improves safety

Safety was the number one concern for the Town of Breckenridge, Colorado, when it was time to start thinking about a new sign maintenance truck. The old truck was equipped with a mechanic's box and high sides that made it difficult to load and unload traffic control devices from the truck. In addition, work crews would often stand on top of the mechanic's box to reach school-zone control cabinets and to install high signs, such as street name signs. Town officials knew this was not safe and began seeking staff feedback and researching more efficient vehicles to help carry out sign maintenance activities.

Their solution for a new truck included designing one side of the truck bed to fold down for easier loading and unloading of traffic control devices. They added a work platform with safety bar for activities that involved working with height, and they selected a new toolbox for improved organization in the truck bed.

They also built steps onto the back of the truck for easier access to the truck bed. Town officials say the $600 spent on additions to the new truck saved money because they made the improvements themselves. They say the cost savings ensured the safety of their staff and improved the efficiency of delivering the town's sign maintenance program. ■

(Reprinted from the 2020 FHWA Build a Better Mousetrap booklet.)

Learn more:

- Scott Davis, Streets Assistant Manager, 970-453-3361, **scottd@townofbreckenridge.com**

Send us your OPERA ideas: Tools, processes, or tips for COVID-19

Do you have ideas for improving tools or processes? Or maybe you've been finding solutions for COVID-related impacts to your job that could benefit other agencies? If so, please send your ideas to the LRRB's Local Operational Research Assistance (OPERA) Program. There is no deadline to submit your proposal, but funding is limited. Please see the OPERA web page for details: **mnltap.umn.edu/opera**. ■

Iowa DOT uses ultra-high-performance concrete for bridge project

Ultra-high-performance concrete (UHPC) is a high-durability, cost-efficient material that is being used to improve life-cycle cost performance in bridge preservation and repair.

The Iowa Department of Transportation recently explored how to use UHPC to address a bridge linking Prairie City to Des Moines. The bridge deck had exhibited repeated concrete spalls caused by corroding reinforcement and deteriorating concrete, which resulted in numerous deck patches over time. Iowa DOT decided to take a more permanent approach to extend the service life of the deck without having to do a costly and disruptive deck replacement by using a UHPC bridge deck overlay.

UHPC applied as an overlay would not only provide a long-lasting and highly durable wearing surface, it would also waterproof the deck, cutting off water intrusion, which causes the reinforcing bars to corrode. UHPC is also suitable for repairing spalls, which potentially could remove a separate deck repair step. Finally, the durability properties of UHPC suggested it would provide a service life that exceeds that of conventional overlay materials.

Because the bridge's original design accounted for a future wearing surface, the UHPC overlay was applied on top of the existing deck without having to remove any existing deck thickness other than the hydroscarification to ensure a quality bond. The choice of doing minimal concrete removal and placing the UHPC on top of the deck expedited deck preparation.

EDC Every Day Counts is the FHWA's initiative to advance a culture of innovation in the transportation community in partnership with public and private stakeholders.

The construction was carried out in two stages, keeping one lane open to traffic at all times. The project took just over two weeks to prepare the deck, place, and cure the UHPC.

Iowa DOT expects the new UHPC overlay to provide many decades of service life with little to no deck maintenance. While the traffic impacts were similar to an overlay operation using conventional materials, the mechanical and durability properties of UHPC indicate that it will outperform conventional materials, potentially providing as much additional service life as a new deck but with far fewer inconveniences to the traveling public.

UHPC for bridge preservation and repair is one of the innovation areas in round 6 of Every Day Counts (EDC). UHPC—a fiber-reinforced, cementitious composite material—can be used in situations that normally use conventional concrete or repair mortars, and in some cases those that use structural steel. ■

(Reprinted from the April 22, 2021, EDC News.*)*

Learn more:

- Every Day Counts website: **fhwa.dot.gov/innovation/everydaycounts**

Autonomous vehicles: The end of stormwater systems?

The adoption of autonomous vehicles in coming decades is expected to have a major impact on road design and urban infrastructure—and one of the largest changes could mean the end of the road for aging and costly stormwater systems.

"At the Minnesota Design Center, we're looking at the design of road and infrastructure systems as a result of autonomous vehicles," says Professor Tom Fisher, the center's director. "We've found the precision of autonomous vehicles requires a different

type of road surface that can resist precise, repetitive wear."

As a result, future roads could be a set of reinforced concrete tracks that allow for much more pervious surface, require fewer materials, and are easier to maintain. And, Fisher says, "perhaps most importantly, they will allow us to eliminate the storm sewer system, which is very expensive for cities and local governments and creates many negative impacts."

As roadways at every level—from alleyways to major arterials—shift to the new design, Fisher says the hydrological impacts would be immediate. "Instead of moving stormwater off site through a stormwater system, you have the ability to capture stormwater in the roadbed and allow it to recharge aquifers. We're working to calculate the impacts of that in terms of hydrology, the elimination of heat islands, creating more space for animal habitat, and creating new bioswales."

The shift to a reimagined urban infrastructure would come at a significant initial cost. However, Fisher says that while the immediate short-term cost is higher, there is enormous long-term savings potential in the elimination of stormwater systems, much lower material use for roadways, and fewer environmental impacts.

To offset the initial costs, governments would need to leverage the increased tax base that comes from the shift to autonomous vehicles.

"There will be opportunities for new kinds of uses all along our infrastructure to help pay for this change," Fisher says. "Autonomous vehicles require fewer and narrower lanes, which allow the right-of-way to be used for other things. Private garages could become businesses and affordable housing, alleyways could become privatized, and today's parking infrastructure could be used for stormwater retention, pickup and drop-off, urban gardens, green spaces, and denser development to create a greater tax base."

Beyond the benefits to local governments through the elimination of the stormwater systems and long-term cost savings, this reimagined infrastructure has the potential to make the urban landscape a better place for everyone who lives and works there.

"We see a future where city streets become narrower, greener, and quieter," Fisher says. "The shift to autonomous vehicles will allow for more bike paths and wider sidewalks, and the ability of autonomous vehicles to operate safely around people using other transportation modes opens up the public right-of-way for many other kinds of uses."

This work was supported by a National Science Foundation Smart & Connected Communities grant. ■

—Megan Tsai, CTS freelancer

'Green alleys' offer stormwater and public health benefits

"Green alleys" provide small patches of green space in urban areas. The alleys, which usually incorporate vegetation, can help prevent environmental degradation by controlling stormwater runoff. For her master's thesis, University of Minnesota graduate Ella Weber explored whether intentionally greened "blooming alleys" can also benefit neighborhood well-being and residents' mental health. Her advisor was Professor Ingrid Schneider of the Department of Forest Resources.

For her work, Weber reviewed previous studies that analyzed the health benefits of larger natural spaces. Research has consistently found that exposure to nature can reduce mental fatigue, she says, and urban parks and greenways provide opportunities for restorative nature experiences. The benefits of small-scale green space, however, are relatively unstudied.

During the summer of 2019, Weber conducted two focus groups and 22 interviews with Minneapolis residents living adjacent to green alleys, aiming to determine whether these public health benefits translate to smaller green spaces. She then identified themes from participants' direct quotes and actions and coded responses based on characteristics from an attention-restoration theory, mentions of stress, and aesthetic preferences.

Prominent in the responses were feelings of "fascination" (with details such as plant diversity or pollinators) and "compatibility" (a sense of belonging in an environment). Residents also reported restorative experience during both purposeful interactions with the green alleys, such as gardening, and incidental experiences, such as taking out the trash.

"Although individuals did not place an emphasis on specific mental health impacts," Weber says, "their mention of factors known to contribute to mental well-being provides strong indication that green-alley residents receive benefits whether or not they are actively aware of them."

She concludes that a "small dose of nature provided by small-scale green spaces can have a meaningful impact on human health." The findings could be used to inform best practices in urban planning and design.

Her research was published in the journal *Urban Forestry & Urban Greening*, issue 57 (2021). Metro Blooms, a Minneapolis nonprofit, spearheaded the initial project in the Lake Nokomis neighborhood in 2014. ■

—Sophie Koch, LTAP freelancer

Beavers from page 1

It worked—and the beavers eventually went away. Problem solved! "I never had doubt that this was going to work. It was pretty foolproof," says Patrick Steger, highway superintendent with the Town of Niles.

This creative solution cost the Town of Niles less than $500. Steger's advice to other agencies is to "work smarter, not harder." He says, "If there's a problem, sit back and think it through. If it doesn't work the first time, keep at it. Stick with it and don't give up." ■

(Reprinted from the 2020 FHWA Build a Better Mousetrap booklet.)

Learn more:

- Patrick Steger, Niles Highway Superintendent, 315-246-7198, **townofniles@hotmail.com**

The beaver pipe cage

Avoid Lyme Disease: Check for ticks

Studies have shown that an infected tick normally cannot begin transmitting Lyme Disease until it has been attached to its host for approximately 24 to 72 hours. Your best line of defense is to examine yourself at least once a day and remove any ticks before they become engorged (swollen) with blood. ■

(From a Safety Tailgate Talk, Vermont LTAP)

Lower-cost ways to control runoff from low-volume roads

Stormwater runoff from roads can contain an array of contaminants. Standard treatment methods are based on studies of urban roads with high average daily traffic (ADT) counts—tens of thousands and higher. Low-volume roads, in contrast, have rarely been studied, so little is known about the types and concentrations of contaminants in their runoff.

To fill this knowledge gap, University of Minnesota researchers collected and analyzed stormwater runoff from low-volume rural roads to determine how contaminants compared to those of high-volume roadways. If the runoff analyses differed considerably, alternative treatments could be possible, says Professor John Gulliver of the Department of Civil, Environmental, and Geo- Engineering, the principal investigator.

Whenever MnDOT and local transportation agencies add a linear acre or more of new impervious surface, they are required by the Minnesota Pollution Control Agency (MPCA) to capture and retain stormwater runoff through an approved treatment. High-volume roads frequently require expensive mitigation strategies.

For this project, low-volume roads were defined as two-lane asphalt paved rural roads with less than 1,500 ADT. Working with nine county engineers, the researchers selected 10 sampling sites in six Minnesota counties based on soil types, land uses, and other factors. The research team then developed and built "first flush" runoff sampler collectors for installation at road edges.

After 174 total rain events from June to October in 2018 and 2019, the researchers and local county agency staff retrieved the collectors and sent the water samples to a lab. Concentrations of total suspended solids, metals (such as zinc from tires and brake pads), total phosphorous, and nitrates/nitrites were measured.

They found that overall, low average daily traffic (ADT) counts did appear to correlate with lower pollutant levels. The adjusted concentrations of solids, phosphorous, nitrate/nitrite, copper, and zinc were found to be lower than those in high-volume road studies in the United States. All samples showed less metal contamination than high ADT urban road runoff typically contains—some to the point of metal being absent or negligible.

Runoff from low-volume roads may contain pollutants from other sources, such as galvanized farm equipment. However, models run by the researchers indicate that simpler mitigation practices, such as ditches and swales, can effectively control these pollutants and meet MPCA standards.


Researchers developed a runoff sampler (left) and worked with agency staff to collect samples.

Based on their findings, the researchers recommend ditches with swales as an effective stormwater treatment for low-volume roads. This method is already used along many rural roads and is considerably less expensive to install and maintain than other best management practices, especially when the swale is in the right-of-way and no additional land has to be purchased

"This study shows that low-volume rural road runoff differs substantially from high-volume urban highway runoff and can therefore be treated in ways that are more effective and at a substantially lower cost," says John Welle, county engineer for Aitkin County. Agencies will be able to use the study's data for their future stormwater permits. The LRRB funded the two-year study. ■

—*Sophie Koch, LTAP freelancer*

Learn more:

- *Characterization of Runoff Quality from Paved Low-Volume Roads and Optimization of Treatment Methods* (LRRB, 2020)

Green infrastructure from page 1

"There's a lot of runoff in an urbanized land cover," Gulliver began. Impervious surfaces such as concrete tend not to allow stormwater runoff to absorb into the soil, and this in turn can cause increased flooding, erosion, and movement of pollutants.

Green infrastructure, in comparison to the more traditional, concrete-based "gray" infrastructure, tries to mitigate these problems by mimicking the natural water cycle and utilizing processes such as infiltration to treat stormwater at its source. It can be used very effectively, Gulliver said, but each green best management practice (BMP) has limits and considerations that must be accounted for.

Initial design is key to the success of a BMP, Gulliver said. Infiltration systems, for example, can fail to do their job from day one if the surrounding soil texture and structure are not taken into account. High groundwater can cause infiltration failure, and Gulliver's research is finding that plant roots play a huge role in increasing the porosity of the soil.

"If you take a soil profile at one location, that may not tell you what the whole practice is going to do," Gulliver said.

Maintenance is also an important consideration. Gulliver's research is finding, for example, that the sediment in stormwater ponds sometimes reaches a failure point and re-releases sequestered phosphorous. This can be prevented through regular sediment dredging, but many ponds were not built with maintenance logistics in mind.

"If these BMPs are going to be sustainable structures, you're not just going to build them and walk away," said Mark Maloney, director of public works for the City of Shoreview. Local governments, he said, need to have the "organizational courage" to budget for BMP longevity.

Dwayne Stenlund, an erosion control specialist with the Minnesota Department of Transportation, suggested that operator's manuals would go a long way toward helping cities plan the logistics and resources needed for maintaining BMPs. He recommended that the manuals include facility specifications, maintenance instructions, and a list of the staff, materials, and money necessary for long-term upkeep.

Ross Bintner, division manager for the City of Edina Engineering Department, added that these BMPs also need to be installed with a systems approach, since the hydrology of one parcel of land inevitably affects that of its neighbors.

Mike Trojan, hydrologist with the Minnesota Pollution Control Agency, said that MPCA manuals do provide some state-level guidance on green infrastructure. However, new information regarding operations and maintenance—such as phosphorous management and soil and vegetation factors—needs to be considered. "We need to build that into the initial considerations at a site," he said.

There is also the question of equity. Stenlund noted that there is often a disparity between stormwater funding and poor/minority communities—wealthier communities tend to get far better access to funding for green initiatives and maintenance.

The panel discussed using a more community-oriented approach to potentially address these issues. Stenlund pointed out that maintenance

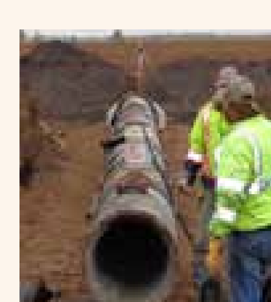
operations tend to languish in obscurity, and he suggests that overcoming this trend could improve design and budgeting decisions within the community.

"We always have a ribbon-cutting when we build a new bridge," Stenlund said, "but when have we ever had a ribbon-cutting event saying, 'Maintenance, you did a great job this year'?"

The webinar was held in conjunction with a joint meeting of the CTS Transportation Infrastructure Council and the CTS Environment and Energy in Transportation Council. ■

—*Sophie Koch, LTAP freelancer*

Seasonal movement at culverts and utilities



Over the years, the LRRB and MnDOT have developed several resources to address and mitigate issues associated with seasonal movement (heaving and depressions). A new quick reference guide synthesizes several of these resources and specifically addresses seasonal movements at culverts and utilities. The new guide includes sections on mitigation construction practices, utility trench treatment, and more. Minnesota LTAP also offers online culvert training. ■

Learn more:

- Mitigating Seasonal Movement at Culvert and Utilities: **lrrb.org/frost-dips**
- Minnesota LTAP training: Culvert Installation and Maintenance for Local Agencies (Online): **mnltap.umn.edu/training/topic/drainage/onlineculvert**

MAINTENANCE

Pavement markings from page 1

different options for selecting, applying, and maintaining them.

Purposes and challenges

Senior Associate Jon Jackels from SRF Consulting Group started the 101 presentation with an overview of the different purposes and challenges of pavement markings.

According to the current edition of the *Minnesota Manual on Uniform Traffic Control Devices* (MN MUTCD), the main functions of pavement markings are to provide guidance and information to drivers. Regulatory markings such as yellow curbs and "no passing" double-lane lines can lay out rules and restrictions, Jackels said, and facility-use markings such as pedestrian crossing lines can indicate who is allowed to use what part of the road.

The MN MUTCD establishes a uniform system of traffic control devices for streets and highways in Minnesota and is a good overall guide for determining rules and requirements for pavement marking application. The current edition from MnDOT can be found at **dot.state.mn.us/trafficeng/publ/mutcd**.

"It's a good reference to go back to and look at when you're doing design," Jackels said.

Further considerations have to be taken when applying the markings. Visibility, cost, longevity, maintenance needs, and ease of application are all factors that have to be considered, and there are often tradeoffs between different methods.

Retroreflective glass beads can increase nighttime visibility when dropped onto painted lines, for example, but they are easily scraped off by snowplows. Recessing them into grooves solves this problem but in turn creates issues with rain pooling in the grooves and muting the retroreflective properties of the beads. There's been work to solve this problem by altering the retroreflective properties of the glass beads so that light can be returned to drivers even through water, Jackels said.

"Deciding on what materials to use for pavement markings requires consideration of many factors," he said, "including type of pavement, preventive maintenance plans, need for wet weather visibility, type and speed of traffic, and ability to maintain markings."

PAINT TYPE	LIFESPAN	COST PER SQUARE FOOT
Paint	6 months to 2 years	$1.20 to $1.60
Epoxy	3 to 5 years	$8.00 to $11.00
MMA (Methyl Methacrylate)	3 to 6 years	$8.00 to $15.00
Thermoplastic	2 to 6 years	$10.00 to $14.00
Colored Pavement	About as long as the original, structural pavement	Up to 50 percent more than non-colored, structural pavement

Colored lanes

Adrian Potter, principal at SRF, delved deeper into one very specific type of pavement marking: colored lanes.

Generally, Potter said, colored lanes are utilized to set aside space for a type of road user—most commonly bicycles and buses. This can take the form of an entire colored lane (usually green or red) or something more limited such as colored "bike boxes," which set aside a spot at the head of an intersection where bicyclists can safely queue for the light.

"These have been used by many cities and are becoming more common," Potter said. "These aren't new things, but they seem to be growing in their use."

When applying colored lanes, many of the points from Jackels' general overview of pavement markings come into play—visibility, cost, longevity, maintenance needs, and ease of application must all be considered. Though the MN MUTCD has yet to standardize the rules for colored lanes, Potter recommended adopting consistent practices to minimize confusion and referring to the National Association of City Transportation Officials (NACTO) *Urban Bikeway Design Guide* and *Transit Street Design Guide* for more information (**nacto.org/publications/design-guides**).

Potter then described some potential materials and some of their pros and cons:

- **Paint:** Easy to apply since most cities already have painting equipment for their roads. Has low durability in high-traffic areas and can be slick when wet (can be solved by adding sand).
- **Epoxy:** Long-lasting and naturally both skid-resistant and retroreflective. Involves more specialized installation.
- **MMA (methyl methacrylate):** Quick to dry and durable. Less widely available, requires special equipment, and can be damaged by pooling water.
- **Thermoplastic:** Durable in high-traffic areas and easy to spot-treat. Cost-prohibitive over large areas.
- **Colored pavement:** Embedded treatment. Can be cost-effective if designers plan to install it at the same time as other renovations, but cost-prohibitive if there are not already plans to repave. Spot maintenance can be difficult.

"There is probably no one-size-fits-all answer here for what you would use for your bike lane or your bus lane," Potter concluded. ■

—Sophie Koch, LTAP freelancer

Learn more:

- MnDOT Traffic Engineering Manual: **dot.state.mn.us/trafficeng/publ/tem**
- MnDOT Pavement Marking Field Handbook: **dot.state.mn.us/trafficeng/pavement/doc-storage/mndotpavementmarkingfieldguide.pdf**
- MnDOT Typical Detail Sheets: **dot.state.mn.us/trafficeng/pavement/typicaldetail**
- MnDOT Approved/Qualified Products: **dot.state.mn.us/products**
- LRRB Tool for Prioritizing Pavement Markings: **lrrb.org/tool-for-prioritizing-pavement-markings-on-low-volume-roads**

The CEAM '101 Series'

The "101 Series" made its first appearance during the 2020 CEAM conference. It was developed as a way of focusing on the foundational skills of municipal engineering—technical, political, ethical, etc.—and was primarily aimed at people who are new to the career path. The first year of the series included presentations on city functions, state aid, and traffic signals. The series was well-received during its pilot year and brought back for the 2021 conference with Engineering 101, Project Management 101, and Pavement Markings 101. ■

Study casts doubt on safety benefits of stop lines at intersections

Adding stop lines at two-way stop-controlled intersections doesn't directly correlate to improved safety, according to U of M researchers. Stop lines are frequently used along with regulatory stop signs to indicate where drivers must stop before they enter the conflicting traffic lane, but very little research had been conducted on this pavement marking's effect.

"The benefits of stop lines had been assumed, not proven," says John Hourdos, director of the U's Minnesota Traffic Observatory. "And while one stop line is not an expensive addition, maintaining them at hundreds of intersections can become a sizable expense for local agencies."

The safety study's key finding was that the presence of a stop line showed no association with crash occurrence when used as the sole predictor. A field study showed that in all cases—both before and after stop line installations—drivers stopped 10 feet or more after the stop sign or stop line.

Additionally, researchers found that the more space there was between the line or sign and the edge of the conflicting driving lane, the more drivers ignored the stop line. After stop lines were added, some cases showed drivers stopping even closer to the conflicting lane than before.

On a more positive note, although the presence of the line did not increase the number of drivers that come to a full stop, overall rolling stops became slower rolling stops, Hourdos says. Researchers concluded that while the marking has some effect, most frequently it is not the predicted one—and in some cases not even the desired one.

The study provides welcome insight at local public agencies such as the City of Edina, which maintains stop lines at 700 intersections. "By no longer installing and maintaining stop lines, agencies can allocate more funding elsewhere for proven safety improvements," says Nick Baler, Edina's traffic safety coordinator.

The research was sponsored by the LRRB. ■

—Megan Tsai, CTS freelancer

INFORMATION SERVICES

THE SHELF

Minnesota LTAP partners with the MnDOT Library to operate a state-of-the-art service that can help you track down almost any resource from Minnesota or beyond. Questions? Contact Marilee Tuite, Minnesota LTAP librarian, 612-626-8753, **ctslib@umn.edu.**

Travel Impacts of a Complete Street Project in a Mixed Urban Corridor *(Mobility 21 UTC, December 2020)*
Evaluates the before-and-after travel impacts resulting from a complete street redesign project through an urban corridor in Pittsburgh, PA.

Holding Strategies for Low-Volume State Routes – Phase I *(Iowa DOT, December 2020)*
Evaluates test sections of a low-volume asphalt road segment to determine treatments that can "hold" these pavements in an acceptable condition until funding is available.

Resources, Practices, and Needs for Weather Forecasting to Facilitate Winter Road Maintenance: Synthesis Report *(Clear Roads, December 2020)*
Determines best practices that agencies use to acquire accurate and timely weather information to strategize winter road maintenance operations and examines the practices used to convey information about forecasts and road weather conditions between agency offices and operators in the field.

Development, Implementation, and Tracking of Preventative Safety Metrics *(Kentucky Transportation Center, February 2021)*
Identifies five major dimensions of an effective safety program and reiterates the value of gaining management buy-in, support, and leadership when working to eliminate incidents and injuries.

Safe Routes to Schools Research with Urban Planning Graduate Students at San José State University *(Mineta Transportation Institute, February 2021)*
Highlights the work of graduate urban planning students to conduct comprehensive assessments of street conditions surrounding five schools in San José, CA.

Asset Management, Extreme Weather, and Proxy Indicators *(Iowa State University, February 2021)*
Develops a suite of methodologies and proxy indicators to assess the risk of transportation assets to flooding.

Cold Central Plant Recycling *(National Road Research Alliance, February 2021)*
Investigates various design options for cold central-plant recycling in low-volume road applications.

A Method of Identifying Critical Road Infrastructure for Maintaining Food Accessibility *(National Center for Sustainable Transportation, UC Davis, March 2021)*
Develops a methodology to identify the roadways that are most critical to food access and uses the travel demand model for Chittenden County, Vermont, as an example.

Workforce Planning and Human Resource Development Strategies for Minnesota's Public Transportation Agencies *(MnDOT/LRRB, March 2021)*
Examines possible causes of the workforce shortage in Minnesota's transportation industry and offers recommendations.

Answers from the Margins: Participatory Planning with Disadvantaged Communities *(University of California Institute of Transportation Studies, March 2021)*
Identifies four successful engagement processes with historically marginalized communities in California by surveying transportation professionals.

Impact of Center Line Rumble Strips and Shoulder Rumble Strips on all Roadway Departure Crashes in Louisiana Two-lane Highways *(Louisiana Department of Transportation and Development, March 2021)*
Demonstrates rumble strips as a low-cost, effective crash countermeasure on two-lane highways.

Work Zone Data Management Applications and Opportunities *(Iowa DOT, March 2021)*
Develops a conceptual prototype for a tool that would facilitate self-reporting of closure details by contractors and maintenance crews.

Stream Restoration Municipal Partnership and Standards *(Pennsylvania DOT, March 2021)*
Provides guidance on how a state DOT and municipalities can work together to deliver and share MS4 sediment reduction load crediting from stream restoration.

NCHRP Research Report 963: A Pandemic Playbook for Transportation Agencies *(Transportation Research Board, April 2021)*
Summarizes effective practices currently used by transportation agencies based on interviews with state departments of transportation and transit agency leaders and operational personnel. ■

Search me

The Minnesota LTAP website features custom search engines to help you find information. You can search:

- LTAP & TTAP Centers
- State DOTs
- Transit agencies
- University transportation centers

Bookmark **mnltap.umn.edu/publications/library**.

Other great resources are:

- LRRB's site: **lrrb.org**
- MnDOT Library's catalog: **dot.state.mn.us/library** ■

Guide helps local agencies select bicycle facilities

A designer or planning official at a local agency can turn to any number of sources for direction in selecting and designing bicycle facilities. In a project sponsored by the LRRB, researchers developed a quick reference guide to help agencies select the best ones for their systems.

A supplement to the *MnDOT Bicycle Facility Design Manual*, the guide includes a detailed list of resources with web links for selection and design information. Resources include state and national bicycle facility design guides and directives on lanes, trails, and maintenance.

A detailed frequently asked questions (FAQ) section is also provided, based on survey results from city and county road agencies. A flowchart on bikeway selection illustrates the process in four stages: policy, planning, selection, and design.

The guide also summarizes survey responses and findings from 46 Minnesota cities and counties, charting the amount of experience agencies had with six types of bicycle facilities: paved shoulders, sidepaths, multi-use trails, standard bike lanes, buffered bike lanes, and contra-flow bike lanes.

Why invest in biking?
Aside from the obvious, such as less traffic congestion, pollution, and pavement damage, the guide gives other reasons:

- Communities with safe and comfortable bicycling attract tourism and new residents.
- Communities with high-quality bicycle facilities are better equipped for technological innovation, as bicycle facilities increasingly serve people using e-scooters and other new mobility devices.
- Residents of communities with low-stress bicycle facility networks experience higher quality of life.
- Children who walk or bike to school are more physically active than children who are driven or bused to school. ■

Learn more:

- *Bicycle Facility Implementation – Quick Reference Guide*: **lrrb.org/bicycle-facility-implementation**

Bike survey snippets

As part of the project, a survey on bicycle facility design and selection was sent to Minnesota cities and counties in September 2019; 46 responded.

Does your agency have a bike plan?

- Yes: 18
- No, but we are writing one right now: 5
- No, but we wish we had one: 6
- No, we have no plans to write one: 15
- Unsure: 1

Has your agency's experience with maintenance issues affected how your agency may design future bicycle facilities?

- Yes: 18
- No: 23 ■

FORTY PERCENT
of all trips in the US are
2 MILES
or less, but
TWO-THIRDS
of those trips are taken in cars.
—FHWA, 2017

Answer to test on page 8: All of them.

TRAINING

Online training

To help slow the spread of COVID-19, Minnesota LTAP has suspended all in-person activities until further notice. In the meantime, we invite you to participate in online training, webinars, and virtual events. Please see our calendar for a variety of options from MnLTAP and other agencies to meet your training needs during this time.

MnLTAP online courses

Culvert Design and Maintenance – $45
(1 RS Maintenance credit) ***LTAP***

Sign Maintenance and Management for Local Agencies – $45
(1 RS Maintenance credit) ***LTAP***

Gravel Road Maintenance and Design – $45
(1 RS Maintenance credit) ***LTAP***

Fundamentals of Construction Inspection – Free
(1 RS Maintenance credit) ***LTAP***

Other online courses eligible for RS credit

Maintenance Stormwater – Free
(0.5 RS Maintenance credit)

Math Basics for Maintenance Technicians
(1 RS Maintenance credit) – Free

Administration and Management Basics
(1 RS Leadership credit) – Free

Installation and Management of Roadside Turfgrasses – $175
(1 RS Maintenance credit)

MnLTAP webinars

Periodically, Minnesota LTAP offers live webinars on maintenance topics. Recordings are archived for later viewing.

Pavement Preservation—Longitudinal Joints – June 23, Free ***LTAP***

Snow and Ice Control Material Application (CTAP) – Free
(0.5 RS Maintenance credit) ***LTAP***

Tips to Improve Your Public Speaking – Free ***LTAP***

Gravel Roads Webinar Series (4-part series) – Free
(0.25 RS Maintenance credit per webinar) ***LTAP***

MnLTAP training videos

These include recordings from some of our in-person and virtual workshops as well as special presentations recorded by our instructors.

Current Practices for Lightly Surfaced Roads – Free ***LTAP***

Minnesota Truck-Weight Education Program: Special Products Presentation – Free

Truck-Weight Calculator Training – Free

ADA Training (3-part series) – Free

LTAP training

LTAP training is marked above with an ***LTAP***. Check the web for details and to register: mnltap.umn.edu. To be added to our mailing list, email mnltap@umn.edu or call 612-625-1813.

Roads Scholar Program

You can earn credits in Minnesota LTAP's two Roads Scholar (RS) certificate programs by completing LTAP and other cosponsored training. One certificate is focused on maintenance operations and the other on leadership and supervision. To learn more or enroll in the program, visit mnltap.umn.edu/roadsscholar. ■

Other online training resources:

- National LTAP Tailgate Talks
- AASHTO's TC3 Library
- APWA eLearning webinars and courses
- and much more!

Dealing with stress

Stress is a common occurrence many of us face every day, but we might not know how to deal with it. Today, especially, there are unknowns that can lead to stress. It is important to learn how to handle stress, because it can affect our performance and relationships at work and at home. And at work, stress can lead to distraction and cause an accident.

Stress usually occurs when there are changes in our lives and we feel that we don't have enough resources to deal with those changes and demands. Stress can occur not only from negative life experiences, but also from positive ones.

Identify your stressors

The first step to managing stress is to identify your "stressors": those things that are making you react.

Which of these do you think
CAUSE STRESS?
Getting married,
WINNING THE LOTTERY,
or having an argument?
See answer on bottom of page 7.

Stressors may be events that cause you to feel sad, frightened, anxious, or happy. You can also cause stress through your thoughts, feelings, and expectations.

A key to dealing with the big and little everyday stressors is coping with stress in a positive way.

- **Acceptance**: One way to manage stress is to accept when things are beyond your control. It may be helpful to think positive thoughts such as, "It's a learning experience."
- **Attitude**: Try to focus on the positive side of situations. Ask yourself, "What good can come out of this?" "What can I learn from this situation?" and "How can I handle this better when it comes up again?"
- **Perspective**: We often worry about things that never happen. Keep things in perspective by asking yourself "How important is this situation? Can I do anything about it? In five years, will I even remember it happened?"

Talk to your supervisor

Employee health has been linked to productivity at work, so your boss has an incentive to create a work environment that promotes employee well-being. Start by having an open conversation with your supervisor. The purpose of this isn't to lay out a list of complaints, but rather to come up with an effective plan for managing the stressors you've identified, so you can perform at your best on the job.

While some parts of the plan may be designed to help you improve your skills in areas such as time management, other elements might include identifying employer-sponsored wellness resources you can tap into, clarifying what's expected of you, getting necessary resources or support from colleagues, enriching your job to include more challenging or meaningful tasks, or making changes to your physical workspace to make it more comfortable and reduce strain. ■

(Condensed from an Everyday Safety Tailgate Talk from New York LTAP.)

Truck-Weight Education Program scheduling free on-demand sessions

The Minnesota Truck-Weight Education Program (TWEP) is currently scheduling fall, winter, and spring on-demand training for 2021–22.

This type of training is held on-site at your organization. Instructors will come to you, tailoring the training content to meet your industry needs and standards. Your organization will be responsible for providing classroom space, presentation technology, and equipment for hands-on demonstrations.

The training is free, but a minimum of 15 participants is required. To schedule a session, contact Katherine Stanley, TWEP program coordinator, at **sell0146@umn.edu**.

TWEP is also looking for local agencies to host public truck-weight training sessions for fall 2021 and spring 2022. Agencies will be responsible for providing classroom space, presentation technology, and equipment for hands-on demonstrations.

In addition, TWEP offers remote technical assistance and support. Please contact **tkweight@umn.edu** to request these services.

TWEP is funded by MnDOT and administered by CTS. ■