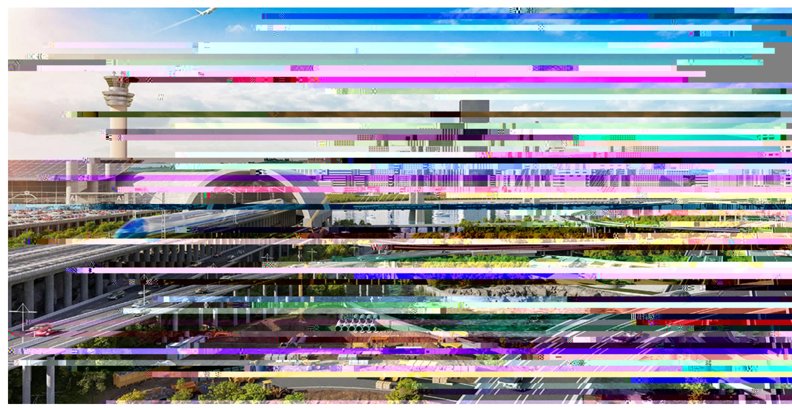
Written by: Jeff Link, Journalist

On August 4, 2020, an intense rainstorm swept through Lehigh County, Pa., unleashing more than seven inches of water in around eight hours, inundating a low, concrete-bounded section of I-78. The sudden, intense microburst — the type of unpredictable, torrential storm becoming increasingly common across the U.S. — closed the eastbound lanes for hours and backed up traff c for miles. The stormwater system beneath the highway simply couldn't keep up. The impact extended to adjacent communities, which were down until repairs could take place.



"We need to think about resiliency there, because if that event happens again and you get a 500-year or a 1,000-year [f ood] event, we need to be able to handle that," says Richard Runyen, chief bridge engineer and director of the Bridge Bureau at PennDOT's Central Off ce in Harrisburg. "We can't have Interstates shut down due to roadway or bridge damage for long periods of time."

The problem, of course, is not limited to Pennsylvania, nor to stormwater systems. The pren,

past their prime. (Governments across the globe are thinking about how these systems are going to maintain and survive in the next 100-plus years; in the U.S. alone, the government is investing $3.5 trillion in stimulus packages for "infrastructure and industries of the future — including clean energy.") Climate change is exacerbating the deterioration, causing bridge failures, "sun kinks" on railway tracks, water treatment plant disruptions, and road buckling. Extreme weather events are wreaking havoc on infrastructure and entire transportation systems.

These systems are failing partly due to their age, Runyen says. In the U.S., projects built in the 1960s and 1970s, an era some call the "golden age of infrastructure," relied on antiquated design models and construction standards. Now, many of these systems require maintenance or outright replacement. In the U.S., levees are 50 years old on average and more than 70,000 of the country's 220,000 bridges require rehabilitation or replacement.

The more challenging issue, says Louis Feagans, managing director of system performance and transportation policy at the Indiana Department of Transportation, is that in the past

50 years, the world has dramatically changed. Funding for state agencies is harder and many states are scrambling to catch up to evolving technologies and infrastructure needs. Roads, highways, and bridges were created when fossil fuels ruled and cars and trucks had much lower MPGs, and with far fewer cars, trucks carrying lighter loads, less-intense rainfall, and cooler temperatures.

There is a critical need to update infrastructure systems sustainably, accounting for the impacts of climate. "Not just to

INDOT, with a total budget of $4.3 million, has developed 12- and 20-year lifecycle strategies for pavement maintenance: Less-intensive repairs, such as crack sealing and patching, are assigned to earlier years; and more intensive work, such as asphalt overlays, occurs near the end of the timelines. Investments in bridge and culvert remediations also affordably extend the longevity of existing assets.

Feagans compares preventative maintenance protocols to routine car tune-ups: “If you don’t change the oil, rotate the tires, you’re going to have issues.”

BUILDING FOR THE FUTURE

At some point, remediation ceases to be cost-effective. Planners, hydrologists, designers, and engineers are recalibrating historic projections for extreme weather events, anticipating climate changes and more severe rainfall. Infrastructure systems will need to withstand extensive damage, preventing roadway shutdowns or loss of life. Typically, stormwater catch systems for Pennsylvania interstates are designed for 50-year flood events, but will likely need to be designed for more severe 500-year floods.

“We’re not on a nice, gentle [climate change] curve anymore; we’re really ramping up,” Runyen says. “And that’s what we have to keep in mind: Things are going to be changing exponentially.”

Resilient design strategies include selecting more durable materials, raising roads and bridges, siting roads farther from river corridors, and changing the configuration of structural elements, among others.

New methods of modeling and testing material strength are being developed. In partnership with Purdue University, INDOT is evaluating sensors that can detect concrete setting firmness. State-commissioned engineers are also testing the elasticity of pavement applications using falling weight deflectometers (FWD) to determine resilience under heavy loads.

Developing methods to curb erosion near bridge embankments, dams, and levees is another active area of research. To protect bridge-abutting roadways susceptible to washouts, PennDOT hired researchers at Lehigh University to evaluate backfill construction techniques. One approach