Michigan Department of Transportation
RESEARCH Administration

RESEARCH SPOTLIGHT

Project Information

REPORT NAME: Infrastructure Protection and Rehabilitation Response to High Lake Levels

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Tools to protect coastal roadways from high water

Understanding how Great Lakes water level trends are changing will help the Michigan Department of Transportation (MDOT) protect coastal roadways from flooding and erosion damage. Research and analysis of several sites around the state at risk for high water damage have produced a tool to inform agency decision-making on preventive mitigation measures. Identifying hazards, predicting potential damage and estimating costs and benefits of taking action will allow MDOT to prioritize future infrastructure investments.

PROBLEM

Great Lakes water levels are naturally variable. High water near roads may cause flooding, backed-up drainage systems or erosion that requires mitigation measures. As seasonal variations have been relatively predictable over the years, MDOT has successfully managed impacts on roadways near lakes and tributaries.

Dyke Road through St. John's Marsh is a key thoroughfare that becomes nearly impassable during high water and wind conditions. Potential mitigation measures include raising the road and building a raised causeway.

In 2019 and 2020, however, water levels in the Great Lakes rose higher than in the past three decades. While MDOT was able to address impacts to coastal roadways with minimal loss of service, the agency recognized the increasing need for preparedness. Representatives from each region formed a High Water Team to discuss historical high water periods and regional responses. The team noted that institutional knowledge of how these threats have been addressed in the past is limited.

MDOT needed a greater understanding of lake water level cycles and changing trends. Wanting proactive, long-term solutions to roadway infrastructure threats, the agency sought to identify at-risk areas and potential mitigation options in order to develop well-informed plans and prioritize infrastructure protection strategies.

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"This project was very successful in giving MDOT a planning and forecasting tool to be proactive in our management of roadways at risk of high water damage."

Hal Zweng, P.E.
Project Manager

RESEARCH

Leveraging the work of the High Water Team, researchers undertook a multifaceted research and planning project to assess risk and propose mitigation alternatives for MDOT's coastal roadways. The team first reviewed research and other literature on water level trends and predictions, adaptation options for transportation infrastructure, benefit-cost analysis approaches, and other topics. Team members then conducted interviews of regional staff across the state to understand past impacts of high water on roadways, and the different measures each region implemented in response.

After reviewing details of approximately 50 sites impacted during the 2019-2020 season, including localized risks, previous mitigation attempts and estimated costs, researchers prioritized five sites for in-depth analyses. The locations represent a range of water hazards and characteristics that are seen across the state. Two of these sites, located in the Bay and North regions, are at increased risk of flooding. The three sites in the Grand, Southwest and North regions have high erosion potential, as the coastal bluffs or dunes that stabilize each road are at risk of deteriorating.

An extensive analysis of each site included additional interviews with regional MDOT staff familiar with the locations, reviews of drawings and studies, site visits, and documentation through aerial imagery. The team also undertook engineering assessments of the risks and mitigation potentials.

Next, a benefit-cost analysis for each site highlighted possible solutions. Assuming a 10-year planning period, researchers estimated the costs of various temporary and permanent measures and compared these with the future costs of damages and travel-time lost if no action were taken. The team also compared the costs of capital investments for permanent solutions against the costs of temporary mitigation measures.

Finally, the team developed a scoring system and decision spreadsheet tool to help MDOT prioritize its mitigation efforts. Considering a location's particular characteristics, factors include the type and degree of hazard threat, traffic volume supported, detour options available, and other metrics. The decision tool can be enhanced as needed to account for changing costs and other variables and will support communicating trade-offs in prioritizing future capital improvements.

RESULTS

The researchers' comprehensive analyses produced a number of findings.

Both flood-prone sites saw multiple periods of flooding over the past 50 years. While the number of flooding events was higher at one site, losses would be greater at the other due to more use. Researchers suggested raising the roadways as a permanent solution, which would be more cost-effective than just one temporary installation of sandbags or taking no action.

The three locations at risk of erosion pose an additional challenge due to the many variables that may impact the potential for erosion. Recommendations for some sites include regularly replenishing sand at beaches, building structures to protect the shoreline or relocating the roadway, though researchers also identified the need for further hydraulic, hydrologic and geotechnical study.

Lastly, the research team applied the new scoring system to 53 sites across the state, giving MDOT greater insight into where its mitigation investments would be most impactful.

IMPLEMENTATION

With new tools and a better understanding of the potential threats to the state's infrastructure, MDOT will have greater decision-making power when it comes to reducing the impacts of high water along Michigan's coastal roadways.

Research Administration

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