



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

Moving from Resilience Pilot to Broad Integration: Minnesota Department of Transportation

Minnesota Department of Transportation (MnDOT) is pursuing multiple initiatives to enhance the resilience of its transportation system, building on the knowledge gained from conducting vulnerability assessments in two districts as part of a pilot project. MnDOT is working to assess slope vulnerability statewide, incorporate resilience into asset management, and integrate risk metrics within project selection.

Key Takeaways

- Participation in the Federal Highway Administration's (FHWA's) Vulnerability Assessment and Adaptation pilot program allowed MnDOT to better understand risk and resilience.
- MnDOT is developing a statewide methodology to assess vulnerability of bridges, culverts, and pipes to flooding from increased precipitation.
- Outputs from the methodology analysis will inform prioritization of adaptation strategies.

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Resilience Context

Minnesota experiences temperature extremes, both heat and cold. In addition, the intense level of flooding that has taken place in the state during the past two decades has brought adaptation and risk reduction to the forefront for many local communities. These types of extreme weather events are contributing factors to a strong desire on the part of MnDOT to pursue resilience strategies statewide. Minnesota's transportation system also faces risks due to its age. MnDOT considers its current design standards to have more resilience built in than infrastructure built 40-100 years ago. Therefore, bringing facilities up to current standards will go a long way in enhancing the resilience of the system.

MnDOT has support for its resilience work from legislators, other state agencies, and local communities. Minnesota's recent governors have provided leadership on climate issues by setting greenhouse gas reduction goals and pushing for clean energy from its electricity providers. Additionally, MnDOT is a member of the Interagency Climate Adaptation Team, a collaborative group of state agencies working to advance strategies for climate adaptation and resilience. MnDOT has also been involved with resilience initiatives in St. Louis County, Hennepin County, and the Metropolitan Council, the state's largest metropolitan planning organization. These efforts foster a resilience community of practice within the state.

MnDOT includes an explanation of "system resiliency" in its 2017 to 2036 Statewide Multimodal Transportation Plan, the state's Long Range Transportation Plan. MnDOT's description of system resilience goes beyond extreme weather and is defined as "reducing vulnerability and ensuring redundancy and reliability to meet essential travel needs. The transportation system is vulnerable to many types of threats and risks, such as severe weather, acts of terrorism and cyber-attacks. Advanced preparation as well as mitigation and adaptation to threats and risks helps to ensure the people and goods are able to continue to travel during emergencies." The Plan also includes as part of its system stewardship objective to "increase the resiliency of the transportation system and adapt to changing needs."

Flash Flood Vulnerability and Adaptation Assessment Pilot



Figure 1. A highway in Minnesota is washed out due to flooding from a mega-rain event. Photo credit: MnDOT.

From 2013 to 2015, MnDOT participated in the FHWA’s pilot program that focused on vulnerability assessments and adaptation options. For its pilot project, MnDOT assessed the vulnerability of over 1,800 assets in two districts to flooding events from increased heavy participation—focusing on bridges, large culverts, pipes, and roads paralleling streams (Figure 1). MnDOT’s project team collaborated with key stakeholders at the agency, county, and state level to develop a set of metrics for exposure, sensitivity, and adaptive capacity for each asset type in order to understand vulnerability to flash flood risks. The team assigned weights to the metrics and grouped assets into five tiers of vulnerability.

The project team then conducted a facility-level assessment on a large vulnerable culvert from each of the two districts using the 11-step process developed by the U.S. Department of Transportation for the Gulf Coast Study, Phase 2. Both culverts served as case studies on how to conduct facility-level adaptation planning that takes into account the potential for damage and economic losses associated with flash flooding under various future precipitation scenarios.

The pilot project was an important learning opportunity for MnDOT, allowing staff to gain an understanding of the transportation system risks and vulnerabilities associated with increased extreme events. Conducting the project also brought adaptation and resilience language more to the forefront of planning conversations and revealed the need for further discussion on how to use climate data and crosswalk climate models with hydraulic design decisions. Although MnDOT’s pilot project was focused on assets in two districts, the agency has built on the lessons learned from the project to embark on efforts to assess vulnerability of slopes, integrate resilience within asset management statewide, and incorporate resilience within project scoring.

Progress Since the Pilot

MnDOT Slope Vulnerability Assessments

In March 2019, MnDOT completed the first phase of a vulnerability assessment of slopes along state highways. MnDOT had wanted to examine slopes as part of its pilot project but did not have sufficient resources to do so. The agency is now using knowledge gained from the pilot project to identify, map, and categorize slopes vulnerable to failure with the potential to affect state highways. As part of the first phase, MnDOT analyzed the risk of slope failure along state highways in 15 counties, covering parts of MnDOT’s Metro district and districts 6 and 7 in the southern part of the state.

As part of the assessment, MnDOT developed a slope vulnerability Geographic Information Systems (GIS) model applicable statewide. The model has three components: identifying past slope failures, modeling the causative factors of past slope failures and how they vary locally, and modeling the risk of new slope failures. MnDOT is considering vulnerability factors such as slope, terrain curvature, proximity to rivers, and proximity to bedrock outcrops and

examining all slope failure types. The second phase of the slope vulnerability assessment expanded the scope of the assessment to cover an additional 30 counties in southern Minnesota.

Extreme Flood Vulnerability Analysis

MnDOT is launching an effort to integrate vulnerability into its asset management systems by building upon the process used for the pilot project. The agency kicked off a three-year project in February 2019 to enhance the methodology used in the pilot in order to characterize the vulnerability of state bridges, large culverts, and pipes to flooding throughout the state (Figure 2). The resulting vulnerability scores will eventually be incorporated into MnDOT's asset management systems and inform prioritization of adaptation actions, including repair and replacement of facilities.



Figure 2. Flood waters washing out a road and bridge in District 1. Photo credit: MnDOT.

MnDOT has found the integration effort challenging due in part to the fact that the pilot project was limited to specific geographies. Additionally, MnDOT had limited time to calibrate the hydraulics tool used in the pilot project and has not conducted a comprehensive analysis to see if post-flooding events correspond with the vulnerability of the assets studied in the pilot. MnDOT plans to evaluate the vulnerability metrics used in the pilot to determine which ones to maintain in the statewide methodology and how to better incorporate cost elements into the vulnerability score. MnDOT would like to use the updated methodology to identify facilities that carry risk and are associated with specific failure mechanisms.

Updated Project Selection Procedure

In November 2018, MnDOT developed a new project selection policy based on a directive from the Minnesota legislature. The majority of MnDOT's projects are asset management projects; most projects start due to a pavement need or a bridge need and then the agency builds the project around that. As part of the new project selection process, MnDOT put in place several scoring mechanisms for its project categories. For example, for selection of pavement rehabilitation, repair, and replacement projects, MnDOT included the number of condition 3 and condition 4 pipes as part of the scoring. Condition 3 pipes are rated as "poor," meaning they are deteriorated and should be considered for repair or replacement. Condition 4 pipes are rated as "severe," meaning they have serious deterioration. This helps drive which pavement projects are done first, and since pipe replacement is included in the projects, it addresses one of the lessons from the pilot project of the importance of maintaining hydraulic infrastructure at risk of flooding due to aging and deteriorating pipes. MnDOT is also looking to integrate vulnerability metrics into its bridge planning index as part of its bridge scoring process, which is a risk score that includes elements such as scour and detour length. MnDOT leverages additional types of investments to address flood risks, such as competitive grant programs for cities or counties seeking improvements for a state highway and awards extra points if the project addresses a flood risk.

Next Steps

MnDOT has created a new position within the Office of Sustainability, held by Jeffrey Meek, focused on advancing climate resilience and adaptation within the transportation infrastructure system. Mr. Meek is embarking on an effort to develop a resilience strategy for the agency, which will consider progress to date and provide a vision for where the agency would like to go in the future. To do this, he is compiling information on past and current agency resilience initiatives and exploring resilience best practices from other DOTs and FHWA. In addition, Mr. Meek is assembling an internal advisory group for resilience, with the intent to make it as inclusive as possible.

Now that the second phase of the slope vulnerability assessment is complete, MnDOT plans to conduct additional slope assessments in the northern part of the state as part of a third phase. MnDOT envisions layering the results from the assessments into its GIS software used for scoping. MnDOT would have a geotechnical risk map to help inform scoping-level decisions. MnDOT also hopes to either incorporate the vulnerability metrics developed as part of the Extreme Flood Vulnerability Analysis into the bridge planning index or add them as a supplementary factor in project scoring.

Resources

- **MnDOT's Climate Resilience Webpage:**
<http://www.dot.state.mn.us/sustainability/climate-resilience.html>
This webpage has links to MnDOT's resilience initiatives, partnerships, and resources.
- **MnDOT's Annual Sustainability Report:**
<http://www.dot.state.mn.us/sustainability/ghg-reduction.html>
MnDOT releases a sustainability report each year which includes information on how the agency is responding to a changing climate.
- **MnDOT Project Selection Policy:**
<http://www.dot.state.mn.us/projectselection/>
MnDOT developed a project selection policy to increase the transparency and public understanding of MnDOT's project selection processes. This webpage includes the policy itself and a guide to MnDOT project selection.
- **MnDOT Flash Flood Vulnerability and Adaptation Assessment Pilot Project:**
https://www.fhwa.dot.gov/environment/sustainability/resilience/pilots/2013-2015_pilots/index.cfm
FHWA developed a case study and final report documenting MnDOT's pilot project focused on conducting a vulnerability assessment of bridges, culverts, pipes, and roads paralleling streams. MnDOT assessed vulnerability to flooding related to increased heavy precipitation in two districts.

Transportation Resilience and Durability Case Study Series

The Federal Highway Administration is developing a series of case studies exploring resilience and durability efforts at transportation agencies across the United States. The case studies are developed through in-depth interviews with a geographically diverse range of transportation agencies. These case studies explore how resilience and durability factor into various phases of transportation decision-making, the scales and types of resilience and/or durability projects at the agencies, and the types of resilience addressed.