DEPARTMENT OF TRANSPORTATION

RESILIENCE IMPROVEMENT PLAN 2024

APRIL 2024

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EXECUTIVE SUMMARY

Minnesota's climate is changing. How states react to this change is an evolving process. The Minnesota Department of Transportation (MnDOT) assessed potential changes in climatic conditions, potential transportation impacts from those changes and potential consequences for the system and for users. The Minnesota Resilience Improvement Plan (RIP) provides opportunities to make our transportation system more resilient to climate change using regional approaches to mitigate risk.

The RIP is Minnesota's first statewide plan focused on building climate resiliency into the transportation system. Minnesota is expected to receive approximately $121 million over five years from the Promoting Resilient Operations for Transformative, Efficient Cost-Saving Transportation (PROTECT) Formula Program. By submitting the RIP to the Federal Highways Administration (FHWA), MnDOT and partners can receive a greater federal cost share for the PROTECT-funded projects listed in the appendix. The RIP is a voluntary plan and a resource for MnDOT and partners. It does not establish requirements for cities and counties for PROTECT funded projects.

The top climate hazard in Minnesota is heavy precipitation and flooding. Other key hazards include extreme temperatures, freeze-thaw changes, abnormal winter weather, landslides, wildfire and coastal erosion.

MnDOT analyzed historic data and future projections for each of the climate hazards and assessed the potential impacts and consequences of the hazards for the transportation system. Statewide maps summarizing the analysis are available in the plan as well as in an online interactive map. MnDOT Climate Resilience webpage. The analysis results are not intended to be used as a definitive or authoritative source. Rather, designers and engineers can combine the analysis results with other site-specific data, like asset condition information, to inform project selection or design.

The RIP identifies three types of strategies that MnDOT and partners can use to advance climate resilience:

- Climate Resilience Projects: Projects will be hazard and site specific, but examples are included in the report.
- Policy and Procedure Updates to Advance Climate Resilience: MnDOT will review and revise design guidance to include climate projections.
- Communication and Education Efforts: This includes corridor planning and regional vulnerability assessments, trainings and additional communication to staff and project partners.

MnDOT and partners can use the RIP to inform additional research, asset management planning, project scoping, project design and project selection. It provides categories of project selection criteria for resilience projects, including projects that receive PROTECT formula funds. The selection criteria include: project readiness, resilience costs and benefits, potential climate hazard impacts, asset vulnerability, past history and co-benefits.

MnDOT will assess plan implementation using performance measures including adaptation/natural environment, asset condition and vulnerability, and climate/extreme weather impacts.

Finally, MnDOT will update the project list in the RIP twice annually, with a comprehensive update planned for 2026 to align with the update cycle for the Statewide Multimodal Transportation Plan.

CHAPTER 1

WHAT ARE WE TRYING TO ACHIEVE?

- Minnesota's climate is changing, affecting the health and economy of our communities. Building resiliency within the transportation sector can help communities prepare for Minnesota's changing climate and support public health and safety and Minnesota's economy.
- The federal Promoting Resilient Operations for Transformative, Efficient Cost-Saving Transportation (PROTECT) program provides a voluntary opportunity for states to develop and submit a Resilience Improvement Plan (RIP) to the Federal Highways Administration (FHWA). When a state or MPO submits this voluntary plan and includes a prioritized list of projects to receive PROTECT funds, the non-federal share of the costs of a project carried out with PROTECT funds shall be reduced by 7%.
- The RIP describes climate hazards that may impact transportation infrastructure and communities. It also identifies strategies that MnDOT and partners can implement to anticipate, prepare for and adapt to Minnesota's changing climate. It is a 20 year plan that serves as a companion document to others in the MnDOT Family of Plans

CLIMATE CHANGE IN MINNESOTA

Minnesota's climate is changing, affecting the health and economy of our communities. The state is on course for more frequent, widespread and intense weather events with the potential to damage homes, businesses, infrastructure, farms and natural resources. Record-breaking floods, like those in Duluth in 2012 and Faribault in 2010 and 2016, can damage streets, wastewater facilities, businesses, and homes, costing local governments, business owners and residents millions of dollars in cleanup and repairs.

The Fifth National Climate Assessment noted, "Climate change is affecting the quality and quantity of water in the Midwest, as well as management practices related to the health of human and natural systems." The report goes on to state, "Observed changes in hydrology include increases in the variability of lake levels, evaporation and water temperatures, along with more intense precipitation, including lake-effect snow and shorter duration of snow and ice cover." Increases in extreme rainfall events negatively impact property, public health and safety and transportation systems. Urban and rural communities are at risk from projected increases in frequency and intensity of extreme rainfall events. Minnesota is among other Midwest states at high risk for increased riverine flood damage. (USGCRP, 2023)

Wildfires in Canada and the western U.S., brought on by changing conditions, have caused unhealthy air quality in our state. Minnesota lakes lost an average of 10 to 14 days of ice cover in the past 50 years, affecting lake and fish health, outdoor recreation opportunities and business owners. Climate change effects harm wildlife habitat, northern tree species and cultural resources like Minnesota's state grain: wild rice (manoomin, psíŋ). In addition, more floods, longer allergy seasons, warmer temperatures and expanded tick ranges threaten our health and wellbeing.

CLIMATE CHANGE AND THE TRANSPORTATION SYSTEM

Building resiliency within the transportation sector can help communities prepare for Minnesota's changing climate and support public health and safety and Minnesota's economy.

INFRASTRUCTURE

The state has a vast transportation system that includes roads, railroads, airports, ports, waterways, pipelines, transit systems, trails, bikeways and walkways. Minnesota has the fourth largest system of streets, roads and highways in the country. The network is made up of 142,8651 centerline miles of public roadways across state, county, city and township systems. When natural hazards – like heavy rain, extreme temperatures and landslides – damage transportation infrastructure, MnDOT and partners must respond to the damage, manage the disruption and repair or replace damaged infrastructure. Sometimes federal funds are available to assist with these activities, but often MnDOT and other transportation agencies must use funds from their budgets to cover unexpected costs. MnDOT and partners can reduce the costs of responding to natural hazards by proactively investing in resilient infrastructure.

PUBLIC HEALTH & SAFETY

The transportation system is a vital part of keeping Minnesotans connected to family, jobs, healthcare, schools, places of worship, shopping, recreation and entertainment. MnDOT and transportation partners strive to provide connections that prioritize people's movement and quality of life. Extreme weather can contribute to conditions that cause fatal crashes and serious injuries, a public health concern identified by the U.S. Surgeon General. In the summer, wildfires can cause poor air quality, making it unhealthy for people to walk, bike, use transit or be outside. Exposure to extreme high and low temperatures and stronger weather events such as blizzards or heavy rain can increase health and safety risks and contribute to system delays. The transportation system is also critical for police, fire and medical services to communities during extreme weather events and plays an integral role in disaster recovery. Furthermore, natural hazards pose risks for MnDOT staff who work in the field. Extreme weather challenges can make it difficult for workers to maintain the transportation system.

ECONOMY

Minnesota's transportation system is designed to support economic development and provide for the economical, efficient and safe movement of people and goods. Businesses need predictable and reliable access to suppliers and customers. People need access to jobs, school, food, childcare, health services and other destinations no matter where they live. When natural hazards disrupt the transportation system, people and goods experience delays and detours. These disruptions can create economic costs.

Flooding along the Minnesota River illustrates the economic impacts of disruptions to the transportation system. River crossings were closed due to flooding six times between spring 1993 and spring 2011 with closure times varying from several days to several weeks. The MnDOT Minnesota River Flood Mitigation Study found that when Highways 101 and 41 were closed, the value of the additional time and miles traveled was $670,000 per day in the year 2009 and was forecasted to be $1,675,000 per day in the year 2030.

RESILIENCE IMPROVEMENT PLAN

The Infrastructure Investment and Jobs Act (IIJA) adopted in November 2021 created the Promoting Resilient Operations for Transformative, Efficient Cost-Saving Transportation (PROTECT) Formula Program to make surface transportation more resilient to natural hazards, including climate change, sea level rise, flooding, extreme weather events other natural disasters through support of planning activities, resilience improvements, community resilience and evacuation routes, and at-risk coastal infrastructure. Planning activities and resilience improvements are intuitively named funding categories. Additional research was needed to give context to the other two funding categories:

- The shorelines of Lake Superior are considered coastline of the United States and transportation infrastructure along Minnesota's North Shore are potentially eligible for PROTECT funding;
- Many states and communities have marked evacuation routes (e.g. for tsunamis) and/or highways designed to evacuate significant populations (e.g. from hurricanes) to ensure communities are resilient and can bounce back from a natural hazard. The Minnesota State Hazard Mitigation Plan lacks any evacuation routes because a safer response for the vast majority of Minnesota's climate hazards is to shelter in a safe place.

Minnesota will receive approximately $121 million over five years from the PROTECT Formula Program. Minnesota may also apply for grant funding from the national PROTECT Discretionary Program, which includes up to $848 million to make transportation infrastructure and service more resilient to climate change and extreme weather events. The PROTECT program provides a voluntary opportunity for states or Metropolitan Planning Organizations (MPOs) to develop and submit a Resilience Improvement Plan (RIP) to the Federal Highways Administration (FHWA). When a state or MPO submits this voluntary plan and includes a prioritized list of projects to receive PROTECT funds, the non-Federal share of the costs of a project carried out with PROTECT funds shall be reduced by 7%. An additional 3% reduction can be achieved by incorporating the complete RIP into a state's long-range statewide transportation plan or in the case of a MPO, their metropolitan transportation plan.

The RIP is Minnesota's first statewide plan focused on building climate resiliency into the transportation system. It creates the framework for broad collaboration and action to prepare for and recover from climate impacts. The RIP describes climate hazards that may impact transportation infrastructure and communities. It also identifies strategies that MnDOT and partners can implement to anticipate, prepare for and adapt to Minnesota's changing climate. It is a 20 year plan that serves as a companion document to others in the MnDOT Family of Plans, although it does provide some late century climate projections to put key hazards in context.

Federal requirements state that a RIP must:

- Be for the immediate and long-range planning activities and investments of the State with respect to transportation system resilience.
- Demonstrate a systemic approach to transportation system resilience and be consistent with and complementary of the State and local mitigation plans.
- Consider transportation system risks, ideally across modes, geographic regions and critical interdependent sectors.
- Include a risk-based assessment of vulnerabilities of transportation assets and systems to current and future weather events and natural disasters. This assessment should consider the probability or likelihood that transportation infrastructure will experience potential current and future weather events, natural disasters and the consequences of those events.
- Address the full range of current and future weather events and natural disasters relevant to the transportation assets and system(s) addressed.

Additional requirements for a RIP, where appropriate include:

- Describing how the plan will improve the ability of the State or metropolitan planning organization to respond promptly to the impacts of weather events and natural disasters; and to be prepared for changing conditions, such as increased flood risk;
- describe the codes, standards, and regulatory framework, if any, adopted and enforced to ensure resilience improvements within the impacted area of proposed projects included in the RIP;
- consider the benefits of combining natural infrastructure and hard surface transportation assets;
- assess the resilience of other community assets, including buildings and housing, emergency management assets, and energy, water, and communication infrastructure;
- use a long-term planning period; and
- include such other information as the State or metropolitan planning organization considers appropriate.

The RIP builds on the Minnesota Statewide Hazard Mitigation Plan, Minnesota Climate Action Framework, Statewide Multimodal Transportation Plan and Minnesota Transportation Asset Management Plan. These resources identify key strategies and actions to advance climate resilience and risk management for the transportation system in Minnesota. The RIP identifies a set of priority strategies for investment and implementation. MnDOT and partners will use the RIP as a guide to plan, select, fund and implement projects across state and federal funding sources in Minnesota.

There is a level of uncertainty when it comes to anticipating future changes in Minnesota's climate. The RIP reflects the best available data that Minnesota has. Moving forward, the RIP will be updated twice annually to add and refresh project lists. In 2026 MnDOT will comprehensively update the RIP to align with the update cycle for the Statewide Multimodal Transportation Plan and to incorporate new climate information and emerging resilience best practices

A naturalized, riprapped embankment between a trout stream and TH52 north of Chatfield, MN

CHAPTER 2

WHAT GUIDES THE RESILIENCE IMPROVEMENT PLAN?

- Statewide plans like the Minnesota State Hazard Mitigation Plan (SMHMP), Minnesota Climate Action Framework (CAF) and Statewide Multimodal Transportation Plan (SMTP) capture Minnesota's commitments to climate resilience.
- The SMHMP profiles and ranks natural and human-caused hazards affecting Minnesota based on their potential frequency, economic impact and deaths and injuries. It lists flooding as the number one natural hazard in Minnesota.
- The MnDOT Transportation Asset Management Plan (TAMP) guides MnDOT's approach to managing transportation infrastructure.
- MnDOT climate resilience research, like the Extreme Flood Vulnerability Analysis, informed the RIP.
- MnDOT also conducted public and stakeholder engagement to guide the RIP. Engagement efforts included 3 advisory groups, 10 virtual engagement opportunities, and a website. MnDOT used input from the engagement activities to identify the key climate hazards and refine the strategies in the RIP.

STATEWIDE PLANS

Communities in Minnesota need resources and support to plan for and implement projects to build a more resilient future for themselves. Minnesota is committed to building resiliency into the transportation system to help communities adapt to climate change. State agency representatives and partners coordinate to understand key hazards, vulnerabilities risks and take action to address needs. Statewide plans like the Minnesota State Hazard Mitigation Plan, Minnesota Climate Action Framework and Statewide Multimodal Transportation Plan capture Minnesota's commitments to climate resilience.

MINNESOTA STATEWIDE HAZARD MITIGATION PLAN (2019)

The State of Minnesota Hazard Mitigation Plan (SMHMP) profiles and ranks natural and human-caused hazards affecting Minnesota based on their potential frequency, economic impact and deaths and injuries. This information is provided on a county level. The SMHMP identifies goals and recommended actions that state agencies can take to reduce risks. The most recent plan updated included climate change considerations, risk analysis of state-owned critical facilities and updated flood hazard analysis.

The SMHMP identifies 10 natural hazards in Minnesota that are highly likely to occur. The SMHMP describes history, probabilities, vulnerabilities and climate change impacts for each hazard:

- Flooding (Top natural hazard)
- Wildfire
- Windstorms
- Tornadoes
- Hail
- Extreme heat
- Drought
- Lightning
- Winter storms
- Extreme cold

The SMHMP also includes mitigation, climate adaptation and resilience strategies and actions:

Mitigation, climate adaptation and resilience strategy types include:

- Data
- Local Planning and Regulations
- Structure and Infrastructure Projects
- Natural Systems Protection
- Education and Awareness Programs
- Mitigation Preparedness and Response Support

Mitigation, climate adaptation and resilience recommended actions include:

- Build greater resilience to extreme precipitation
- Identify opportunities to strengthen the climate resilience and health of vulnerable populations of Minnesotans across state agency programs and through cooperation with local governments
- Increase focus on preserving natural and restored terrestrial and aquatic ecosystems and habitat to increase resilience of wildlife and native plants
- Strengthen agricultural water management efforts to increase resilience to climate change impacts
- Increase focus on managing climate impacts in cities, towns and other population centers
- Strengthen our climate information infrastructure to support climate adaptation practices

MnDOT contributes to the SMHMP during the planning process, provides input on the statewide mitigation strategy and makes sure the agency's concerns are included. Transportation incidents are covered in section 6.7 of the SMHMP. If mitigation funding is available, the agency will apply for eligible funding to bring facilities to current standards, which are more resilient to weather events.

Many of the mitigation and climate adaptation actions in the current plan focus on incorporating resiliency into our normal agency processes. This will decrease the impact of natural disasters and allow the agency to include resilient solutions in our proposed projects under FHWA Emergency Reimbursement.

MINNESOTA CLIMATE ACTION FRAMEWORK (2022)

The Minnesota Climate Action Framework sets a vision for how Minnesota will address and prepare for climate change. Developed by the Climate Change Subcabinet and Advisory Council on Climate Change, it identifies immediate, near-term actions state agencies need to take in partnership with tribal nations, cities, counties and communities to achieve the long-term vision of a carbon-neutral, resilient and equitable Minnesota. Many of the action steps outlined in the framework are integrated into existing MnDOT plans such as the Statewide Multimodal Transportation Plan (SMTP). The Framework includes a "Resilient Communities" Goal with seven priority actions designed to provide communities in Minnesota with tools to plan for and become more resilient to climate change impacts:

1. Provide more resources for adaptation: Expand funding, staff capacity, technical support and training for planning and implementation of adaptation and resilience projects.
2. Increase capacity of the GreenStep Cities program: Share resilience best practices and adaptation resources and expand pilot programs that include tribal nations, schools, counties and townships.
3. Plant climate-ready trees and preserve mature trees: Climate-ready tree species are well-adapted to challenges such as heat, drought, extreme weather and pests. Along with mature trees, they decrease energy use in homes and buildings and mitigate heat islands. They should be used to replace diseased trees.
4. Expand green infrastructure and stormwater management: control flooding, restore lost habitat and improve water quality.
5. Adopt resilient building policies: Adopt provisions in construction and remodeling codes that prioritize adaptive reuse and create resilient design standards.
6. Assess vulnerabilities at critical facilities: Use climate projections to predict future hazards and make plans to ensure continuity of operation.
7. Combat heat islands: Provide funding and technical assistance to help communities reduce their urban heat island effect.

The Framework includes three measures of progress related to Resilient Communities:

1. By 2026, at least 25 adaption projects that increase community resiliency are fully funded.
2. By 2030, 100% of Minnesotans live in communities with plans that identify climate risks and actions to build resiliency.
3. Achieve 30% overall tree canopy in Minnesota communities by 2030 and 40% by 2050.

The Framework also highlights opportunities to make an equitable transition to a more resilient Minnesota by:

- Prioritizing engaging front line communities to identify climate risks and actions to mitigate risks.
- Funding resiliency planning and infrastructure improvements in communities that have been historically under invested in.
- Prioritizing clean-up strategies and climate adaptation investments in neighborhoods with fewer resources and that are disproportionately affected by unhealthy water, soil and air.

STATEWIDE MULTIMODAL TRANSPORTATION PLAN (2022)

As the highest policy plan for transportation in Minnesota, the Statewide Multimodal Transportation Plan (SMTP) provides objectives, performance measures, strategies and actions for Minnesota's transportation system over the next 20 years. Many strategies and actions identified in the SMTP relate to and have implications for the RIP.

The Climate Action objective includes two resilience related strategies:

- Protect people and communities through regional approaches to mitigate risk from the changing climate and extreme weather.
  - Integrate climate change considerations into transportation decision making and evaluate opportunities to mitigate risks.
  - Develop corridor and regional vulnerability assessments.
  - Coordinate with agencies on stormwater management within and on adjacent lands to the transportation system.
- Increase resiliency of people and communities by adapting infrastructure to withstand the changing climate.
  - Adapt design and maintenance practices to increase the resiliency of the transportation system.
  - Coordinate with partners to identify and implement transportation right-of-way uses that reduce threats to people from exposure to extreme weather and temperatures.
  - Use economic, disaster and public health recovery efforts to rebuild in a way that is more resilient.
  - Leverage data to inform investment and project development decisions and identify new approaches to climate adaptation.
  - Prioritize infrastructure resiliency along critical freight corridors to ensure safe and efficient delivery of goods during adverse conditions.

The SMTP also includes transportation safety strategies that focus on ensuring the safety of more vulnerable people, especially those walking, rolling, bicycling and taking transit. These strategies also address infrastructure modifications to accommodate all modes of transportation using complete streets, context sensitive and Safe System approaches. Strategies that support safety can also advance climate resilience.

The 20-Year Minnesota State Highway Investment Plan (MnSHIP) links the policies and strategies laid out in the Statewide Multimodal Transportation Plan to improvements on the state highway system. MnSHIP includes a focus on beginning to adapt to a changing future.

MNDOT TRANSPORTATION ASSET MANAGEMENT PLAN (2022)

The MnDOT Transportation Asset Management Plan (TAMP) guides MnDOT's approach to managing transportation infrastructure. In addition to being a federal requirement, the TAMP helps MnDOT further evaluate risks, develop mitigation strategies, analyze life cycle planning, establish asset condition performance measures and targets and develop investment strategies. The TAMP covers twelve MnDOT-owned asset classes: pavements, bridges, culverts, deep storm water tunnels, overhead sign structures, high-mast light tower structures, noise walls, signals, lighting, pedestrian infrastructure, buildings and intelligent transportation systems.

In the TAMP, extreme weather and asset resilience are considered for each asset class. Where applicable, the TAMP includes mitigation strategies to manage risks for each asset class. For example, a risk to pavement is "significant damage to the asset through man-made or natural events." The corresponding mitigation strategies are:

- Identify potential needs in scoping (climate models, slope vulnerability analysis, emergency response history, etc.).
- Identify a separate pot of money that may be used to address reactive needs.

- Better study these events and learn more about how to mitigate them.
- Study more resilient designs.

The RIP builds on a strong foundation of existing plans, including the Minnesota Statewide Hazard Mitigation Plan, Minnesota Climate Action Framework, Statewide Multimodal Transportation Plan and Minnesota Transportation Asset Management Plan. These resources identify key strategies and actions to advance climate resilience and risk management for the transportation system in Minnesota.

RELATED RESEARCH

MnDOT Climate Resilience Research

To support the state and contribute to best practices around the country, MnDOT has or will be conducting several climate and resilience research projects. Research topics include:

- Extreme flooding and slope vulnerability analyses and adaptation assessments
- Climate change and changes needed to hydraulic design of transportation infrastructure
- Climate change and adaptation of urban stormwater infrastructure
- Climate change and impacts to freeze thaw cycles
- Mitigating the effects of climate change on pedestrians

A list and copies of reports are available on the MnDOT climate and resilience research webpage.

Regional Transportation Resilience Research

In addition to MnDOT's statewide research, some Metropolitan Planning Organizations and Regional Development Commissions conducted regional climate resilience studies. For example, the Metropolitan Council completed a Regional Climate Vulnerability Assessment to evaluate correlations between heat, vegetation and the built environment and to screen regional assets for potential flood risk and subsequent vulnerability. The CVA includes a Human Vulnerability Report that used spatial analysis to examine specific human vulnerability indicators in relation to place-based climate hazards of extreme heat and localized flooding. The Region Nine Development Commission developed a Climate Change Vulnerability Assessment and Adaptation Plan to assess South Central Minnesota's vulnerability to climate change and create strategies for the region to adapt to climate change.

STAKEHOLDER AND PUBLIC ENGAGEMENT

In addition to state plans and prior research, stakeholder and public engagement informed the RIP. Engagement activities were designed to collect input from MnDOT staff, partners and the public.

PARTNER ENGAGEMENT

MnDOT engaged staff and external partners through several advisory groups and external meetings to guide the development of the RIP.

MnDOT RIP Project Management Team (PMT)

The PMT met in September 2023 to provide input on the development of the RIP. PMT members included representatives from the Minnesota Pollution Control Agency, Hennepin County, Polk County and MnDOT staff from the Office of Asset Management, Office of Environmental Stewardship, Office of Maintenance, Bridge Office and District 3. The PMT helped identify types of assets and climate hazards to include in the vulnerability assessment.

PROTECT Subgroup

MnDOT created the Climate and Resilience Workgroup (CRW) in response to the three new transformative federal climate and resilience programs established in the IIJA (NEVI Formula Program, Carbon Reduction Program and PROTECT). The CRW provides recommendations to

MnDOT leadership and convened the PROTECT Subgroup to guide the RIP development process. PROTECT Subgroup members include representatives from the Minnesota Pollution Control Agency, Department of Natural Resource, Department of Public Safety, cities and counties, Regional Development Organizations and University of Minnesota, as well as MnDOT staff. The group met 6 times between June 2023 and February 2024 to provide input on the vulnerability assessment and the strategies in the RIP to advance climate resilience.

MnDOT Resilience Advisory Team

MnDOT created the Resilience Advisory Team in 2019 to bring together agency staff to guide climate resilience work. The Resilience Advisory Team includes representatives from the MnDOT Bridge Office, Office of Environmental Stewardship, Office of Maintenance, Asset Management Office, Emergency Management, District 6 and Office of Sustainability and Public Health. The team met approximately monthly between June 2023 and February 2024 to guide development of the RIP.

Climate Expert Virtual Workshop

MnDOT held a virtual engagement session in August 2023 to collect input from experts on climate hazards in Minnesota and the upper Midwest. Climate specialists from the National Oceanic Atmospheric Administration (NOAA), the Minnesota State Climatology Office, the University of Minnesota Climate Adaptation Partnership, the Great Lakes Integrated Sciences and Assessments (GLISA), the Minnesota Association of Floodplain Managers, the Midwestern Regional Climate Center at Purdue University and the National Drought Mitigation Center at the University of Nebraska attended. MnDOT used the input to select the climate hazards included in the vulnerability assessment.

Virtual Transportation Partner Forums

MnDOT hosted a virtual engagement session in September 2023 to collect input from transportation partners and organizations with an interest in climate resilience. The meeting included representatives from the Minnesota Farmers Union, the City of Mankato, Carver County, Hennepin County, St. Louis County, Scott County, Stearns County, Washington County, Arrowhead Regional Development Commission, Met Council, Region Five, St. Cloud APO and West Central Initiative. The group vetted the climate hazards identified by the climate specialists, offered examples of how extreme weather impacted the transportation systems in their jurisdictions, identified barriers to increasing resilience and provided actions MnDOT could take to address the barriers.

MnDOT also led 8 virtual engagement sessions in February and March 2024 to collect input from Area Transportation Partnership members and representatives from watershed boards. The sessions were designed to gather feedback on the draft strategies in the RIP. MnDOT adjusted the strategies based on feedback gathered during the engagement sessions.

PUBLIC ENGAGEMENT

Resilience Improvement Plan website

The project website was hosted on MnDOT's Let's Talk Transportation platform at https://talk.dot.state.mn.us/resilience-improvement-plan. The website went live in July 2023 and included information about the RIP, an email list sign-up to stay informed, an online forum and a link to read more information about the PROTECT Program in Minnesota. The website received 587 views and no questions or comments on the online forum.

CHAPTER 3

HOW WILL MINNESOTA'S CHANGING CLIMATE IMPACT TRANSPORTATION INFRASTRUCTURE AND COMMUNITIES?

- MnDOT conducted a vulnerability assessment to understand risks to Minnesota's transportation system based on current and future weather events and natural disasters.
- The climate hazards analyzed and presented in the assessment include: heavy precipitation and flooding, extreme temperatures, freeze-thaw changes, abnormal winter weather, landslides, wildfire and coastal erosion.
- MnDOT analyzed historic data and future climate projections for each of the climate hazards and assessed the potential exposure of Minnesota transportation system assets to the hazards over time.
- Heavy precipitation and flooding presents a near term risk to transportation assets in Minnesota, while other climate hazards may not have significant impacts until mid or late century.
- With a better understanding of Minnesota's current and projected climate hazards, MnDOT combined information about asset-level climate hazard exposure with potential traveler impacts to create a comprehensive risk score for transportation system assets.
- Most roads, bridges and large culverts and slopes have a low climate risk score. Some bridges and large culverts along Lake Superior, in the Twin Cities metro area and in southeast Minnesota have high climate risk scores because of potential exposure to heavy precipitation and proximity to the 100 year flood plain. It's important to note that the climate risk score did not take into account hydraulic capacity. The climate risk scores for slopes are highest in northeast and southeast Minnesota and parts of the Twin Cities metro area.

ASSESSMENT PROCESS

MnDOT conducted a vulnerability assessment of the state and local transportation network to understand risks to Minnesota's transportation system based on current and future weather events and natural disasters. The assessment serves as a starting point for understanding relative potential risks to the transportation system from key climate hazards over time. It is not intended to be used as the single, authoritative source for investment decisions, project scoping or design.

STATEWIDE TRANSPORTATION ASSETS

The assessment included assets on the State Highway System, Federal Aid System and local transportation networks. MnDOT assessed the potential impacts of climate hazards on a variety of assets. Each climate hazard section within this plan provides details about the types of assets that are most likely to be impacted and maps showing the potential transportation system impacts. The complete assessment with information about local system impacts is available as an interactive map at MnDOT Climate Resilience webpage.

CLIMATE HAZARDS

A hazard is something that is potentially dangerous or harmful. As climate changes over time, it presents a range of climate hazards to infrastructure, public health, safety, natural systems, the economy and other assets and systems that Minnesota relies on. MnDOT met with climate scientists, internal subject matter experts and external partners to review the list of key hazards from the 2019 SMHMP and refine it based on the climate hazards expected to have the greatest impact on the transportation system in Minnesota.

The climate hazards analyzed and presented in this assessment are:

- Heavy precipitation and flooding
- Extreme temperatures
- Freeze-thaw changes
- Abnormal winter weather
- Landslides
- Wildfire (Data limitations prevented a future projections analysis)
- Coastal erosion (Data limitations prevented a future projections analysis)

MnDOT analyzed historic data and future projections for each of the climate hazards and assessed the potential exposure of Minnesota transportation system assets to the hazards over time. For example, the assessment suggests that roads in the southern part of the state could be impacted by increased extreme temperatures by late century. Extreme heat will be more likely in this region, affecting both staff and contractors as well as potentially bridge expansion issues and binder grades.

GLOBAL CLIMATE MODELS

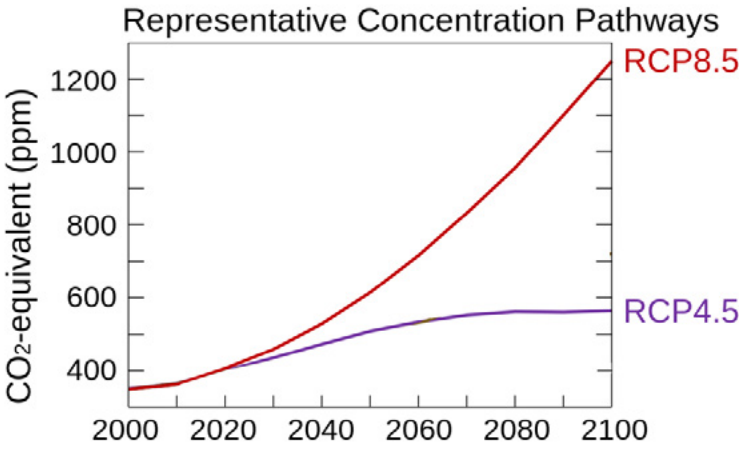
The vulnerability assessment incorporates global climate data compiled by the Intergovernmental Panel on Climate Change (IPCC). Climate modeling data helps estimate the Earth's natural response to the increasing percentage of greenhouse gasses in the atmosphere. Research institutions represent these physical processes through Global Climate Models (GCMs). MnDOT used two models, the fifth and sixth Coupled Model Intercomparison Project (CMIP5 and CMIP6) to analyze Minnesota's potential climate hazard exposure.

Appendix B outlines how CMIP6 data was used for all temperature-focused analyses and CMIP5 was used for most precipitation analyses to align these projections with projections used in an ongoing Extreme Flood Vulnerability Assessment (EFVA). To enhance spatial resolution of GCMs, a statistically downscaled method, Locally Constructed Analogues (LOCA), was used to analyze the potential exposure to each climate hazard.

REPRESENTATIVE CONCENTRATION PATHWAYS

The IPCC represents future emissions conditions through a set of representative concentration pathways (RCPs) that reflect scenarios for greenhouse gas emission concentrations under varying global economic forces and government policies. MnDOT used two scenarios for the assessment:

- Low Emissions Scenario: RCP 4.5, which assumes that emissions will peak near mid-century.
- High Emissions Scenario: RCP 8.5, which assumes that high emission trends continue to the end of century.



Representative Concentration Pathways used for assessing projected vulnerabilities

TIME FRAMES

MnDOT compared the potential exposure to the climate hazards across time periods. This helps identify near-term and long-term vulnerabilities. For this study, the time frames were defined as the past, middle and end of century. Each of these time frames represents an averaged 30-year period of 2040 to 2069 and 2070 to 2099 compared to a historical time period of 1985 to 2014.

CLIMATE HAZARDS

HEAVY PRECIPITATION AND FLOODING

The Minnesota State Climatology Office found that Minnesota is getting wetter, especially in the southern parts of the state, with heavy precipitation statewide that is more frequent and intense. A storm with a likelihood of occurring once every 100 years (or a one percent chance of occurring in any given year) is known as a "100-year storm event" and it is used to determine certain design measures such as how large to build a stormwater pond. Understanding how the 100-year storm may change in the future can help build more resilient infrastructure that can withstand heavier storm events.

Figure 1 shows the projected maximum daily 100-year storm precipitation depth on the State Trunk Highway System for two different time periods compared to data from 1985 to 2014. The graph on the left shows projected maximum percentage changes in the late century under a low emissions scenario and the graph on the right under a high emissions scenario. Figure 1 is not intended to be used as an authoritative source for project scoping or design, but rather illustrates the assumptions about heavy precipitation and flooding that were incorporated into the climate risk scores described later in the RIP.

Some portions of the map likely overemphasize near term risks to the transportation system while other areas likely underemphasize risks. Answering the question of how much and where it will rain years from now is difficult and has uncertainty. However, overall trends can give a sense for what we may see in the future. Areas with larger increases in heavy precipitation could be different than those shown on the maps or could shift throughout the state over time as our climate changes.

Flooding may be a near-term risk for some roads in Minnesota. Two to three percent of MnDOT's roadway mileage in each district are within the 100-year floodplain mapped by the Federal Emergency Management Agency (FEMA) and included in the State Hazard Mitigation Plan

(SMHMP). Several MnDOT buildings are in or near the FEMA 100-year floodplain as mapped in the 2019 SMHMP. Projected increases in extreme storms will cause these facilities and roadways to flood more frequently and increase the number of facilities and roadway miles at risk.

One data challenge with using the FEMA flood maps for an accurate statewide assessment of flood vulnerability is the way data is updated. Aligning this plan with the current, 2019 SMHMP means that any updates to the floodplain data, coordinated by Minnesota's counties, would not be incorporated into this plan. Additionally, the 2024 SMHMP is being updated and will be released later this year with a FEMA floodplain dataset that was unavailable when the data analysis for this plan was conducted in late 2023.

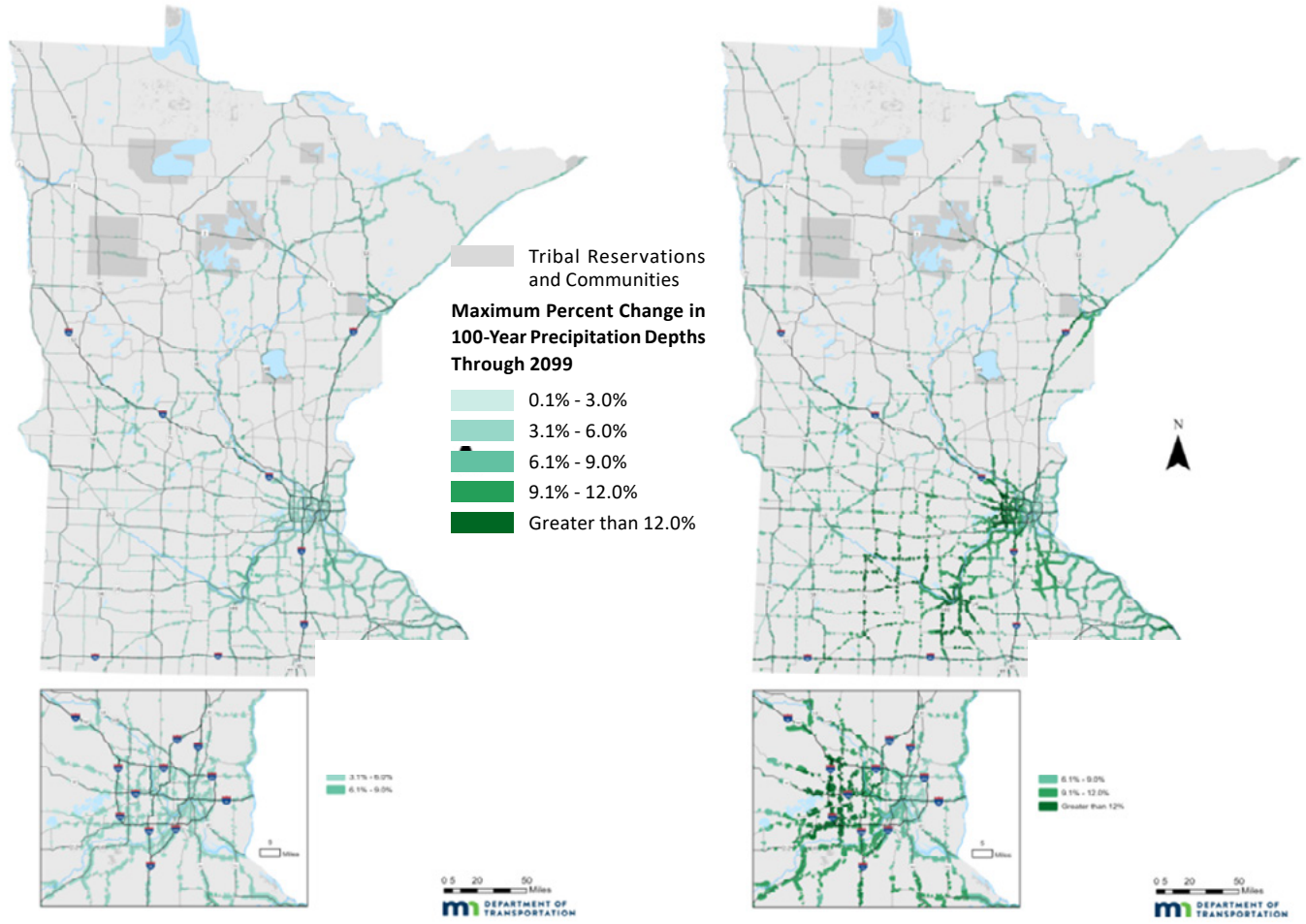
Community Vulnerabilities that Could Affect MnDOT: To the extent community infrastructure and/or services are disrupted by floods, MnDOT could find it difficult to address their own flood concerns. This is especially the case if locally maintained roads, bridges, and culverts are washed out. Flood-related disruption of electrical grids could also impair MnDOT's ability to provide services and exacerbate congestion.

MnDOT Vulnerabilities that Could Affect Community Vulnerability: Short-term disruptions and long-term damage to roads, bikeways, and sidewalks due to flooding and landslides can impact the mobility and access. In addition, emergency services could find it more challenging to respond to incidents.

Figure 1. Projected maximum percent change in daily 100-year storm precipitation depth, State Trunk Highway System

Low Emissions Scenario

High Emissions Scenario



Appendix C provides additional figures to illustrate the potential impacts of heavy precipitation and flooding on the State Trunk Highway system. A more complete assessment of potential climate impacts to state and local transportation assets is available as an interactive map at MnDOT Climate Resilience webpage.

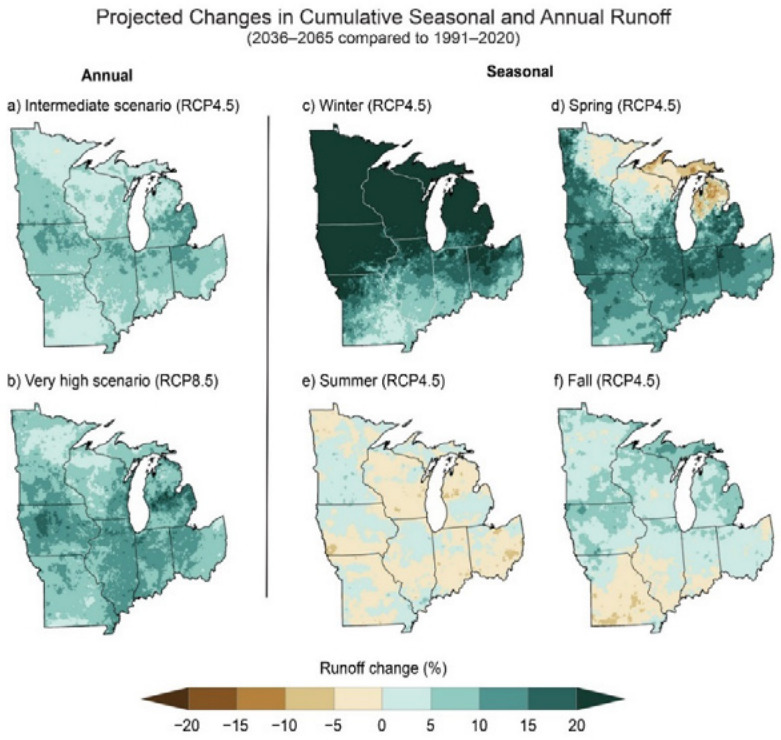
Climate Change Projections and Hydraulic Design

The Fifth National Climate Assessment (2023) noted, "Climate change is affecting the quality and quantity of water in the Midwest, as well as management practices related to the health of human and natural systems." The report goes on to state, "Observed changes in hydrology include increases in the variability of lake levels, evaporation and water temperatures, along with more intense precipitation, including lake-effect snow and shorter duration of snow and ice cover." Increases in extreme rainfall events negatively impact property, public health and safety and transportation systems. Urban and rural communities are at risk from projected increases in frequency and intensity of extreme rainfall events. The 2023 United States National Climate Assessment also found that Minnesota is among other Midwest states at high risk for increased riverine flood damage.

Figure 2 is taken from the Fifth National Climate Assessment and shows projected increases in runoff on an annual and seasonal basis for the vast majority of Minnesota. Winter runoff is projected to increase by more than 20% across the state, spring runoff is projected to increase by 5-20% across most of the state (excluding northeastern Minnesota), and summer and fall runoff is projected to increase by up to 15% in some areas of the state. With runoff being a direct contributor to flood risk, the figure below suggests that Minnesota's flood risk is anticipated to increase based on the projected changes in runoff throughout the year.

Another source of future hydrologic data is the future precipitation projections provided by the US Department of Defense's Strategic Environmental Research and Development Program. This dataset analyzes individual storm events. The SERDP tool provides future precipitation estimates based on future years and with two emissions scenarios. The data supporting the SERDP tool show that Minnesota can expect the total depth from a 5-year, 24-hour rainfall event in some parts of the state to increase approximately 15% and the total depth from a 100-year, 24-hour rainfall event to increase approximately 20% under a high emissions scenario for 2070-2099. Sources such as the SERDP tool may be considered by designers to estimate future flood risk and incorporate adaptation strategies when appropriate.

Figure 2. Six maps of the Midwest illustrate projected changes in cumulative seasonal and annual runoff for 2035–2065 compared to 1990–2020.



While the SERDP tool and the figures provided in the Fifth National Climate Assessment provide projected changes in precipitation and/or runoff for specific emissions scenarios and timeframes, they should be considered as just two of many potential sources of information about future rainfall, runoff and flood risk potential that a designer should consider. Climate science and computer-based climate modeling are constantly evolving, and as a result, the corresponding projections for future precipitation are being updated frequently. Additionally, there are dozens of climate models that can be applied to project future climate conditions, and different techniques (dynamical and statistical) for downscaling the data for a specific region. Because of this, climate projections obtained from different models or through different downscaling methods can vary significantly. With this in mind, MnDOT is currently developing guidance for project designers to appropriately apply future projected precipitation data for hydraulic designs. It is anticipated that this guidance will describe the use of several future precipitation projections rather than relying on a single source for project design.

EXTREME TEMPERATURES

Minnesota is getting warmer, especially at night across all seasons, with winters warming fastest in the northern parts of the state. Summer days are projected to trend hotter, especially in late-century timeframes. Figure 3 shows the projected average annual days above 95 degrees for two different time periods compared to data from 1985 to 2014.

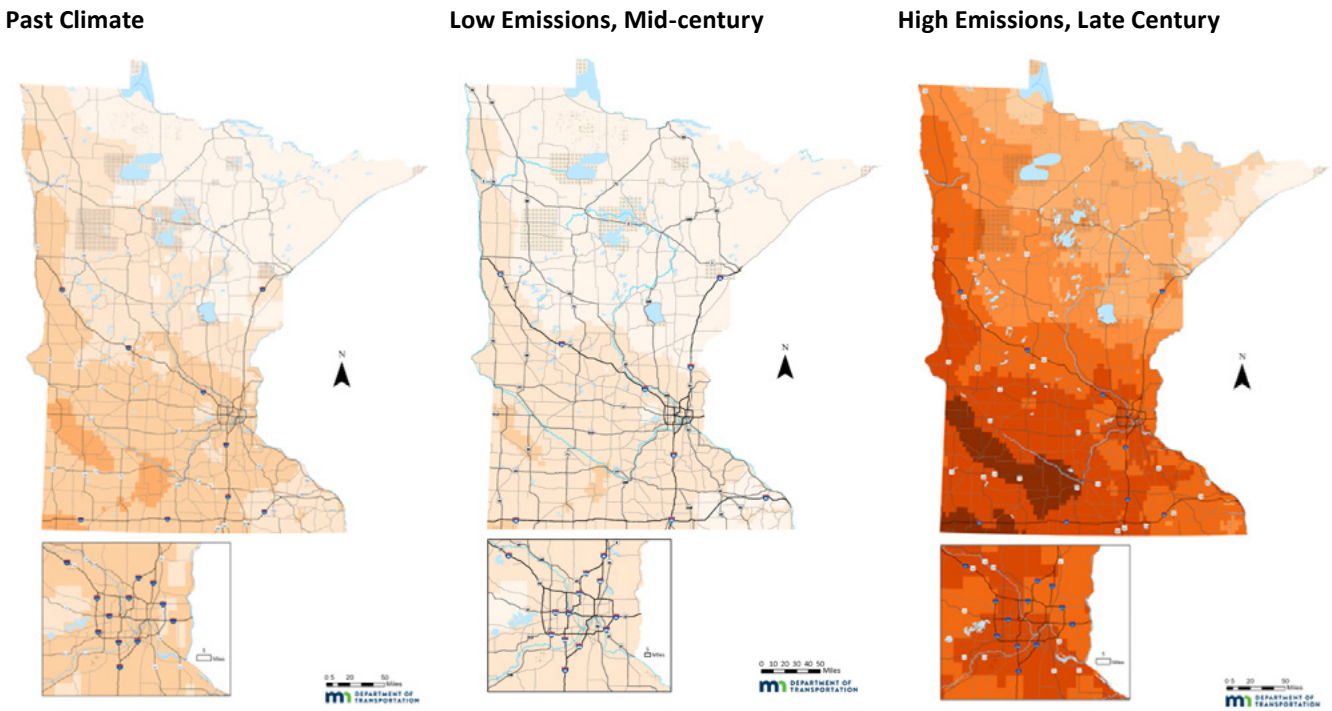
Extreme temperatures, or changes in the expected high and low temperatures, impact pavement and bridge performance. Temperatures are an important consideration for selecting pavement binder–the "glue" that holds asphalt together. If temperatures are hotter than what the binder is rated for, the pavement can become pliable resulting in pavement deformation, like pavement rutting. If temperatures are cooler than what the binder is rated for, the pavement can become more brittle, shrink and crack. Binder types may need to change towards the end of the century due to higher average temperatures, particularly in the southern part of the state. Engineers design bridges to expand during heat waves and shrink during cold streaks. If bridge temperatures exceed the temperature limits and range the bridge was designed for, damage to the bridge can occur. Throughout the state, both high and low bridge concrete temperatures are projected to rise. Extreme low temperatures are projected to continue to increase more rapidly than high temperatures and the range of temperatures that bridges will need to be designed to withstand is expected to decrease. Bridge thermal contraction tolerances are likely to remain adequate but thermal expansion tolerances may need to change in the future, particularly for the northwestern part of the state.

Extreme temperatures can also impact electronic equipment, buildings and workers. With more extreme high temperatures projected under climate change, it is likely that some electronic equipment will need to be protected from extreme heat. It will be important for buildings to offer climate control with passive cooling or air conditioning options and for workers to have appropriate protections during extreme heat.

Community Vulnerabilities that Could Affect MnDOT: Several of MnDOT's functions rely on the local electric grid. Extreme heat can put a strain on the grid and, in extreme cases, lead to power outages. Such temperature-related disruptions could affect MnDOT's services and the functioning of the network. For example, signal outages would likely create congestion and raise safety concerns.

MnDOT Vulnerabilities that Could Affect Community Vulnerability: Any signal outages during extreme heat could exacerbate community vulnerability by leading to congestion and delaying first responders from reaching those suffering from heat related illnesses. In addition, extreme heat impacts human stress, especially for vulnerable populations, and landscape stress, which reduces plant and tree benefits for people walking, biking, and using transit.

Figure 3. Change in Average Annual Days Over 95F from Past Climate



Appendix C provides additional figures to illustrate the potential impacts of extreme temperature on the State Trunk Highway system. A more complete assessment of potential climate impacts to the state and local transportation networks is available as an interactive map at MnDOT Climate Resilience webpage.

FREEZE-THAW CHANGES

With warming winters, Minnesota is already experiencing more days each year where the high temperature is above freezing and the low temperature is below freezing. Figure 4 shows the projected average number of freeze-thaw days per year within two different time periods compared to data from 1985 to 2014.

Increased frequency of freeze-thaw cycles may reduce pavement lifespans and degrade slope stability. Water can get into pavement through cracks when it rains or snows. When temperatures dip below freezing, water expands causing cracks and potholes in pavement and loosening soil and rocks on roadside slopes. The more often that temperatures fluctuate around freezing, the more potential there is for pavement damage and slope impacts. Northern Minnesota could experience more freeze-thaw days by mid-century, however, there may be fewer freeze thaw days statewide by the end of the century. Under a high emissions scenario Minnesota winters will warm enough that southern and western Minnesota will experience dramatically fewer freeze thaw cycles.

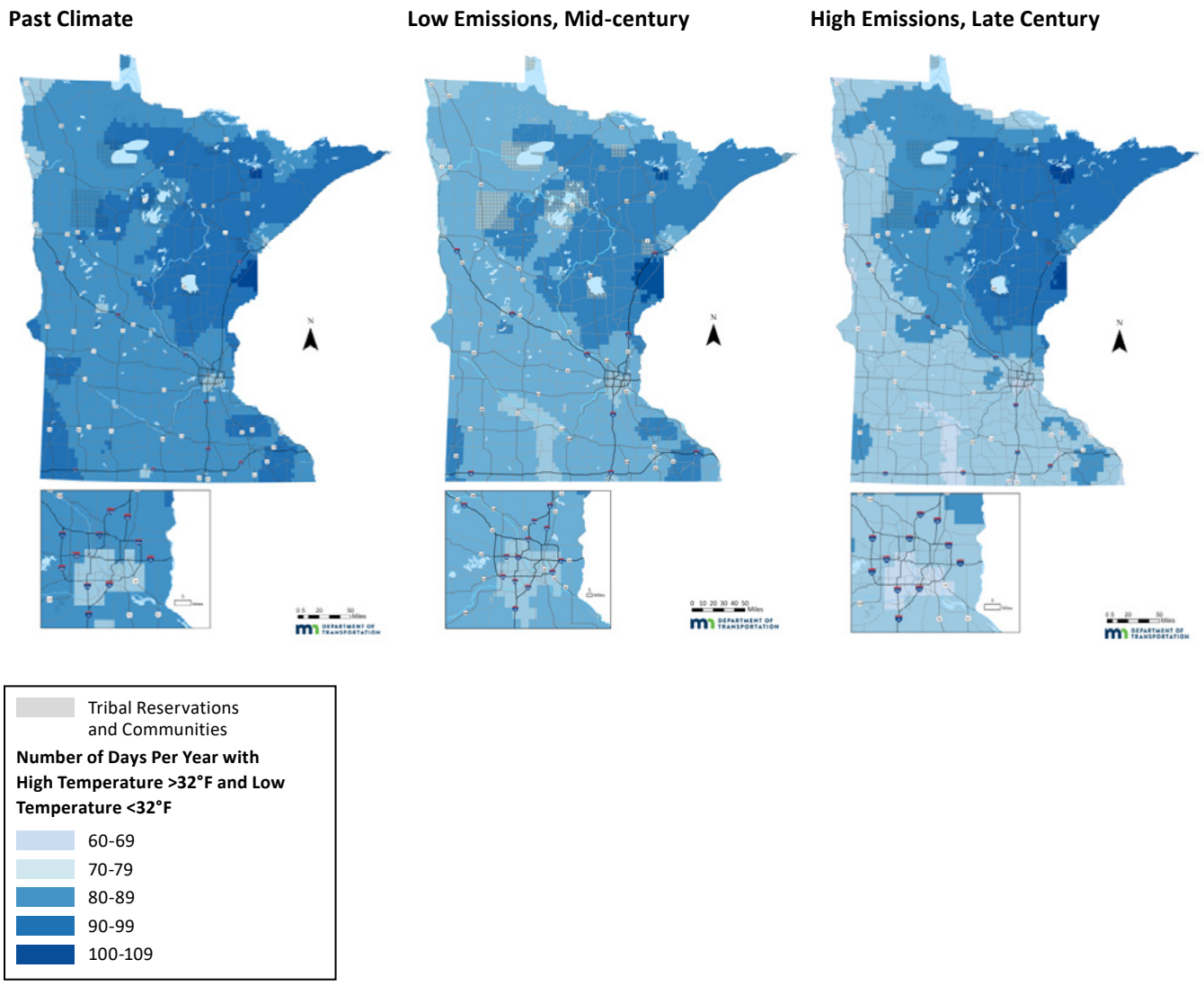
The frequency of freeze-thaw cycles can also impact bridges. Importantly, when moisture that is 3 inches into a bridge's concrete freezes it will become ice and expand. Air temperatures at or below 15°F will cause this to happen. As the moisture freezes and expands, it may damage the concrete, reduce the service life of the structure and, in extreme cases, potentially pose a safety threat. By late-century Minnesota winters are projected to warm enough that the frequency of freeze-thaw cycles for concrete bridges is expected to decrease.

Community Vulnerabilities that Could Affect MnDOT: Changes in freeze-thaw frequency are not expected to result in broader community vulnerabilities that could affect MnDOT.

MnDOT Vulnerabilities that Could Affect Community Vulnerability: Freeze-thaw induced road closures (primarily from rockfalls or slope failures) could have localized impacts on first responder access, increasing community vulnerability. Changes or increases in freeze-thaw cycles can also lead to ice accumulation, which poses slip hazards and reduces accessibility for people walking.

A springtime landslide permanently closes a section of Hwy 67 along the Minnesota River valley.

Figure 4. Average Number of Freeze Thaw Days per Year



Appendix C provides additional figures to illustrate the potential impacts of freeze-thaw changes on the Trunk Highway network across the state. A more complete assessment of potential climate impacts to the state and local transportation networks is available as an interactive map at MnDOT Climate Resilience webpage.

ABNORMAL WINTER WEATHER

As Minnesota's winter weather warms, the state is experiencing more severe winter storms and more rain (instead of snow) in winter months. Figure 5 shows the projected average liquid equivalent in frozen precipitation on days below freezing within two different emissions scenarios at mid-century, compared to data from 1985 to 2014.

Winter weather includes heavy snowstorms, blizzards, freezing rain, sleet, ice storms and blowing and drifting snow. These conditions can impact roads by creating unsafe conditions for people driving. Blizzards can create unsafe driving conditions because of white-outs and drifts located on road surfaces - they are especially hazardous in flat and open areas of the state. The Minnesota Climatology Office found that a particularly bad winter storm in 2017 resulted in a crash every two to three minutes in the Twin Cities area. Removing snow and ice from the state road network is also a very expensive undertaking for MnDOT. In the past five years MnDOT spent $698 million on winter maintenance operations. While winter weather projections reflect weather conditions that southern Minnesota has already experienced over the last 40 years, more research and engagement with maintenance professionals is needed to better understand how Minnesota's roadway maintenance operations might evolve with the Upper Midwest's warming winters.

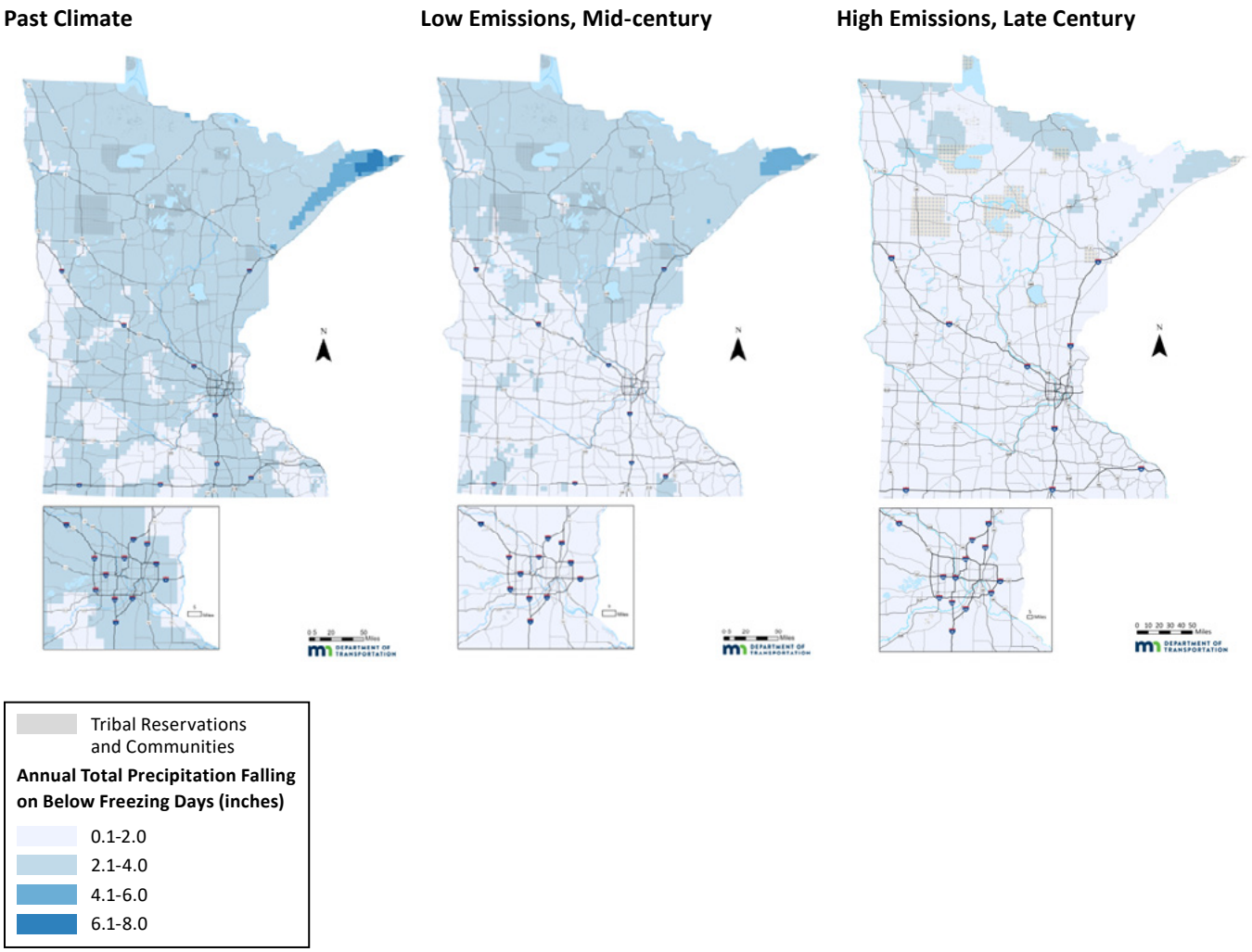
Projections show that Minnesota could experience less total frozen precipitation by mid-century, but the amount of precipitation during each event is expected to increase. The form of winter precipitation has already started to change and the likelihood of precipitation that changes from freezing rain, sleet and snow within one weather event will become more common. Warmer winters and more intense storms could lead to more rain and sleet which will require different treatments and pose different risks than traditional cold and snowy winters. By late century, heavy winter storms in the southern part of the state will likely result in more rain rather than accumulating snowfall.

Historic data shows that Minnesota's winters have been warming and yet the date for the median last freeze, 28°F, has not been changing. Last-freeze dates across Minnesota range from mid-April in southern Minnesota to early June in areas of northern Minnesota. While the full implications of warming winters with traditional last-freeze dates are not clear, it does mean that in the short term spring snowstorms and winter weather should be expected within winters traditional range.

Community Vulnerabilities that Could Affect MnDOT: Local transportation networks that are impassable due to winter storms reduce the mobility and accessibility provided by the state road network in that the "last mile" cannot provide the direct connection to destinations. A local community's ability to remove snow and ice from their street network thus can affect the performance of the overall transportation system. In addition, if MnDOT facilities are dependent on the local electrical grid, disruptions to this system during winter storms could affect MnDOT's abilities to provide services and further exacerbate traffic impacts.

MnDOT Vulnerabilities that Could Affect Community Vulnerability: Closures of roads due to snow and ice could cause temporary cancellation of goods delivery, limit the ability of emergency services to respond to incidents, and impede power restoration efforts.

Figure 5. Average Liquid Equivalent in Frozen Precipitation on Below Freezing Days



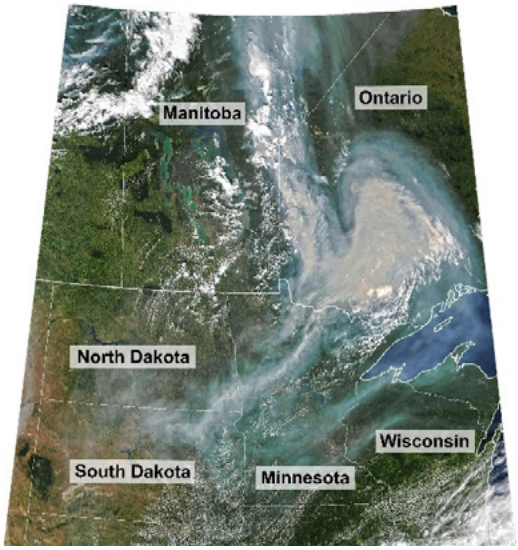
Appendix C provides additional figures to illustrate the potential impacts of changes to the average liquid equivalent in frozen precipitation on below freezing days on the Trunk Highway network across the state. A more complete assessment of potential climate impacts to the state and local transportation networks is available as an interactive map at MnDOT Climate Resilience webpage.

WILDFIRE

Wildfire and wildfire smoke is a threat to Minnesota's communities, travelers, transportation infrastructure and individuals who work on and along the transportation system. Comprehensive data about the projected impact of climate change on future wildfires in Minnesota is not yet available.

While an analysis of wildfire probability in western states or Canadian provinces was outside the scope of this analysis, 2023's 5th National Climate Assessment was clear, "wildfire smoke from both local and distant sources poses a threat to human health by aggravating cardiovascular and respiratory conditions such as heart arrhythmias and asthma." According to the Assessment, "many Midwest counties will experience increased exposure to wildfire smoke." Ensuring that state, local and contracted transportation professionals are adequately protected will need to be an operational consideration during future burn seasons.

Impacts from Wildfire Smoke in the Midwest



A satellite image shows wildfire smoke moving from Canada into the Upper Midwest and Northern Great Plains states on July 11, 2021. From the 5th National Climate Assessment**.**

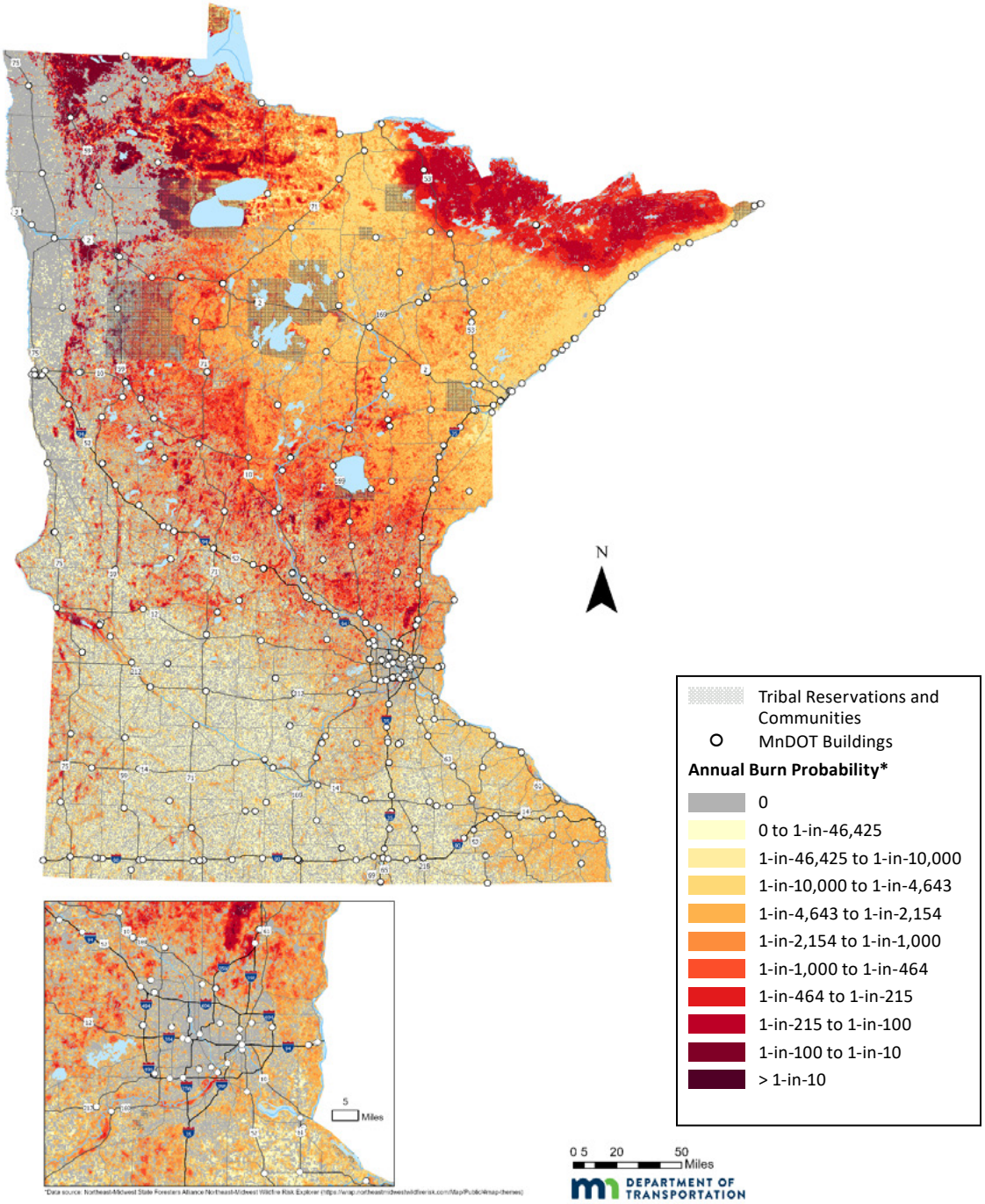
According to the Minnesota State Hazard Mitigation Plan, "Changes in Minnesota's climate…may be influencing the frequency, severity and areal coverage of wildfires. For example, warmer winters with inconsistent snow cover, the arrival of wet conditions prior to the growing season, plus early and more frequent thaws, all combine to prolong the exposure of susceptible vegetation to dry conditions, potentially extending the peak wildfire season." This plan also notes, "documented and projected increases in the frequency and intensity of heavy and extreme rainfall suggest that Minnesota is becoming and will become more prone to post-fire landscape hazards." Such landscape hazards may include erosion and landslides.

Figure 6 shows current locations in Minnesota where there is a higher risk of wildfire. This figure, developed by the Minnesota Department of Natural Resources, shows where wildfire risk is highest in Minnesota. Projections of this data into future climate scenarios are not currently available. The annual burn probability is highest in northwest Minnesota, just north of the Twin Cities, and the Boundary Waters region of northeast Minnesota. Wildfires can destroy or damage assets like roads, bike paths, electronic equipment, buildings and other structures. They can create harder ground, reduce vegetation and increase erosion potential that increases flood risk for several years. Bridges and culverts in a burned area may not be designed for unique flood risks like debris left by fires being transported by flood waters and posing a risk for bridges, culverts and roads. Wildfires also create dangerous conditions for people using the transportation system because of low visibility and poor air quality.

Community Vulnerabilities that Could Affect MnDOT: The management of post-fire landscapes is the responsibility of many landowners and largely out of MnDOT's control. However, their actions can affect the flood probabilities at MnDOT bridges and culverts. It's important to establish post-fire landscapes management strategies and agreements, ideally in advance of fires, so that post-fire flood and debris flow risks can be managed.

MnDOT Vulnerabilities that Could Affect Community Vulnerability: The disruption of the Trunk Highway system or abilities to disseminate information could affect a community's ability to provide safe transportation from burn areas. MnDOT has worked closely with other government units to ensure the efficient and effective evacuation of those affected by wildfires; such cooperation will become even more important in the future.

Figure 6. Annual Wildfire Burn Probability in Minnesota



Appendix C provides additional figures to illustrate the potential impacts of wildfire on the Trunk Highway network across the state. A more complete assessment of potential climate impacts to the state and local transportation networks is available as an interactive map at MnDOT Climate Resilience webpage.

LANDSLIDES

The movement of a mass of rock, debris, or earth down a slope by the force of gravity is considered a landslide. Landslides occur when slope or soil stability changes from stable to unstable and include a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over-steepened slope is the primary reason for a landslide, there are other contributing factors:

- Erosion by rivers create over steepened slopes;
- Rock and soil slopes are weakened through saturation by snowmelt or heavy rains;
- Excess weight from accumulation of rain or snow, or from man-made structures may stress weak slopes to failure and other structures.

Slope materials that become saturated with water may develop a debris flow or mud flow. The resulting slurry of rock and mud may pick up trees, houses, and cars, thus blocking bridges and tributaries causing flooding along its path.

Climate change is exacerbating the potential for landslides. The increasing frequency and intensity of heavy rainfall events, dry spells and freeze-thaw cycles all contribute to increased slope and soil instabilities.

The 2019 State Minnesota Hazard Mitigation Plan (Pg. 174-176) identified four major regions of erosion concern:

Northwest Minnesota

Red River Valley bank failures are typically the result of slumping in which a block of earth moves downward … because they consist of clay rather than sand, silt, or gravel.

Mid Minnesota Watershed (Le Sueur and Minnesota rivers)

The geologic history of this area paired with modern land use, creates rivers highly susceptible to significant bluff failures, bank erosion, and ravine growth. … Dry sand and gravel lack cohesion and typically seek an angle of repose of approximately 30 to 45° depending on the average grain size and mixture. If storm water is focused and creates a ravine in dry sediment, newly formed steep slopes quickly fail to the angle of repose. This style of failure has occurred along the high terraces of the Minnesota River in Eden Prairie both recently and historically.

Western Lake Superior Watersheds

Red clay erosion is significant in the western Lake Superior basin. The predominant red clays are interspersed with sands and silts that are geologically young and are undergoing a high rate of natural erosion.

Agricultural Areas

Agricultural practices in highly erodible soil types can create conditions conducive to landslide occurrence. Natural and human caused changes in hydrology play a critical role in the failure of stream banks, bluffs and ravines, as more water is entering ravines and rivers. Land use changes have increased runoff to rivers from urban and agricultural land uses. Vegetation changes, such as conversion of native prairie, pastures and wetlands to row crops and removing trees and vegetated buffers, reduce soil stability, reduce evapotranspiration and increase runoff.

Agricultural areas are more susceptible than forests because they lack large, deep tree roots that can hold soil material together. Pastures on steep lands, typically have shallow-rooted grasses and may also experience slumping. With certain soil types, landslides may become liquefied and turn into mudslides.

MnDOT conducted a statewide Slope Vulnerability Study after landslides affected the Trunk Highway system in a majority of MnDOT's eight districts. The study independently verified the assessed regional challenges outlined in the State Hazard Mitigation Plan.

Community Vulnerabilities that Could Affect MnDOT: Minimal

MnDOT Vulnerabilities that Could Enhance Community Vulnerability: Minimal

COASTAL EROSION

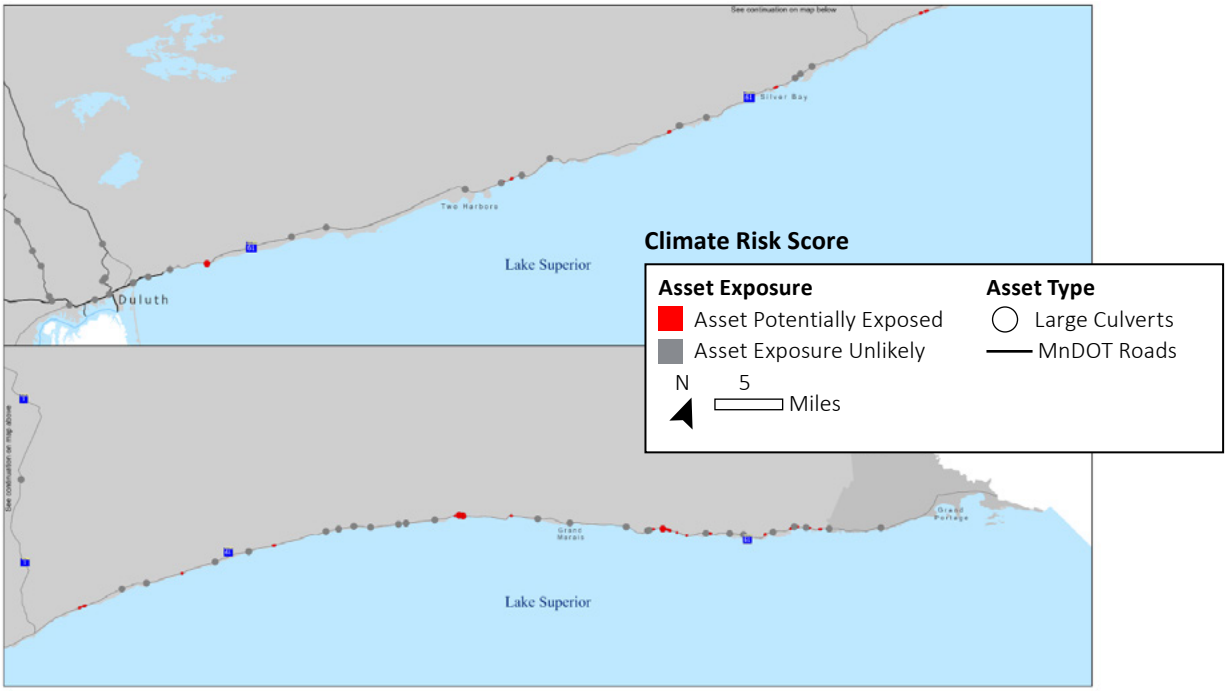
Coastal erosion is a threat along portions of Minnesota's 189-mile Lake Superior shoreline. Climate change may alter lake levels and change coastal erosion rates. Comprehensive data about the projected impacts of climate change on Lake Superior, how that may affect Lake Superior, its weather patterns and changes to potential hazard exposure along the lake is not yet available. A 2020 assessment of North Shore coastal erosion hazards conducted by the Arrowhead Regional Development Commission (ARDC) and regional partners was incorporated into this Resilience Improvement Plan's data analysis. Figure 7 shows MnDOT roads and large culverts (greater than 10 feet) that are within 150 feet of portions of the Lake Superior shoreline that are susceptible to coastal erosion. These locations should be evaluated and monitored by MnDOT to identify instances where coastal erosion may impact MnDOT's assets.

Developing better data about Lake Superior and the way climate change is projected to affect the lake is a priority for communities along Lake Superior. To that end, MnDOT has joined a locally led partnership that would create decision-relevant, high-quality climate information and decision-making tools. This partnership has submitted a proposal for a NOAA grant and the data and tools the grant would fund would help increase infrastructure and community resilience along Lake Superior's North Shore. Any relevant data developed by this effort would be incorporated into future versions of the Resilience Improvement Plan.

Community Vulnerabilities that Could Affect MnDOT: Minimal.

MnDOT Vulnerabilities that Could Affect Community Vulnerability: Lengthy closures and detours for state highway 61 along the North Shore could have a significant impact on the communities and residents that live north of a closure. Of the three designated trauma centers along the North Shore, Two Harbors is the farthest north. Lengthy transportation disruptions along the North Shore can create unsafe circumstances for residents and disrupt tourist access to an area of Minnesota with a regional economy that benefits from tourism.

Figure 7. Trunk Highway Roads and Culverts within 150 feet of Lake Superior Coast Erosion Hazards



A more complete assessment of potential climate impacts to the state and local transportation networks along Lake Superior's coastline is available as an interactive map at MnDOT Climate Resilience webpage.

ASSESSMENT RESULTS: CLIMATE RISK SCORES

With a better understanding of Minnesota's current and projected climate hazards, MnDOT combined information about asset-level climate hazard exposure with potential traveler impacts to create a comprehensive risk assessment for transportation system assets.

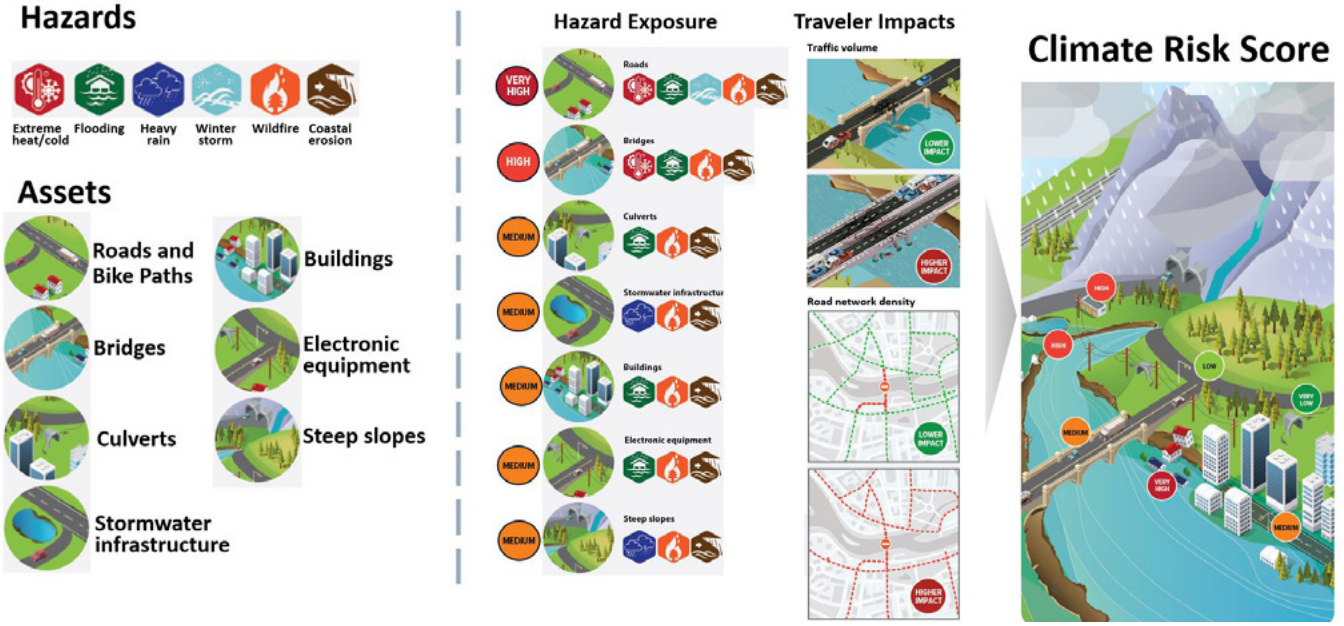
TRAVELER IMPACTS

MnDOT used two measures to evaluate the potential consequences of asset damage due to a climate hazard:

- Number of travelers impacted: the federal functional classification of roadways was used because data challenges prevented the use of measured traffic volumes along state and local roadways. Federal functional classification is the grouping of streets and highways into classes based on the service they are designed to provide. The federal functional classification provides a relative estimate of the number of people who typically travel on a given road.
- System redundancy: The denser the network of roadways, the more detour options likely to be available and the shorter the detour is likely to be. An analysis gap was determining whether redundant multimodal transportation options might exist when a detour was implemented.

IDENTIFYING RISKS: COMBINING HAZARD EXPOSURE WITH TRAVELER IMPACTS

MnDOT developed a climate risk score for every roadway in Minnesota by combing the potential exposure to climate hazards for each timeframe and emissions scenario assessed with the potential traveler impacts to generate a climate risk score for individual assets. Asset-level climate hazard exposures were developed by identifying which hazards were projected to impact an asset across all timelines and emissions scenarios. System-level climate risk scores were developed by combining asset-level hazard exposure with roadway traffic volumes and network density to better understand how many travelers would be impacted by a potential asset failure and a potential detour.



Figures 8 through 11 show the climate risk scores for roads, bridges and large culverts and slopes along the State Trunk Highway System. Assets that are darker on the map may face more risks related to climate change. A more complete assessment to the state and local transportation networks is available as an interactive map at [MnDOT Climate Resilience webpage](#).

Most roads, bridges and large culverts and slopes have a low climate risk score. Some bridges and large culverts along Lake Superior, in the Twin Cities metro area and in southeast Minnesota have high climate risk scores because of potential exposure to heavy precipitation and proximity to the 100 year flood plain. It's important to note that the climate risk score did not take into account hydraulic capacity. The climate risk scores for slopes are highest in northeast and southeast Minnesota and parts of the Twin Cities metro area.

Appendix B provides additional details about the method used to calculate the climate risk scores.

Figure 8. Climate Risk Scores for Roads, Minnesota State Trunk Highway System

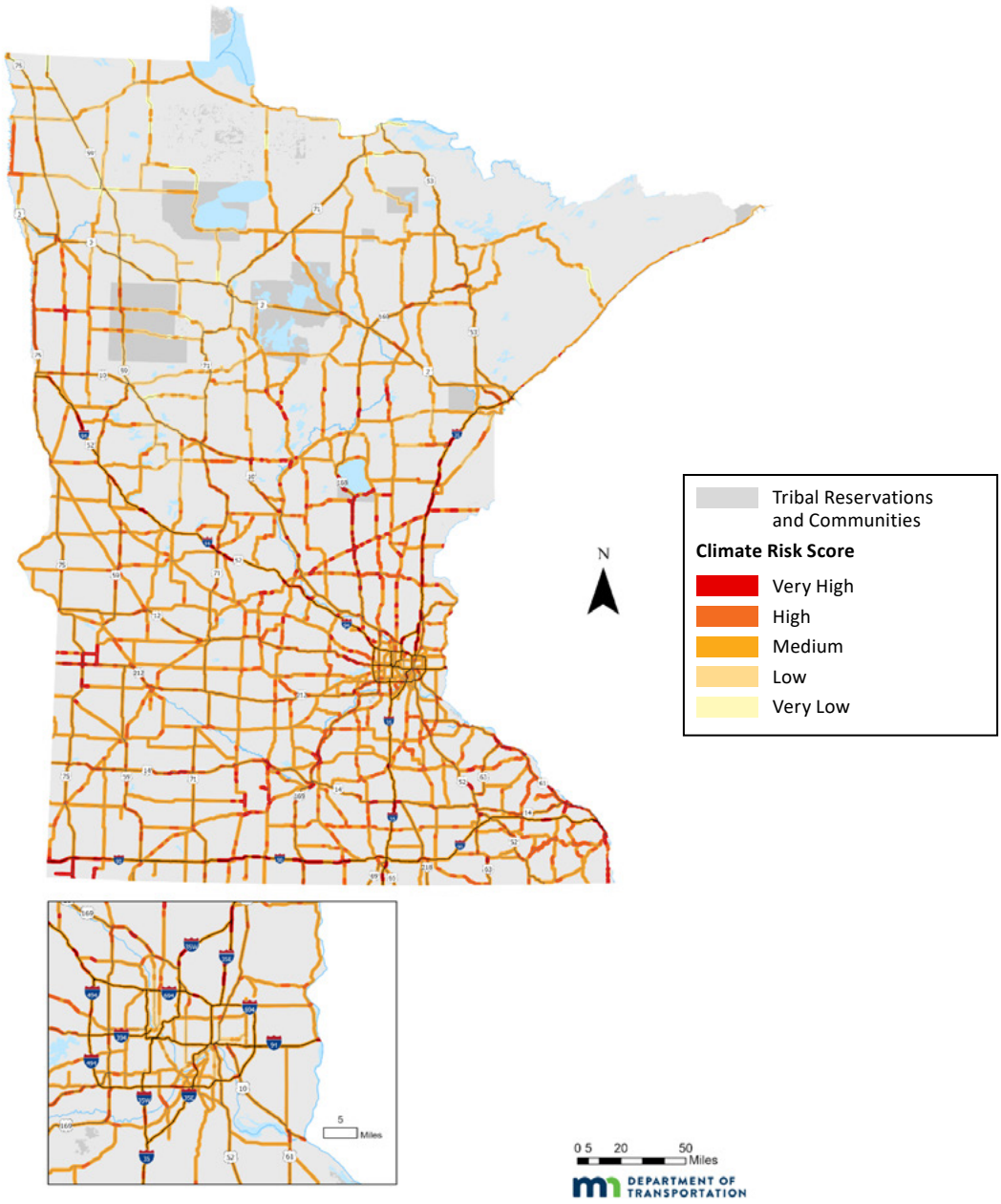
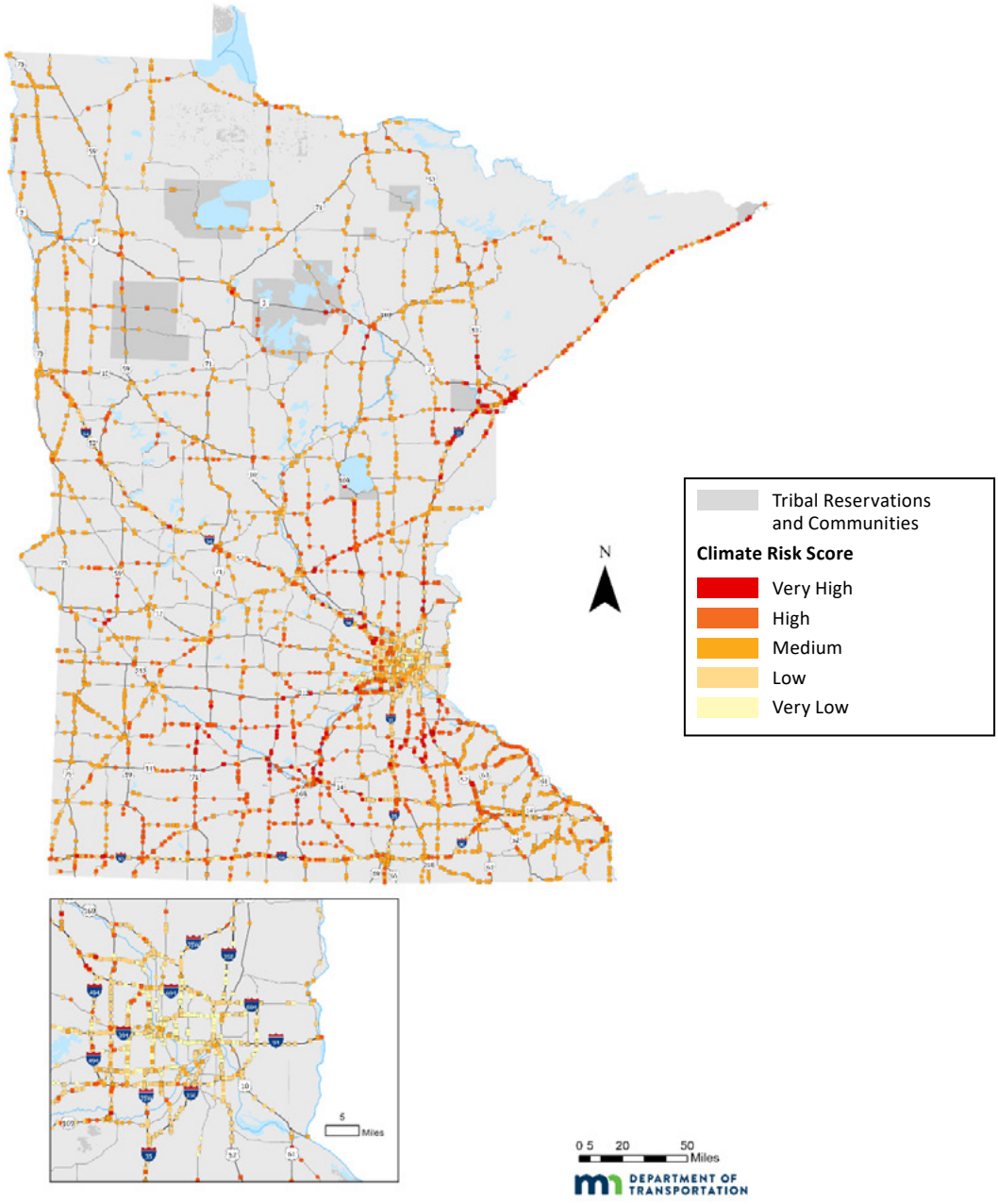


Figure 9. Climate Risk Scores for Bridges and Large Culverts, Minnesota State Trunk Highway System[1]



[1] This map does not reflect waterway adequacy, it reflects asset exposure to heavy precipitation and proximity to the 100 year flood plain as used in Minnesota's 2019 State Hazard Mitigation Plan.

Figure 10. Climate Risk Scores for Slopes, Minnesota State Trunk Highway System

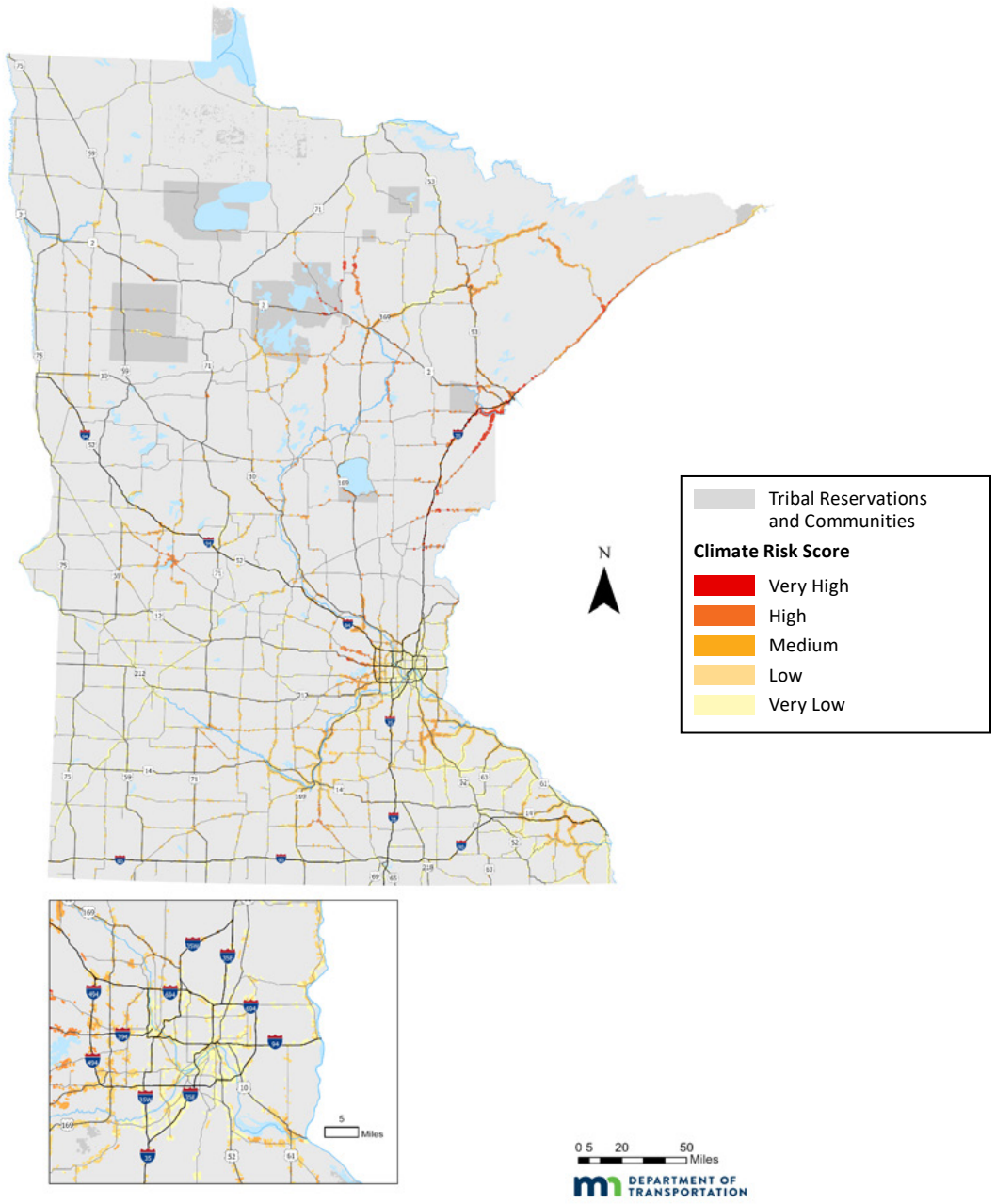


Figure 11. Climate Risk Scores for Bikeways.

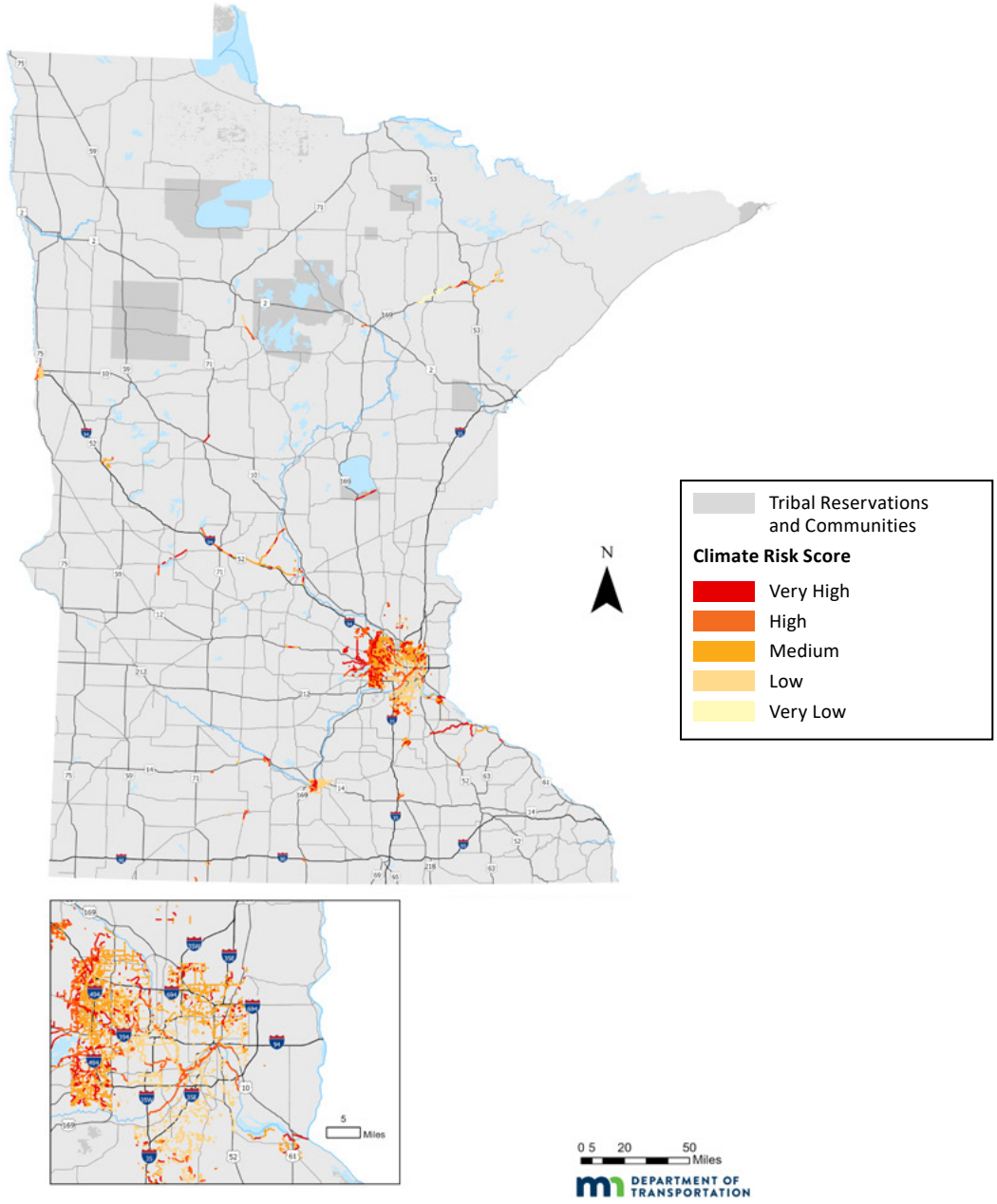
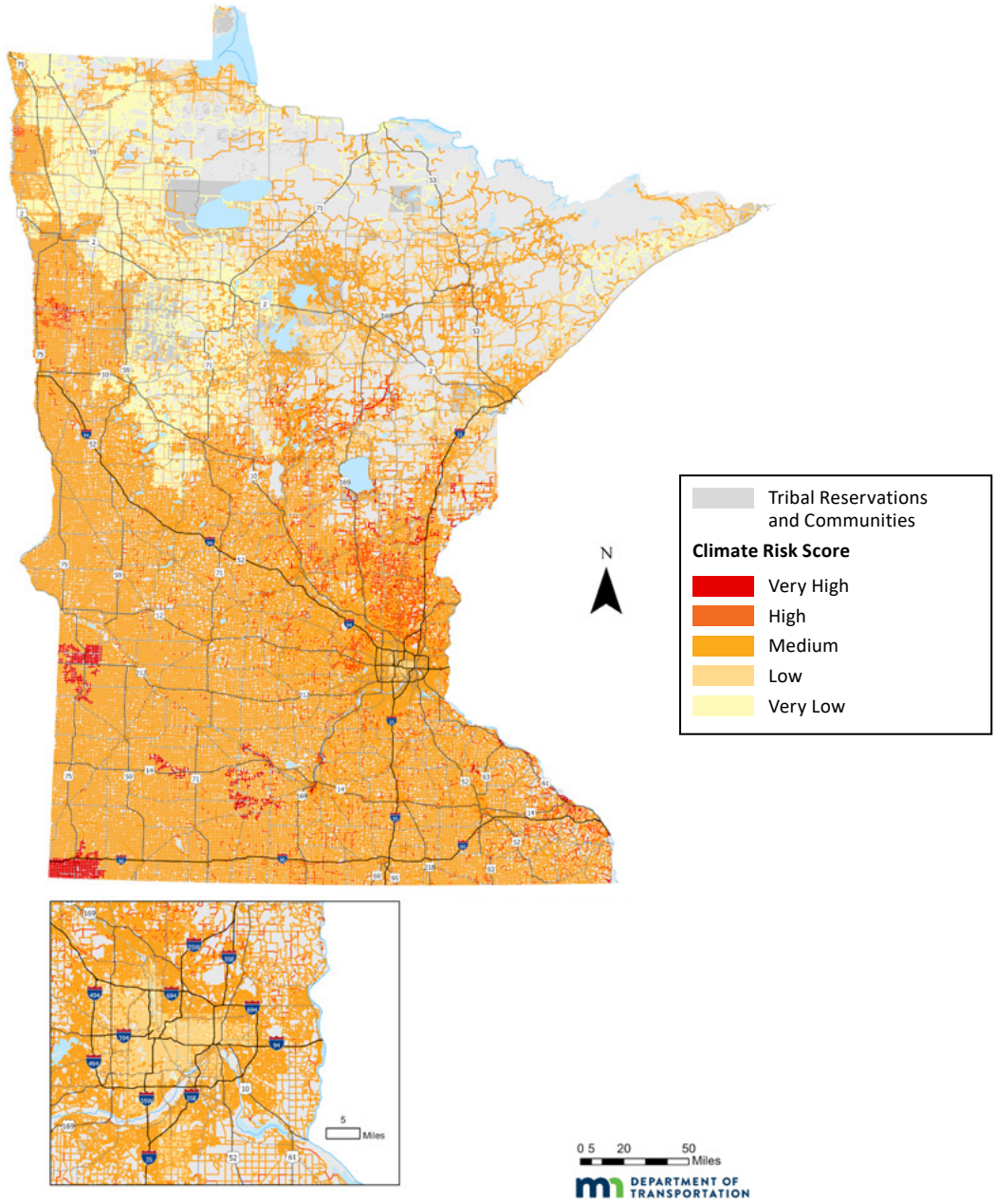


Figure 12. Climate Risk Scores for Local Roads.



OTHER CLIMATE HAZARDS

Additional climate hazards impact Minnesota's transportation system but were not included in the vulnerability assessment. Examples include erosion, windstorms, tornadoes, hail, drought, invasive species and earthquakes. MnDOT and partners can refer to the SMHMP for more information about the relative risks and potential impacts of these hazards at a county level. This information could help choose between projects in different counties, for example.

CHAPTER 4

WHAT STRATEGIES WILL MNDOT USE TO ADVANCE CLIMATE RESILIENCE?

There are immediate opportunities for MnDOT and partners to invest in climate resilience projects. Project types and their related climate hazards are summarized in Table 1. MnDOT and partners can use this resource to inform project design when a climate hazard is present. While some project types are specific to certain asset types (e.g. bridge reconstruction in at risk-flood zones), many of the project types are relevant to multiple types of asset includes roads, active transportation and transit infrastructure. MnDOT will also advance policy and procedure updates and communication and education efforts to advance climate resilience.

TABLE 1. PROJECT TYPES AND RELATED CLIMATE HAZARDS

Project Types	Related Climate Hazards	Projects
Bridge Reconstruction and Elevation of Roads in At-Risk Flood Zones	Heavy precipitation and flooding, Erosion, Drought	Enhance bridge design; Increase freeboard clearance; Riprap and bridge foundations; Channel design; Monitoring
Armoring	Heavy precipitation and flooding, Erosion, Drought	Vegetated riprap; Permanent erosion control mat; Articulated blocks in a sag point
Culvert Replacement/Urgent Repairs	Heavy precipitation and flooding, Freeze-thaw cycles, Wildfire	Increasing culvert size; Replacing poor-condition culverts
Floodplain Conservation/ Preservation	Heavy precipitation and flooding, Freeze-thaw cycles	Restore inland wetlands; Flood setbacks; Bank vegetation and seeding; In-stream structures; Bioswales, vegetative swales, and bioretention ponds; Trees planting
Landslide and Rockfall Protection	Heavy precipitation and flooding, Freeze-thaw changes, Wildfire, Landslides	Surface water management; Debris flow catchment; Rockfall mitigation; Reduce driving force on slopes; Underground drainage; Vegetation and seeding; Bioengineering and biotechnical stabilization
Drainage Area Enhancements	Heavy precipitation and flooding, Extreme temperatures, Freeze-thaw cycles	Snow fences; Outcome-focused partnerships with other government units, landowners, and land managers;
Wildfire Protection	Wildfire, drought	Defensible space; Fire-resistant landscaping; Vegetation management; Hardening
Lake Superior Armoring and Natural Design	Coastal erosion, Precipitation, Drought, Landslides	Sea walls and bulkheads; Revetments and slope protection; Groins and jetties; Living shorelines/ shoreline stabilization; Barrier Islands; Sand and rock beaches

The RIP identifies a set of priority strategies for investment and implementation to improve transportation system resilience in Minnesota. MnDOT and partners will use the RIP as a guide to plan, select, fund and implement projects across Minnesota.

STRATEGY DEVELOPMENT PROCESS

MnDOT identified climate resilience strategies based on best practices, existing codes and standards, policies and feedback from MnDOT staff and partners during plan development. The strategies also reflect research from the National Cooperative Highway Research Program (NCHRP), Federal Highway Administration (FHWA) and other state departments of transportation.

The RIP includes three types of strategies:

- Climate Resilience Projects
- Policy and Procedure Updates to Advance Climate Resilience
- Communication and Education Efforts

CLIMATE RESILIENCE PROJECTS

There are immediate opportunities to invest in climate resilience projects. Each section of project types identifies related climate hazards. When high risk assets are identified related to one or more climate hazards and funding is available, MnDOT and partners can select from this list of project types. This is not intended to be an exhaustive list of options and not all projects make sense for all assets and climate hazards. Project design should involve careful consideration of the climate hazard that contributes to the risk and the asset type, as well as the condition of the asset and its potential vulnerability to climate hazards. In addition, some of the project types go above and beyond current design standards for MnDOT.

BRIDGE RECONSTRUCTION AND ELEVATION OF ROADS IN AT-RISK FLOOD ZONES

Related Climate Hazards: Heavy Precipitation and Flooding, Erosion and Drought

Enhance Bridge Design

Bridge superstructures (deck, girders, railing, etc.) can be designed to increase the structure's ability to absorb or deflect impacts during a high flood, mudflow, landslide or other severe event. Increasing the span of a bridge is a good strategy for decreasing vulnerability of the bridge by reducing upstream flood elevations and corresponding flood risk to the bridge and roadway but is often the costliest strategy. This option should be carefully considered if a lengthened span creates the need for a new bridge pier because this may create a new vulnerability risk for the structure.

Increase Freeboard Clearance

Bridges are typically designed to a 50-year flood level with a minimum freeboard of three feet. Freeboard is the distance between the lowest part of a bridge superstructure, the low chord elevation and the high water elevation. Increasing the minimum freeboard adds resiliency to a bridge by providing a larger opening for water to flow through, reducing the probability of bridge damage during flooding from high water, debris, and ice. Bridges with increased freeboard are more likely to pass debris such as trees in areas affected by wildfires, again reducing the damage potential.

As with bridges, roadways located in a floodplain or other flood-prone areas may be vulnerable to overtopping. In instances where persistent overtopping occurs, raising the roadway grade will similarly increase the roadway's freeboard, thereby increasing the resiliency to flooding.

Rip Rap and Bridge Foundations

Scour and erosion are more likely during heavy precipitation and flooding. Bridge scour is the removal of streambed material caused by swiftly moving water

from around bridge abutments or piers. It can compromise the integrity of a bridge. Rip rap (loose rock, concrete blocks or other material placed along shorelines, slopes and bridge foundations to protect from scour and erosion) can shield bridge foundations from the eroding effects of moving water.

Deep foundations can reduce the consequences of scour and erosion by using drilled shafts or piles designed to extend beyond the anticipated scour depth. Combining increased foundation depths and increased abutment scour protection for bridges can help build resilience against increased heavy precipitation and flooding.

Channel Design/Monitoring

Vegetated, sloped banks in channels may help to slow erosion and reconnect floodplain areas to the main channel flow, thereby leveraging the natural flood storage function of floodplain areas. For roads located in chronically flooded areas, floodplain culverts, elevating the roadway, armoring or reinforcing roadway embankments or relocating the road outside of the floodplain will increase resilience. Floodplain culverts on either side of a bridge can reduce velocity by not concentrating flows which can help minimizing roadway impacts.

Longer drought periods are opportunities to evaluate bridge foundations when riverbeds or channel bottoms are dried up. Drought periods are also opportunities to do maintenance and install anti-scour measures scheduled during low water levels.

ROADWAY EMBANKMENT ARMORING

Related Climate Hazards: Heavy Precipitation and Flooding, Erosion and Drought

Armoring a roadway embankment does not prevent inundation but can prevent erosion (up to complete roadway loss) and longer-term road closures by reducing the time and resources needed to repair a damaged roadway following a flood. These strategies should include adaptations such as adding vegetated riprap, permanent erosion control mat or articulated block to the downstream roadway embankment at a "sag" point in a road where overtopping may occur. Directly addressing the damage risks with these lower cost adaptations typically have a strong benefit/cost ratio and allow more vulnerable areas to be addressed sooner with available resources. Additionally, unlike adaptations that increase conveyance, there typically are no increases in downstream flow rates from armoring adaptations. Furthermore, with the uncertainty of future intensities in extreme storms, armoring is typically an easier alternative (less cost and impact) to provide a resilient roadway for a wider range of future projected conditions.

CULVERT REPLACEMENT OR URGENT REPAIR WHERE APPROPRIATE

Related Climate Hazards: Heavy Precipitation and Flooding, Freeze-Thaw Cycles and Wildfire

With changing climate conditions projected to bring heavy precipitation and flooding, inadequately sized or critically poor condition culverts could cause road overtopping/inundation, increased maintenance requirements for sediment and debris removal and even roadway failure if a culvert is washed away or collapses.

Wildfires are known to increase peak storm flows and debris flows within streams. The impacts to infrastructure within watersheds, including the vulnerability of culvert systems are an issue of concern for roadways in wildfire-prone areas. The implications for culverts will vary depending on the size and severity of the fire and the size of the contributing drainage area. Potential risks should be understood by an engineering practitioner when considering the cost-benefit economics of various adaptive design options.

FLOODPLAIN CONSERVATION/ PRESERVATION

Related Climate Hazards: Heavy Precipitation and Flooding, Freeze-Thaw Cycles

The most efficient and inexpensive natural infrastructure strategy for riverine flooding protection is often floodplain conservation and preservation. When undisturbed, floodplains act like a bathtub to store floodwaters. These natural floodplains are often inland wetland ecosystems, like freshwater marshes, swamps, bogs and fens. Generally, wetlands are an effective option for reducing risk in and along rivers where semi-aquatic plants slow down the flow of floodwaters, soak them up and hold soil in place. Because conservation and preservation is a relatively passive strategy that does not involve new construction, there is relatively little cost. Floodplain conservation/ preservation projects require careful consideration of the costs and benefits of managing land ownership, permitting and maintenance issues.

Restore Inland Wetlands

In areas that have already undergone development, restoring historic wetland ecosystems or creating new wetland ecosystems can bring the same benefits as conservation and preservation. Co-benefits include biodiversity, carbon sequestration and societal benefits. Wetlands are diverse ecosystems, supporting a wide range of species. Wetland vegetation and sediment trap and store carbon from the atmosphere. Because they can trap sediment and pollution, wetlands can also improve water quality. Having natural areas like wetlands in communities can provide opportunities for outdoor recreation and create aesthetically pleasing landscapes. However, because this is a more active strategy that adds natural infrastructure, it is generally more expensive and labor-intensive than conservation and preservation. Both approaches—conserving existing ecosystems or creating new ones—can carry the same flood protection benefits as well as co-benefits.

Flood Setbacks

MnDOT and partners can combine floodplain ecosystems and wetlands to create flood setbacks. Flood setbacks establish a minimum distance between stream corridors and infrastructure to keep the infrastructure out of a likely flood zone and allow space for natural streams to meander and change course without impacting infrastructure. For example, when a roadway is setback from a stream corridor and elevated above the 100-year flood elevation, flood damage potential can be reduced significantly by providing space for a stream to naturally meander and change course without affecting built infrastructure. The setback area between the stream corridor and the infrastructure can be a natural floodplain, yielding benefits from a functioning hydraulic system and reducing risk to the nearby infrastructure.

Bank Vegetation and Seeding

On a smaller scale, bank vegetation and seeding can introduce natural infrastructure along riverbanks to achieve similar benefits. This strategy involves planting native river plants along riverbanks, which can protect against erosion and decrease the magnitude of floods. The plant roots hold soil in place, while the plants themselves can trap sediment. Plants can also slow the flow of floodwaters. Installing bank vegetation can bring co-benefits similar to those from the use of natural floodplain ecosystems, including carbon sequestration, increased biodiversity and improved aesthetics. This is also a relatively inexpensive strategy, with costs largely being incurred during installation. Maintenance generally involves regular monitoring to ensure that the plants are still healthy and in place and to remove invasive species if needed.

In-Stream Structures

Another strategy to prevent erosion along riverbanks is to install in-stream structures, such as bendway weirs, to divert water flow to the center of the channel and reduce the speed of water flow along the stream bank where roadways or other infrastructure are located. Other in-stream structures such as rock riffles can reduce the stream grade, slowing the velocity of the water and

improving fish habitat: boulders can create protected areas for fish, while riffles can increase downstream oxygen levels. These strategies are generally low-cost and low-maintenance: once installed, management largely includes periodic inspections and maintenance if necessary.

Bioswales and Bioretention Basins

Bioswales and bioretention basins have traditionally been constructed as stormwater best management practices that filter pollutants out of stormwater runoff by promoting infiltration. To test the effectiveness of bioswales and bioretention basins in providing flood risk mitigation benefits, MnDOT partnered with University of Minnesota researchers to complete the Climate Change Adaptation of Urban Stormwater Infrastructure project in 2023. Data produced through that research indicates the volume of runoff intercepted and infiltrated by bioswales and bioretention basins is insignificant compared to volume of runoff leading to flooding. As a result, peak flood flows in watersheds with these features nearly matched the flows in the same watersheds without the features. Based on this research, bioswales and bioretention basins should not be expected to provide a significant flood risk reduction benefit.

While not significantly reducing flood risks, bioswales and bioretention ponds provide water quality, ecosystem, safety and aesthetic benefits. The plants help manage water flows and can uptake nutrients in stormwater runoff, reduce erosion potential by holding soil in place, and the permeable ground cover allows infiltration into the soil. Bioswales have milder slopes than traditional swales, and have vegetation intended to increase nutrient uptake in plants, thereby reducing pollutants in stormwater. Bioretention basins are meant to collect and infiltrate stormwater runoff, thus promoting pollutant capture in the underlying soils. The two categories can work together, with the bioswales moving water into the bioretention basins. They are also cost-effective and are among the least expensive strategies per volume of runoff treated. Bioswales, vegetative swales and bioretention ponds can also catch and break down pollutants in stormwater.

Trees

Trees can also help protect against risks related to stormwater. Trees planted near transportation infrastructure can intercept and absorb the stormwater through their roots, decreasing the volume of water. Tree roots also hold soil in place and prevent erosion. Key considerations in implementing trees as stormwater management strategies include species selection, planning conditions and maintenance. When successfully installed, trees can offer a variety of co-benefits, including improved air quality, enhanced habitats, temperature regulation and improved aesthetics.

LANDSLIDE AND ROCKFALL PROTECTION

Related Climate Hazards: Heavy Precipitation and Flooding, Freeze-Thaw Changes, Wildfire and Landslides

Between 2019-2021 MnDOT conducted a statewide Slope Vulnerability Study to assess the risks associated with different types of landslides and to identify risk management activities. Many types of landslides happen in Minnesota with the most common being earth flows, debris flows, debris slides, rockslides and rockfalls. The study found that of these, rockfalls and both rotational and translational landslides have been most frequently observed across the state. Appendix B provides additional information about the connections between climate hazards, landslide types and landslide protection measures. Understanding the factors that contribute to instability is the most effective way to identify the strategies that will lessen the potential impacts of unstable/erodible slopes.

Strategies for stabilizing slope conditions might include enhanced drainage, debris flow catchment, rockfall mitigation, reduction of driving force and subsurface draining as well as natural infrastructure solutions like vegetation and seeding and bioengineering and biological stabilization. Transportation project managers should consult the MnDOT's Geotechnical Manual to determine what strategies are most appropriate for the context they are addressing when scoping and designing engineered strategies

Surface Water Management

Intense and/or prolonged rainfall can contribute to slope instability and erosion. Surface runoff directed towards steep slopes can result in washouts and slope failures. Creating drainage systems to intercept surface runoff before it runs onto a slope as fast-moving, concentrated flow is an essential part of safe highway design. This can include adding storm sewer or stabilized conveyance to direct runoff to lower elevations. The long-term performance of these drainage systems depends on periodic maintenance to ensure they operate as designed.

Rockfall Mitigation

Natural fractures and joints in rocky slopes can be exacerbated by increased freeze-thaw cycles, maximum 24-hour precipitation and the presence of groundwater. Rock pieces can be dislodged and/or abruptly detach from steep slopes. Cost and the potential for significant danger are the primary factors in selecting a strategy to mitigate rockfalls. Rockfall stabilization methods can include excavation, reinforcement and drainage while protection methods might include mesh/cable nets, barrier fences and in some cases ditches.

Debris Flow Catchment

Heavy precipitation or rapid snow melt can cause debris to flow downstream. A major reason that debris will flow downhill is that the natural contours of a slope will collect and focus runoff. Routing stormwater underground can minimize the risks of debris flow. Reducing the impacts of debris flows might mean building debris flow catchment fences across drainage channels. These fences will intercept debris flow and stop or slow the flows, reducing or preventing the destruction these flows can cause. Regularly maintaining and clearing out these fences is critical to ensuring that they work.

Example of debris flow detention fencing holding back debris flow.

Reduce Driving Force on Slopes

When designing a roadway, engineers usually identify potential landslides that could happen due to geologic reasons. Construction can activate old, dormant slides or slides that have not been identified. Reducing the likelihood of these slides usually involves reducing the forces driving or causing the slide and increasing the resistance forces that prevent the sliding from moving.

An example of reducing the driving force is to excavate or remove material from the top of a slide mass to reduce the driving force of a slide. An example of increasing the resistance force is to add fill to the base or toe of the slide to increase the weight that resists the forces from above, making it harder for the slide to move.

Structures like retaining walls, soldier pile walls, soil nails, rock bolts, tie-backs and other structural ground support may also be ways to stabilize a slope by increasing resistance for a specific slide. These general concepts are useful in many different types of slides.

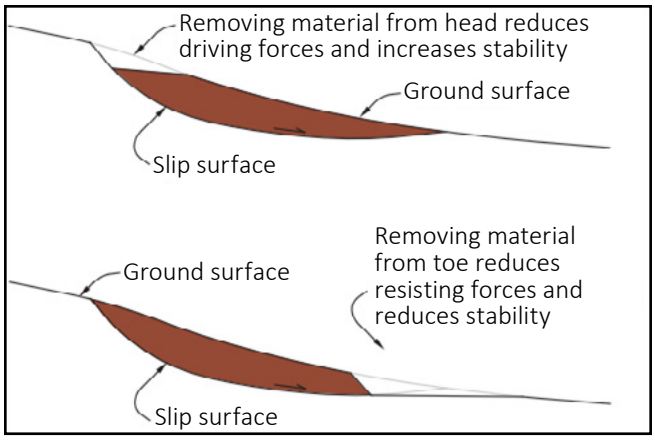


Illustration of the differences in stability resulting in excavation at the head and toe surfaces of a slope. (Rex Baum, USGS)

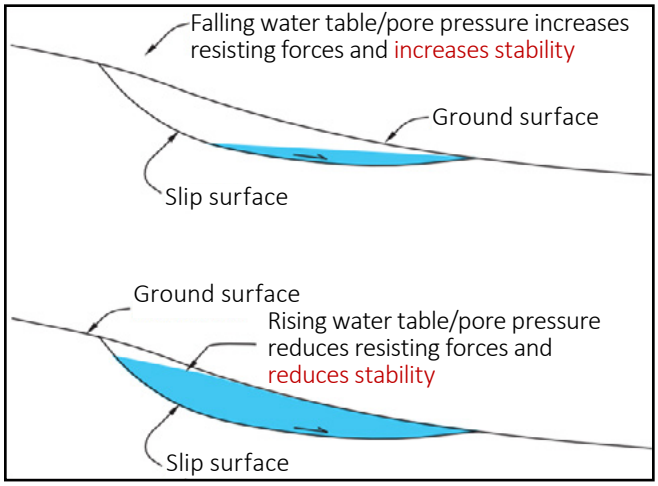
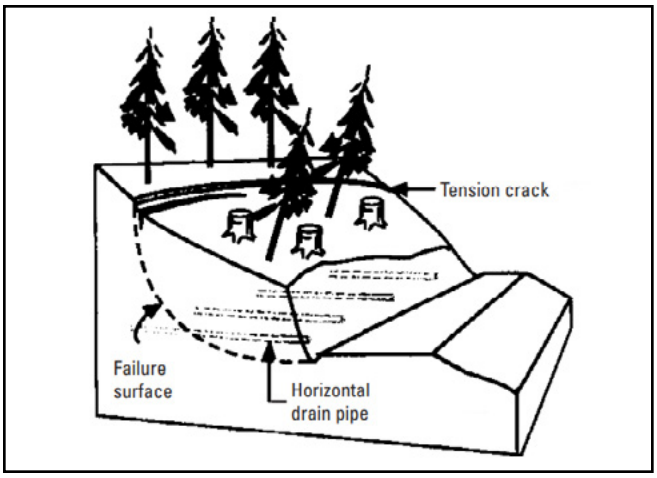


Illustration of the importance of water in the stability of a slope. (Rex Baum, USGS)

Underground Drainage

Another way to reduce landslide potential caused by rainfall and groundwater is to reduce groundwater pressure within a slope. This is accomplished primarily by installing underground drainage. Draining the slope will reduce water levels and both reduce the driving force and increase the strength of the slope. This can be an effective way to stabilize both small and large landslide locations.



Schematic of drainpipes (USGS)

Vegetation and Seeding

Vegetating and seeding slopes can reduce erosion. The roots help hold soil in place and plants help slow the flow of runoff. Vegetation will help stabilize soil for the shallow part of a slope but cannot prevent deeper landslides. Best practices for vegetating and seeding slopes include using native plants and ground cover. Placing vegetation at the top of a slope, or close to the impervious runoff source, can help manage stormwater runoff before it can make it down a slope. Infiltration trenches and diversion berms can also be beneficial. Another runoff management technique is soil enhancement; increasing the organic matter content of the slope's soil can improve its ability to absorb runoff without eroding. Best practices include using materials like compost, aged mulch, manure and sewer sludge.

Bioengineering and Biotechnical Stabilization

Biotechnical stabilization strategies can also promote slope stability by decreasing soil erosion. For example, adding a berm at the top of the slope increases downhill weight, creating a counterforce that resists slope failure. Biotechnical stabilization also generally involves more labor and construction than bioengineering (the use of plant material, living or dead), as biotechnical stabilization can make use of inert structural components, such as terracing, stones, green walls and geotextiles.

DRAINAGE AREA ENHANCEMENTS

Related Climate Hazards: Heavy Precipitation and Flooding, Extreme Temperatures and Freeze-Thaw Cycles

The types of strategies included in this category are not often a transportation or public works department's responsibility. These departments own and operate hydraulic infrastructures including ditches that manage water sent towards roadways from drainage areas that extend beyond most transportation right of ways.

Watersheds of all sizes, from regional basins to urban storm drains and agricultural drain tiles direct water to hydraulic infrastructure like ditches, culverts, detention basins and bridges. When a community's transportation system is compromised by increasing heavy precipitation, flooding and winter rain flowing down a drainage area, transportation or public works departments can be part of a community solution for managing water.

MnDOT, tribal and local communities already play important roles supporting community-based strategies through partnership with other governments, landowners and land managers. Building on existing work and engaging partners early in the project development process to encourage collaborative planning can help deliver projects that support shared community transportation and resilience needs.

Tactical responses to increase transportation infrastructure and community resilience, like enhanced and compensatory storage, water treatment and retention, enhanced storm management designs, increasing soil health and nature-based designs will continue to be important ways to manage increased runoff from larger drainage areas.

Snow Fences

Snow fences are typically placed outside of a roadway right of way to help prevent blowing snow from drifting and settling on the roadway by detaining snow upwind from roadways. The need for fencing disproportionately exists in rural parts of Minnesota with fence placement mostly happening on adjoining private property that serves agricultural purposes. When placed on private agricultural property compensation agreements reflect lost agricultural capacity due to permanent or temporary fencing. An example of a temporary fence would be rows of unharvested corn left standing.

Snow fence in southwestern Minnesota.

Snow fence designs are developed with structural and natural components and placed at optimized distances from roadways. The detention of a snowpack's snow water equivalent away from ditches, culverts and bridges increases the capacity for these transportation assets to manage mid-winter or springtime snowmelt. These fences help provide safer, more consistent driving conditions during winter months and they reduce maintenance costs, maintenance needs and dramatically reduce chloride use.

WILDFIRE PROTECTION

Related Climate Hazards: Wildfire, Drought

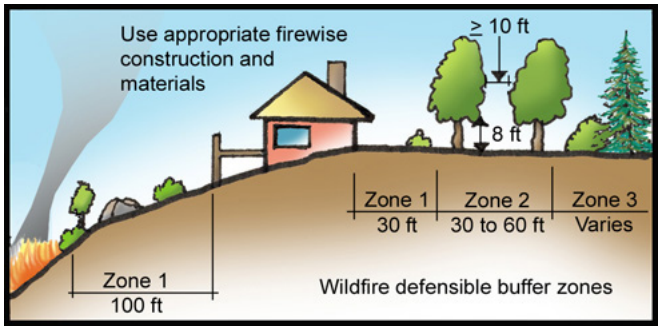
Defensible space, fire-resistant landscaping, vegetation management such as prescribed burns and hardening can protect the transportation system from risks associated with wildfire. MnDOT and partners can use these strategies in:

- forest-covered lands, brush-covered lands, grass-covered lands or land that is covered with flammable material.
- areas where Minnesota has primary financial responsibility for prevention and suppression of wildfires, and
- moderate, high or very high fire hazard severity zones as identified by fire prevention agencies and/or local authorities.

Defensible Space

MnDOT and other units of government across Minnesota have offices, truck stations, rest areas, and other facilities within areas of significant wildfire burn probability.

Preventing wildfire damage to facilities and assets can be as simple as providing defensible space around these structures. Defensible space is a buffer that is created between a building or asset and the combustible vegetation surrounding it. Maintaining an open, defensible space can help firefighters respond effectively and can help slow or stop the spread of wildfire and protect the building from radiative heat impacts. Defensible space can be applied to both buildings and along roadway right of ways.



Wildfire defensible buffer zone. (Conservation buffers, US Forest Service)

Fire-Resistant Landscaping

Planting low-flammability plants and/or ensuring timely and appropriate maintenance practices can reduce the accumulation of dead vegetation, especially when the maintenance happens before fire season. Using fire resistant landscaping along the right-of-way and outside of facilities can inhibit fire ignition and slow or stop the spread of an existing wildfire. Water conservation is another benefit of fire-resistant landscaping, as plants that are fire-resistant are typically drought- tolerant natives. Creating a fire-resistant landscape involves using high-moisture plants that are resistant to ignition and have a low sap content, trees that are less flammable than other species, and rock, mulch, gardens, stone walls and other landscape features to create fire breaks.

Hardening

MnDOT and partners can also harden facilities to prevent ignition and damage to buildings and assets by using ember- and heat-resistant materials. Some of these changes are straightforward and are already being implemented by many states. For example, in some cases, state DOTs have replaced plastic culverts with metal ones to prevent them from melting in the event of a wildfire.

ARMORING AND NATURAL DESIGN TO PROTECT THE LAKE SUPERIOR COASTLINE

Related Climate Hazards: Coastal Erosion, Heavy Precipitation, Drought and Abnormal Winter Weather

Coastal erosion along Lake Superior is caused by: geology, heavy precipitation, runoff, drought, abnormal winter weather and fluctuations in Lake Superior's water levels. Transportation and public works departments will need to consider each of these variables when they select appropriate engineering strategies like sea walls and bulkheads, revetments and slope erosion protection, and groins as jetties as well as natural infrastructure solutions like living shorelines, barrier islands, sand and rock beaches, dunes and lake vegetation beds to manage erosion.

The key considerations for engineering designs that adapt to climate change along Lake Superior is accounting for the uncertainty of future lake levels. Engineering designs that rely on historic levels may not take the uncertainty of changing lake elevations into account. Project managers should consider a range in values and select strategies that perform well under a wide set of circumstances. Natural infrastructure adaptations often perform well under a range of values because when they are designed, installed and maintained appropriately, they can naturally adapt to evolving conditions.

Appendix B provides additional information about the connections between climate hazards and strategies to consider along the coast of Lake Superior.

Sea Walls and Bulkheads

Sea walls and bulkheads protect an asset from wave erosion. They tend to be either concrete or engineered fill structures (sea walls) or a retaining structure to support an asset subjected to somewhat lower levels of erosive force (bulkhead). Consequently, sea walls are typically more massive and more capable of resisting greater wave forces than a bulkhead. Design parameters for these types of facilities are well established (scour depth, design wave energy, etc.); however, for resilient design and adaptation, assumptions should incorporate updated parameters based on the anticipated conditions for the future. Based on the variability of the coastline conditions, these structures must be designed on a site-specific basis to ensure that they are appropriately incorporated into a given site.

Revetments and Slope Erosion Protection

Revetments and slope armoring are some of the most common engineered strategies in coastal zones. Benefits include long-term protection for a roadway infrastructure, as well as people traveling along the roadway. Large rock slope protection is the most widely used and tested method. The key elements include placement of core rock to provide the structural core of protection and placing large stones, boulders or rip rap as the outer protective layer for the installation. Design parameters for these types of facilities are well established (scour depth, design wave energy, etc.). For adaptation purposes, design assumptions and parameters should be updated based on anticipated conditions in the future.

Groins and Jetties

Groins and jetties typically extend into the water next to a road or highway. These structures help encourage beach formation by trapping sand that is moved by near-shore currents. These structures accumulate sand on the "upstream" side as the structure intercepts sand moving along the shore that is moved by repeated wave action. By accumulating sand deposits, the structures protect against lake level rise, storm events, beach erosion and cliff retreat. Site-specific considerations become important in designing these structures as the direction of littoral drift can change along the coastline. Another consequence of interrupting the littoral drift is that erosion nearly always increases downstream of the structure as the sediment that normally protects that part of the coast is being removed from circulation as it accumulates on the upstream side. Careful planning of downstream consequences is important to the overall success of a given design. As with other engineered solutions, design parameters for these types of facilities are well established; however, for resilient design and adaptation, assumptions should incorporate updated parameters based on the anticipated future conditions.

Living Shorelines/Shoreline Stabilization

Living shorelines often combine several nature-based strategies to create a shoreline that captures the benefits of natural infrastructure solutions for coastal protection. These shoreline stabilization combinations are site-specific and may include different types of vegetation. Living shorelines can also take a hybrid approach and combine green and gray infrastructure (structures, armatures, aggregates and geotextiles) where appropriate. Living shorelines are most effective when they use native vegetation and are designed in such a way to blend with their surrounding ecosystem. Living shorelines protect against damage caused by rising lake levels and erosion by buffering wave energy and increasing the shoreline elevation. Living shorelines typically require little maintenance once established and are less costly than traditional infrastructure alternatives.

Barrier Islands

Barrier islands protect land from strong waves and currents, while also promoting coastal features like bays, lagoons and marshlands, which have their own benefits in protecting coastal areas. These islands develop and grow based on shifting lake levels and changing weather patterns and can experience serious erosion. Enhancing the ability of barrier islands to withstand these stresses in the long run maintains or possibly enhances a barrier island's effectiveness.

Sand and Rock Beaches

Similar in concept to barrier islands, sand dunes and rock beaches absorb the energy from storm winds and waves. This leads to less flooding as a result of lower storm surge along the coast. This strategy includes placing additional sand on a beach or including rocks to accomplish the same goal. One of the challenges with expanding sand beaches or enhancing their ability to reduce storm surge impacts is that there is no guarantee that the sand will stay on the beach. There are many examples of where communities have provided additional sand to mitigate the effects of wave action only to see the sand disappear into the water body.

POLICY AND PROCEDURE UPDATES TO ADVANCE CLIMATE RESILIENCE

Review and Revise Design Guidance to Incorporate Future Climate Projections

MnDOT is developing hydraulic resiliency design guidance and supporting resources for designers to appropriately apply future climate projections to hydraulic engineers. This guidance includes introduction of a "check storm" analysis which guides the designer to evaluate an event that exceeds the design event, identify potential flood risk and consider incorporating adaptation strategies to reduce flood risk.

MnDOT is also developing a database of records from previous flood and heavy rainfall events that resulted in damage to MnDOT infrastructure. Once completed, the database is intended to be used throughout the Transportation Project Development Process, but particularly during the planning and scoping phases, to identify locations on state highways where damage from flood or heavy rainfall events has occurred and therefore mitigation measures may be needed. The database will consist of data collected from various sources including District flood response records, emergency relief records, maintenance records and other flood-related information. This dataset could be considered along with other datasets, such as one showing culvert condition, to further assess flood vulnerability statewide.

PLANNING, COMMUNICATION AND EDUCATION EFFORTS

PROTECT Formula Funds: Minimum 2% for Planning

The Infrastructure Investment and Jobs Act specified a minimum 2% of a state's PROTECT Formula Funds must be used for planning purposes. MnDOT will use these funds in ways that yield statewide benefits by increasing the understanding of one or more climate hazards or increase the technical capacities for transportation professionals to building resilient responses to one or more of Minnesota's climate hazards.

Corridor Planning and Regional Vulnerability Assessments

MnDOT added staff focused on corridor planning in 2023. The unit's initial tasks are to establish consistent guidance for the creation of corridor plans around the state and to prioritize which state highway corridors MnDOT will direct planning resources toward. The Resilience Improvement Plan can be incorporated into both of these efforts. In addition, the RIP can inform district planning efforts beyond the corridor plans. For example, MnDOT will explore developing regional vulnerability assessments for the agency's 8 construction Districts.

Trainings

In 2024, MnDOT is partnering with the National Highway Institute to provide training for MnDOT staff on addressing climate resilience in highway project development and preliminary design. The training will cover past, current and future climate conditions, temperature and precipitation projections, systems-level vulnerability assessments and adaptation analysis for project decision making. MnDOT will develop additional training to help MnDOT staff and partners incorporate climate resilience into project planning, scoping and design. Training will emphasize opportunities to address climate hazards and vulnerabilities that Minnesota has already experienced. If there is interest, similar training may be expanded to include tribal and local governments.

Additional Communication

Additional communication will focus on keeping MnDOT staff and partners informed about statewide transportation climate resilience efforts, MnDOT progress on resilience performance measures, standardized messaging and protocols during system disruptions and additional training opportunities.

CHAPTER 5

HOW WILL MNDOT AND PARTNERS USE THE RESILIENCE IMPROVEMENT PLAN?

- Data from the RIP could be added to the Corridor Risk Map Tool to integrate climate resilience information into the asset managing and planning process for MnDOT.
- Information from the RIP serve as a companion to the MnDOT Guidance on State Environmental Assessment Worksheet (EAW) Questions on Climate Adaptation and Resilience and Greenhouse Gas Emissions/Carbon Footprint during project scoping and design.
- MnDOT developed project selection criteria that MnDOT Districts and Area Transportation Partnerships are encouraged to use to select projects for PROTECT Formula program funding.
- MnDOT, tribal and local governments can pursue additional funding like the PROTECT Discretionary Grant Program when PROTECT Formula funding is not sufficient to address priority resilience projects.
- See Appendix F for a list of FY25-28 PROTECT Formula Program Projects and PROTECT Discretionary Program Applications and Appendix E for Interactive Climate Risk Scores Map Guidance.

MnDOT and partners will use the RIP to inform additional research, asset management planning, project scoping, project design and project selection. As MnDOT begins to implement the RIP, more details and clarity around roles may be needed. The PROTECT formula program is just one of many avenues to implement projects to advance climate resilience. The "Project Scoping and Design" and "Project Programming" sections describe how MnDOT and partners can use data from the RIP to assess risk in the near-term to inform project selection.

As part of our commitment to adopting a systemic approach, MnDOT acknowledges the importance of coordination with various modes of transportation, including transit, fixed rail and alternative modes such as biking and pedestrian pathways. To ensure comprehensive planning and effective risk assessment, MnDOT will engage collaboratively with Metropolitan Planning Organizations (MPOs) that oversee transit agencies, as well as Greater Minnesota Transit Agencies.

ADDITIONAL RESEARCH

The RIP provides a high-level vulnerability assessment to understand key climate hazards and risks to Minnesota's surface transportation system. Data included in the RIP are not intended to be used to design project elements, e.g. exact culvert sizes. Instead, the data are meant to flag near and long-term climate hazards that may affect a project's lifecycle costs or a project's resilience (e.g. should upsizing a culvert be considered in a project location). MnDOT and transportation partners will conduct additional research to translate the vulnerability assessment findings into quantitative data that can inform project design.

Understanding more about the potential risks of heavy precipitation and flooding is a priority because the RIP revealed that it is the top climate hazard in Minnesota. In 2022 MnDOT completed an Extreme Flood Vulnerability Assessment that analyzed flood vulnerability in one

Minnesota county. The assessment used a quantitative method for characterizing the flood vulnerability of bridges, large culverts and pipes. MnDOT's Bridge Office is in the process of building on this analysis to conduct a statewide assessment of the extreme flood vulnerability of bridges, large culverts and pipes on MnDOT's system. MnDOT lacks similar asset data for other transportation networks and cannot do a similar analysis of non-MnDOT assets. The current phase of this project is refining the tool for use. Completion of the next project phase will allow project managers to better understand the potential for inundation along sumps on both the Trunk Highway system and other transportation systems across the state.

The results from the EFVA tool can be combined with other datasets to identify and prioritize flood resilience projects and could potentially also be used to evaluate design alternatives.

As MnDOT conducts additional research, the agency will explore the following questions:

- How can the statewide Extreme Flood Vulnerability Assessment incorporate new climate modeling data when it is released (e.g. CMIP6, CMIP7, etc.)?
- How can assessments incorporate a confidence interval to account for uncertainties in projections?
- How can assessment data be built into decision making tools (e.g. Bridge Office Replacement and Improvement System (BORIS), Transportation Asset Management System (TAMS)?
- Can MnDOT start measuring moisture accumulation during winter storms so that during one storm event the volume of winter rain and the snow water equivalent can be considered by maintenance operations?

As MnDOT prepares vulnerability assessments for additional asset types, the goal will be to deliver vulnerability assessments designed in a similar, risk-based quantitative way with similar outputs. This will allow for easier comparisons between asset types which support benefit costs analysis and prioritized decisions between asset types.

ASSET MANAGEMENT PLANNING

The Transportation Asset Management System (TAMS) is MnDOT's primary enterprise asset and work management system for pavement and ancillary assets such as signals, lighting, traffic barriers, signs, drainage infrastructure (e.g., pipes, structures, ponds, tunnels), pavement markings and intelligent transportation assets (e.g., dynamic message signs, traffic monitoring cameras, Road Weather Information Systems). The system tracks asset inventory, condition and maintenance work performed on the asset. This data helps guide critical agency decision making. For example, system data is used to report on the Minnesota State Highway Investment Plan (MnSHIP) and Transportation Asset Management Plan (TAMP).

TAMS includes information that will help future resiliency tracking efforts. For example, MnDOT tracks culvert repairs that happen because of flooding. MnDOT also uses TAMS to track maintenance costs due to roadway repair from blow-ups.

As part of asset management planning, MnDOT is creating a Corridor Risk Map Tool to capture and present critical risk-based information to key decision makers. The tool will allow MnDOT to manage risk across several asset classes and assessed at statewide, district and corridor levels. It will contain several layers, including asset condition, bridge health index, slope vulnerability index and individual asset risk ratings that include likelihood and consequence of failure. Data from the RIP could be added to the Corridor Risk Map Tool to integrate climate resilience information into the asset managing and planning process.

MnDOT Hydraulics is also collaborating with Maintenance and District Hydraulics/Water Resources staff throughout all MnDOT Districts to develop a database of locations that have experienced flooding in the recent past. This database can help inform project scoping and design

decisions, validate the results of the Extreme Flood Vulnerability Analysis and data from the RIP, demonstrate the widespread nature of flood impacts to support funding requests, inform project scoping and design decisions and ultimately lead to flood mitigation project implementation.

PROJECT SCOPING AND DESIGN

MnDOT Guidance on State Environmental Assessment Worksheet (EAW) Questions on Climate Adaptation and Resilience and Greenhouse Gas Emissions/Carbon Footprint can help inform designers during project scoping and design. While not all MnDOT projects are required to complete an EAW, this guidance offers best practices and supplements EQB's Revised EAW Guidance, which includes developing a carbon footprint and incorporating climate adaptation and resilience. In addition to introducing the concept of a "check storm" consistent with the hydraulic resiliency design guidance, the Guidance on State EAW Questions on Climate Adaptation also provides the suggested questions to consider during project scoping that can help inform design decisions and assess current and future vulnerabilities. Information from the RIP can help answer some of the questions:

- How might future projections of rainfall depth and intensity impact stormwater management system design?
  - How might the stormwater drainage system perform with future projected rainfall intensities? If pipes or culverts are overwhelmed, where does the runoff go and is there risk of damage?
  - Could stormwater BMP performance be impacted by projected rainfall depths?
- Are there water bodies receiving stormwater discharge from the project expected to be impacted by climate change? Could different tailwater conditions for the stormwater management system affect system performance?
- Does the project involve crossing a waterway which is projected to be impacted by climate change? What is the anticipated impact on vertical clearance and/or structure size?
- Is the project located within or near a floodplain which may be impacted by climate change?
- If peak water levels identified in design of various stormwater management features increase, will critical infrastructure be impacted?

PROJECT PROGRAMMING

Project programming is a critical way for MnDOT and partners to build resilience in the transportation system. There are two funding avenues for highway improvements in Minnesota: MnDOT Project Programming and State Aid Project Programming. Each of these different programming categories address different project types and pull from differing funding sources.

MnDOT Project Programming refers to projects programmed and funded directly by MnDOT. To select and prioritize MnDOT projects, MnDOT is guided by the 20-year State Highway investment Plan (MnSHIP). This document determines the amount of money planned for a variety of project types, including projects addressing safety, mobility, repair and replacement of existing infrastructure and others. MnDOT district and specialty office staff use a scoring framework to prioritize and select projects to fund and implement within each category. These are recorded in the 10-year Capital Highway Investment Plan (CHIP) and the 4-year State Transportation Improvement Plan (STIP).

State Aid for Local Transportation ("State Aid" for short) is a program that administers funds to the County State Aid Highway (CSAH) and Municipal State Aid Street (MSAS) programs. These are funded through the Highway User Tax Distribution Fund. It is also used to distribute Federal Aid highway dollars and state bonding and general funds. The important distinction for this program is that MnDOT does not exercise direct control over project selection and implementation; MnDOT only administers the program, with funding for local governments distributed through

a formula and project selection and prioritization done at the local level. These projects are often conducted with a supportive relationship between MnDOT and the local municipalities.

Ultimately, since both funding avenues are used for project implementation, they will play a key role in addressing resilience in Minnesota. In the future, information from the RIP can inform the development of additional project programming considerations related to resilience.

PROTECT Formula Program Project Evaluation and Selection

MnDOT distributes PROTECT Formula Program through the MnDOT Districts and Area Transportation Partnerships (ATPs). Table 2 shows the funding targets for Federal Fiscal Years 23-28. MnDOT District staff will coordinate the climate resilience needs and priorities of their district to ensure the PROTECT Formula Program projects align the with the RIP and federal requirements. For funds provided to the ATPs, the ATP will solicit and select projects based on guidance in the RIP. MnDOT Districts and ATPs will have the flexibility to select projects that align with their regional priorities while maintaining consistency with the RIP and the PROTECT Formula Program priorities.

TABLE 2. ANNUAL FUNDING DISTRIBUTION TARGETS, PROTECT (FY 2024 – 2028)

	FY2024		**FY2025**		**FY2026**		**FY2027**		**FY2028**	
	Districts	ATP	District	ATP	District	ATP	District	ATP	District	ATP
District 1	1,400,000		1,750,000		1,500,000					
ATP 1		800,000		800,000		600,000		500,000		500,000
District 2	900,000		1,125,000		1,000,000					
ATP 2		500,000		500,000		400,000		300,000		300,000
District 3	2,000,000		2,500,000		2,125,000					
ATP 3		1,200,000		1,200,000		900,000		700,000		700,000
District 4	1,400,000		1,625,000		1,500,000					
ATP 4		600,000		600,000		400,000		300,000		300,000
District 6	1,400,000		1,750,000		1,500,000					
ATP 6		1,000,000		1,000,000		700,000		600,000		600,000
District 7	1,200,000		1,500,000		1,250,000					
ATP 7		700,000		700,000		500,000		400,000		400,000
District 8	700,000		875,000		750,000					
ATP 8		500,000		500,000		400,000		300,000		300,000
Metro District	9,000,000		11,250,000		9,625,000					
ATP M		6,400,000		6,400,000		4,800,000		3,600,000		3,600,000

MnDOT developed project selection criteria that MnDOT Districts and Area Transportation Partnerships are encouraged to use to select projects for PROTECT Formula program funding. The selection criteria are based on best practices in other states for integrating resilience into the project selection process.

PROTECT projects are meant to increase transportation system resilience. PROTECT funds can be used to fund complete projects or to increase the resilience of elements within a larger transportation project. The following selection criteria are intended to score the resilience elements of either a complete project or the project elements that would receive PROTECT funds. For example, a transportation or a public works department could use the following criteria to determine whether mitigating slope vulnerability within a project would score better than mitigating flood vulnerability within a different project. The scoring would be used to compare and prioritize which of the two resilience improvements should receive PROTECT Formula funds.

Project Readiness

The PROTECT Formula Program presents an immediate opportunity to deliver projects. It's important for projects to be well developed and ready for construction. MnDOT and partners can evaluate project readiness by assessing the key milestones that a project has met. Examples of key milestones include preliminary engineering and environmental compliance steps. Also, if a project is identified in another plan (e.g. comprehensive plan, safety study, etc.) it should receive a higher score for project readiness.

Resilience Costs and Benefits

MnDOT and partners should consider whether the proposed project offers resilience benefits. One way to evaluate this criterion is to review whether the project incorporates one or more of the project-level strategies described in Chapter 4 of the RIP and whether the strategies fit with climate hazards and asset condition at the location. Subject matter experts, like MnDOT hydraulic engineers, should be involved in evaluating the resilience benefits of proposed projects.

Potential Climate Hazard Impacts

When evaluating potential climate hazard impacts, MnDOT and partners should consider whether the asset has a high risk of impacts from the climate hazards identified in the RIP including heavy precipitation and flooding, extreme temperatures, freeze-thaw changes, wildfire and coastal erosion. The RIP data will be available as an interactive map (MnDOT Climate Resilience webpage) to help MnDOT and partners assess the risk of individual climate hazards. MnDOT and partners can also use information from the Extreme Flood Vulnerability Tool or past flood recordkeeping database, as available, to assist with this step of evaluation.

Asset Vulnerability

The RIP does not include information about asset condition or capacity, but this is an important consideration when prioritizing and selecting projects to receive funding. MnDOT and partners should consider asset condition and capacity to generate a more comprehensive risk assessment. For MnDOT, asset condition is available from several asset management systems like BORIS And TAMS for MnDOT assets. Asset capacity can be determined through Hydrologic & Hydraulic Modeling, Bridge Hydraulic Report or can be approximated based on flood history observations. For partners that do not use an asset management system, seeking guidance from Maintenance staff will provide valuable insights into where vulnerable assets may exist. MnDOT and partners should prioritize projects that address assets in poor condition that have high risks associated with at least one climate hazard.

Past History

Past history can also provide a more complete picture of asset vulnerability that can assist with project prioritization. MnDOT and partners should consider whether the asset has a demonstrated history of damage or failure or resulted in direct impacts to users such as detours due to road closures. This information may be available in the database of locations which have experienced flooding in the recent past. This information may also come from local maintenance staff by requesting anecdotal evidence of repeated damage or failure.

Co-benefits

Projects should advance equity, safety, access and health to be consistent with MnDOT priorities. MnDOT and partners can evaluate project equity impacts by considering the extent to which the project benefits disadvantaged communities. Project selection teams should use the Justice40 tool and other tools to identify disadvantaged communities and evaluate potential benefits. MnDOT and partners can evaluate project safety benefits by considering the project's potential to reduce crashes and whether the project serves an existing high crash rate area, particularly for vulnerable road users. Project selection teams should use the MnDOT Vulnerable Road User Assessment to evaluate project safety benefits.

MnDOT and partners can evaluate access by considering the extent to which the project will increase multimodal travel options, particularly by those without access to a motor vehicle. MnDOT and partners can also assess health by considering the project's potential to protect human health by reducing risks caused by climate hazards.

PROTECT Discretionary Program Projects MnDOT, tribal and local governments can pursue additional funding like the PROTECT Discretionary Grant Program when PROTECT Formula funding is not sufficient to address priority resilience projects. See Appendix F for a list of FY25-28 PROTECT Formula Program Projects and PROTECT Discretionary Program Applications.

MnDOT Maintenance teams have access to spiked ice rollers when freeze thaw cycles create persistent roadway ice that cannot be removed using traditional methods like snowplow blades and sand and chemical applications.

CHAPTER 6

HOW WILL MNDOT AND PARTNERS EVALUATE PROGRESS ON THE RESILIENCE IMPROVEMENT PLAN AND MAKE UPDATES?

- MnDOT will assess plan implementation using performance measures including adaptation/natural environment, asset condition and vulnerability, and climate/extreme weather impacts.
- MnDOT will update the project list in the RIP twice annually, with a comprehensive update planned for 2026 to align with the update cycle for the Statewide Multimodal Transportation Plan.

PERFORMANCE MEASURES

MnDOT will assess RIP implementation against three categories of climate resiliency performance measures: adaptation/natural environment, asset condition and vulnerability and climate/extreme weather impacts. These performance measures are focused on the state transportation system.

ADAPTATION/NATURAL ENVIRONMENT

Performance measures in this category describe how the system is being adapted to mitigate against climate change and/or how using natural features or vegetation helps achieve that goal. Adaptation/natural environment performance measures address stormwater treatment, trees and shrubs, native vegetation – seeding, native vegetation – planting and designs that incorporate climate projections.

Stormwater Treatment

Performance Measures: no more than 10% of a transportation system's stormwater treatment features rated in Very Poor and Failing condition.

This measure was selected to start identifying and prioritizing the major stormwater treatment features on the trunk highway system at risk of failing to help determine the system's resilience. The initial measure was selected as a simple way to track current features installed.

Trees & Shrubs

Performance Measure: Percentage of trees and shrubs surviving after 2 years, report separately for rural and urban areas (2 categories).

Tree and shrubs, particularly in urban areas, are important for providing shade and reducing urban heat spots. Data on trees planted as part of construction projects is already captured in the AASHTOWare software system. This is more of a community resilience measure instead of an infrastructure resilience measure. This performance measure may help identify environmental justice issues related to the transportation system.

Native Vegetation - Seeding

Performance Measure*:* Percent of seeding using native vegetation

Native vegetation is better able to protect our infrastructure from extreme weather. It creates an improved soil structure that is has a higher capacity to absorb stormwater runoff. The variety of locally-adapted species create plantings that are better able to withstand droughts, wet periods, heat waves and cold spells. This allows the roadside vegetation to reliably protect the transportation infrastructure.

Native Vegetation - Planting

Performance Measure: Percent of plants using native vegetation

Native species are locally adapted and better able to perform their necessary functions through extreme weather, similar to native vegetation through seeding.

ASSET CONDITION & VULNERABILITY

Performance measures in this category describe specific asset conditions that either directly measure vulnerability to climate change or are proxies for potential vulnerabilities in the system. These performance measures are measuring asset conditions for the current system and were selected because they can be controlled or directed by transportation and public works departments. Asset condition and vulnerability performance measures track highway culvert condition, bridge culvert condition and scour critical bridges. When new statewide vulnerability assessments are complete, they may be used to inform additional performance measures.

Highway culvert condition

Performance Measure: Percent of highway culverts in poor or very poor condition.

Target = 10% or fewer in poor or very poor condition

Highway culvert condition is considered an excellent proxy of the vulnerability of a culvert. Culverts in poor and very poor condition are more likely to washout.

Bridge culvert condition

Performance Measure: Percent of bridge culverts in poor condition (NBI 4 or less).

Target = 4% or fewer poor (NHS), 10% or fewer poor (Non-NHS)

Bridge culverts are defined as culverts with span of 10-ft and greater. Bridge culvert condition is considered an excellent proxy of the vulnerability of a culvert. Bridge culverts in poor condition are more likely to washout. This is a similar measure to the highway culverts, but for bridge size culverts.

Scour critical bridges

Performance Measure: Number of scour critical bridges on the trunk highway system.

Target = 0 scour critical bridges on the trunk highway system

There was a significant effort starting in the late 1980's to identify the risk of bridge failure due to scour. All bridges on the system are evaluated for scour criticality and have a scour rating. This measure is to primarily showcase the important work done to minimize the risk of bridge failure due to scour. Scour is considered in the bridge project selection methodology, as one of the risk drivers.

CLIMATE/EXTREME WEATHER IMPACTS

Performance measures in this category describe how the system has been impacted by climate or extreme weather. These performance measures cannot be controlled or directed by transportation or public works departments. Performance measures address flooding/washouts and pavement blow-ups.

Flooding/Washouts

Performance Measure: Dollars spent on maintenance for flooding/washouts annually.

The impacts of flooding and washouts are best described by dollars expended to clean-up and fix those areas. Developing a list and tracking the location of floods and washouts that create repeated damage or impact the traveling public can help determine where the most cost-effective resilience investments can be made. MnDOT tracks flooding and washouts in a Transportation Asset Management System (TAMS) and can spatially analyze where persistent challenges exist.

PROGRESS EVALUATION AND PLAN UPDATE CYCLE

MnDOT will evaluate the performance measures associated with the RIP annually. Some of the information will be available on the MnDOT Performance Measures Dashboard and in the annual Transportation System Performance Reports which are archived on the Dashboard webpage.

MnDOT will update the project list in the RIP twice each year. MnDOT and partners will complete a more comprehensive RIP update in 2026 to align with the update cycle for the Statewide Multimodal Transportation Plan (SMTP). Information from the RIP will be incorporated into the SMTP during the next update in 2027. The RIP update will incorporate any changes to statewide transportation policy goals and objectives. The update may also include adjustments to the plan update cycle. MnDOT will lead the update with coordination and cooperation from ATPs, local transportation partners, state agencies, climate experts and Tribal Nations in Minnesota.

UPDATE CONSIDERATIONS

MnDOT and partners will consider several questions during the RIP update:

What's changed in the transportation sector?

It will be important to consider changes in state policies, as reflected in the updated modal plans and SMTP and any new legislation related to climate resilience and adaptation. The update should include a review of any changes in MnDOT's approach to decision making, including any relevant changes to asset management, project scoping, project design, project selection and performance measurement.

How can we support climate resilience for vulnerable users?

MnDOT will broaden the scope of the RIP during the next update to better address the needs of people walking, biking, and using transit.

What are the interdependencies between critical sectors?

MnDOT will explore interdependencies between the transportation sector and other critical sectors like the power sector and agricultural sector. It will be important for MnDOT to review the best available information about resilience in other critical sectors and engage sector representatives in the planning process.

How has the climate changed/increased in resilience in the last 4 years?

It will also be important to consider how Minnesota's climate continues to change. The update should include a review of the best available climate modeling data and an updated vulnerability assessment, as well as a new national scan of best practices for advancing resilience.

How have we spent the PROTECT formula funds and what has their impact been?

It will be valuable to evaluate investments from the PROTECT formula program to understand the types of projects that MnDOT and partners funded, as well as their resilience benefits.

Based on information from these considerations, MnDOT will be positioned to design a more effective approach to preparing and implementing the RIP.

APPENDIX A
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APPENDIX B

EXPOSURE METRICS USED TO DEVELOP HAZARD RATINGS

TABLE A1: EXPOSURE METRICS USED BY ASSET-HAZARD COMBINATION

Hazard	Asset Type Affected	Measure/Depiction
Extreme heat	Roads (asphalt binder grade)	Average annual degree days over 50°F
	Bike paths (asphalt binder grade)	Average annual degree days over 50°F
	Bridges (thermal expansion)	Maximum four day moving average high temperature
Extreme cold	Roads (asphalt binder grade)	Absolute minimum temperature over 30-year period
	Bike paths (asphalt binder grade)	Absolute minimum temperature over 30-year period
	Bridges (thermal contraction)	Minimum four day moving average low temperature
Freeze-thaw	Roads (pavement)	Number of days per year with high temperature >= 32°F and low temperature < 32°F
	Bike paths (pavement)	Number of days per year with high temperature >= 32°F and low temperature < 32°F
	Bridges (concrete)	Number of days per year with high temperature >= 32°F and low temperature < 15°F
	Slopes (rockfall)	Number of days per year with high temperature >= 32°F and low temperature < 32°F

Hazard	Asset Type Affected	Measure/Depiction
Heavy precipitation and flooding	Roads	2019 SMHMP (largely FEMA) 100-year floodplain
	Bike paths	2019 SMHMP (largely FEMA) 100-year floodplain
	Bridges	Percent change in 24-hour precipitation depth in hydraulic unit code 4 or 10 watershed for 50-year return period
	Large culverts	Percent change in 24-hour precipitation depth in hydraulic unit code 4 or 10 watershed for 50-year return period
	Pipes (highway culverts)	Percent change in 24-hour precipitation depth in hydraulic unit code 4 or 10 watershed for 50-year return period
	Pipes (entrance culverts)	Percent change in 24-hour precipitation depth at asset for 10-year return period
	Stormwater ponds	Percent change in 24-hour precipitation depth at asset for 100-year return period
	Catch basins & drop inlets	Percent change in 24-hour precipitation depth at asset for 10-year return period
	Stormwater pump stations	Percent change in 24-hour precipitation depth at asset for 50-year return period
	Slopes	Percent change in 24-hour precipitation depth at asset for 100-year return period
	Traffic signals	2019 SMHMP (largely FEMA) 100-year floodplain
	ITS devices	2019 SMHMP (largely FEMA) 100-year floodplain
	RWIS devices	2019 SMHMP (largely FEMA) 100-year floodplain
	WIM and ATR devices	2019 SMHMP (largely FEMA) 100-year floodplain
	Buildings	2019 SMHMP (largely FEMA) 100-year floodplain

Hazard	Asset Type Affected	Measure/Depiction
Winter weather	Roads	Average annual precipitation depth on days when maximum temperature < 32°F
		Annual average maximum precipitation depth on days when maximum temperature < 32°F
Wildfire	Roads	Annual wildfire burn probability
	Bike paths	
	Bridges	
	Culverts	
	Stormwater pump stations	
	Slopes	
	Traffic signals	
	ITS devices	
	RWIS devices	
	WIM and ATR devices	
	Buildings	
Coastal erosion	Roads	Lake Superior shoreline erosion susceptibility mapping
	Bike paths	
	Bridges	
	Culverts	
	Stormwater ponds	
	Catch basins & drop inlets	
	Stormwater pump stations	
	Slopes	
	Traffic signals	
	ITS devices	
	RWIS devices	
	WIM and ATR devices	
	Facilities	

DATA SOURCES FOR EXPOSURE METRICS

Measure/Depiction	Data Source
Average annual degree days over 50°F	LOCA[1] CMIP6[2]
Maximum four day moving average high temperature	LOCA CMIP6
Minimum four day moving average low temperature	LOCA CMIP6
Absolute minimum temperature	LOCA CMIP6
# of days per year with high temperature >= 32°F & low temp. < 32°F	LOCA CMIP6
# of days per year with high temperature >= 32°F & low temp. <= 15°F	LOCA CMIP6
100-year floodplain	2019 SMHMP
% change in 24-hr. 10-year precip. depth	LOCA CMIP5 to align with projections in the ongoing Extreme Flood Vulnerability Assessment (EFVA) study[3]
% change in 24-hr. 50-year precip. depth	LOCA CMIP5 to align EFVA projections
% change in 24-hr. 100-year precip. depth	LOCA CMIP5 to align EFVA projections
Annual precipitation depth on days when max temp. < 32°F	LOCA CMIP6
Annual max precipitation depth on days when max temp. < 32°F	LOCA CMIP6
Annual wildfire burn probability	Northeast-Midwest State Foresters Alliance Northeast-Midwest Wildfire Risk Explorer
Coastal erosion and lake level variability	Arrowhead Regional Development Commission

[1] Locally Constructed Analogues (LOCA), a statistically-based method of climate model downscaling (spatial resolution enhancement)
[2] Coupled Model Intercomparison Project (CMIP), a United Nations' Intergovernmental Panel on Climate Change (IPCC) led effort to coordinate climate modeling amongst various research groups around the world. CMIP6 is the latest round of this ongoing project.
[3] Extreme Flood Vulnerability Assessment, MnDOT study to look at climate risks to bridges and culverts.

APPENDIX C

RISK VULNERABILITY ASSESSMENT: ADDITIONAL FIGURES

TABLE A1. PROPORTION OF ROADWAY MILEAGE WITHIN THE PRESENT DAY 100-YEAR FLOODPLAIN BY MNDOT DISTRICT

MnDOT District	MnDOT Roads	Other Public Roads
1	2%	2%
2	5%	6%
3	2%	2%
4	2%	2%
Metro	2%	2%
6	3%	3%
7	2%	2%
8	2%	2%

TABLE A2. AVERAGE ANNUAL NUMBER OF DAYS OVER 95 BY MNDOT DISTRICT

MnDOT District	Past Climate	Mid-Century		Late Century	
		Lower Emissions Scenario	Higher Emissions Scenario	Lower Emissions Scenario	Higher Emissions Scenario
1	0	3	7	7	29
2	1	7	13	12	41
3	1	10	18	17	50
4	2	13	22	22	57
Metro	2	14	25	24	61
6	1	12	21	21	59
7	3	20	31	31	72
8	4	**20**	31	30	70

TABLE A3. AVERAGE CHANGE IN CONCRETE BRIDGE HIGH TEMPERATURE BY MNDOT DISTRICT

MnDOT District	Mid-Century				Late Century			
	Lower Emissions Scenario		Higher Emissions Scenario		Lower Emissions Scenario		Higher Emissions Scenario	
	MnDOT Bridges	Other Public Bridges	MnDOT Bridges	Other Public Bridges	MnDOT Bridges	Other Public Bridges	MnDOT Bridges	Other Public Bridges
1	6°F	6°F	8°F	7°F	8°F	7°F	14°F	14°F
2	6°F	6°F	9°F	9°F	8°F	7°F	15°F	15°F
3	5°F	5°F	8°F	8°F	7°F	7°F	13°F	13°F
4	5°F	5°F	8°F	8°F	7°F	7°F	14°F	13°F
Metro	5°F	5°F	8°F	8°F	7°F	7°F	13°F	13°F
6	5°F	5°F	8°F	8°F	6°F	6°F	13°F	13°F
7	5°F	5°F	8°F	8°F	6°F	6°F	13°F	13°F
8	5°F	5°F	7°F	7°F	6°F	6°F	13°F	12°F

TABLE A4. PROPORTION OF ROADWAY MILEAGE POTENTIALLY REQUIRING A CHANGE IN THE ASPHALT BINDER GRADE HIGH TEMPERATURE RATING BY MNDOT DISTRICT

MnDOT District	Mid-Century				Late Century			
	Lower Emissions Scenario		Higher Emissions Scenario		Lower Emissions Scenario		Higher Emissions Scenario	
	MnDOT Roads	Other Public Roads	MnDOT Roads	Other Public Roads	MnDOT Roads	Other Public Roads	MnDOT Roads	Other Public Roads
1	2%	2%	0%	0%	0%	0%	13%	14%
2	7%	5%	0%	0%	0%	0%	16%	15%
3	0%	0%	0%	0%	0%	0%	88%	88%
4	0%	1%	0%	0%	0%	0%	82%	80%
Metro	0%	0%	0%	0%	0%	0%	100%	100%
6	0%	0%	0%	0%	4%	3%	100%	100%
7	0%	0%	3%	3%	14%	12%	100%	100%
8	0%	0%	1%	1%	6%	6%	100%	100%

TABLE A5. PROPORTION OF ROADWAY MILEAGE PROJECTED TO EXPERIENCE AN INCREASE IN THE ANNUAL MAXIMUM BELOW FREEZING PRECIPITATION EVENT AMOUNT BY MNDOT DISTRICT

MnDOT District	Mid-Century				Late Century			
	Lower Emissions Scenario		Higher Emissions Scenario		Lower Emissions Scenario		Higher Emissions Scenario	
	MnDOT Roads	Other Public Roads	MnDOT Roads	Other Public Roads	MnDOT Roads	Other Public Roads	MnDOT Roads	Other Public Roads
1	23%	28%	21%	20%	15%	14%	1%	1%
2	73%	74%	65%	66%	53%	57%	34%	35%
3	12%	12%	40%	44%	15%	13%	0%	0%
4	22%	21%	60%	64%	45%	46%	15%	14%
Metro	0%	0%	6%	6%	2%	1%	0%	0%
6	3%	3%	5%	7%	0%	0%	0%	0%
7	30%	33%	55%	62%	5%	4%	0%	0%
8	16%	15%	70%	72%	5%	5%	0%	0%

TABLE A6. PRESENT DAY AVERAGE ANNUAL WILDFIRE BURN PROBABLY ALONG ROADWAYS BY MNDOT DISTRICT

MnDOT District	MnDOT Roads	Other Public Roads
1	0.00016%	0.00055%
2	0.00036%	0.00076%
3	0.00018%	0.00039%
4	0.00022%	0.00029%
Metro	0.00004%	0.00011%
6	0.00002%	0.00005%
7	0.00002%	0.00003%
8	0.00004%	0.00006%

Combining Potential Exposure to Hazards with Potential Traveler Impacts

Figure A1 illustrates how the hazard ratings were calculated. The hazard exposure data were assigned a numerical value ranging between zero and four based on their relative severity compared with other assets of the same type. The numerical values were set such that zero represented very low (or no) exposure and four represented very high exposure. A similar exercise was performed for the two traveler impact metrics with higher numbers assigned to values where potential traveler impacts from a disruption could be high (i.e., roads of higher functional class and/or lower network density) and lower numbers assigned to values where the impacts were assumed to be less. The assigned values were then summed up across all relevant data fields for the given asset type. This summed score (shown in the right-most column in Figure A1) for each asset was then reclassified into the five hazard rating categories shown at the bottom of the figure.

Figure A1. Climate Risk Score Methodology

Asset	Hazard 1 Exposure Current	Hazard 1 Exposure 2040-2069	Hazard1 Exposure 2070-2099	Hazard 2 Exposure Current	…	Federal Functional Class	Network Density	Total
1	0	1	1	1		4	1	8
2	3	3	4	2		3	0	15
3	4	4	4	4		2	4	22
4	2	2	3	1		2	2	12
5	0	0	1	0		4	1	6
…								

Hazard Rating

Very high | High | Medium | Low | Very low

This rating approach was used primarily because of a lack of probabilistic data for some of the hazards and asset types and because of limited resources to collect and process the data. As such, this scoring approach has several limitations. First, using indicators to define different hazard ratings necessarily introduces subjective interpretations. Second, because the assessment is very high level it cannot provide definitive conclusions on whether individual assets will with certainty be adversely affected by a given hazard. Lastly, because different metrics are necessarily used in the scoring for each asset type, the resulting scores are not comparable across asset types: they can only be used to identify relative differences within asset types. Nonetheless, the ratings do provide some sense of which assets may experience more adverse effects from climate change in the future and, consequently, where to focus additional effort to study the risks and possible adaptation options.

TABLE A7: CLIMATE STRESSORS AND POTENTIAL AS CONTRIBUTOR TO LANDSLIDES BY LANDSLIDE TYPE

Landslide Type	Climate Stressor Susceptibility			
	Wildfire	Intense, Short-term Rainfall	Prolonged Rainfall	Rapid Snowmelt
Earth Flow	+++	+	+++	+
Debris Flow	+++	+++	+++	+++
Debris Slide	+++	+++	+++	+
Rock Slide	+	+++	+++	+
Rockfall	+	+++	+++	+

+++ Major potential contribution to landslides
++ Medium potential contribution to landslides
+ Minor potential contribution to landslides

TABLE A8: APPLICABLE LANDSLIDE TYPES FOR RESILIENCE STRATEGIES

Resilience Strategies	Applicable Landslide Types				
	Earth Flow	Debris Flow	Debris Slide	Rock Slide	Rock Fall
Enhanced Drainage	+++	+++	+++	+++	+++
Debris Flow Catchment	+	+++	+++	++	++
Reduction of Driving/ Resistance Force	+++		+++	+++	+++
Subsurface Drainage	+++	+++	+++	+++	+++
Vegetation and Seeding	+++	+++	+	+	+
Bioengineering and Biotechnical Stabilization	+++	+++	+	+	+

Note: Natural infrastructure strategies indicated in green.

+++ Major potential contribution to landslides
++ Medium potential contribution to landslides
+ Minor potential contribution to landslides

TABLE A9: CLIMATE STRESSOR AND HAZARDS MITIGATED BY RESILIENCE STRATEGIES

Resilience Strategies	Wildfire	Intense, Short-term Rainfall	Prolonged Rainfall	Rapid Snow-melt
Enhanced Drainage		+++	+++	+++
Debris Flow Catchment	+++	+++	++	++
Reduction of Driving/ Resistance Force	N/A			
Subsurface Drainage		+++	+++	+++
Vegetation and Seeding	++	+++	++	+
Bioengineering and Biotechnical Stabilization	N/A			

Note: Natural infrastructure strategies indicated in green.

+++ Major potential contribution to reducing hazard impacts
++ Medium potential contribution to reducing hazard impacts
+ Minor potential contribution to reducing hazard impacts

TABLE A10: HAZARD TYPES AND RESILIENCE STRATEGIES FOR COASTAL ENVIRONMENTS

Resilience Strategies	Applicable Landslide Types			
	Lake Level Rise	Storm Events	Beach Erosion	Cliff Retreat
Sea Walls and Bulkheads	+++	+++	+	+++
Revetments and Slope Erosion Protection	+++	+++	++	+++
Groins and Jetties	+++	+++	+++	+++
Living Shorelines/Shoreline Stabilization	+	+++	+++	+++
Barrier Islands	+++	+++	+++	+++
Sand & Rock Beaches	+	+++	+++	+++
Dunes	+++	+++	+	+
Lake Vegetation Beds	+	+	+++	+

Note: Natural infrastructure strategies indicated in green.

+++ Potential for major benefits
++ Potential for medium benefits
+ Potential for minor benefits

APPENDIX D

PUBLIC AND STAKEHOLDER ENGAGEMENT SUMMARY

RESILIENCE ADVISORY TEAM: VULNERABILITIES WORKSHOP

August 4, 2023 | 10:00-11:00

PROJECT TEAM

Brian Shekleton, Chris Dorney, Mike Meyer, Sienna Templeman, Linda Spohr, Jaylen Lyles

WORKSHOP ATTENDEES

MnDOT Resilience Advisory Committee:

Douglas Mati, Rachel Pichelmann, Kristoffer Langlie, Nathan Braman, Keri Her, Katherine Lind, Erin Meier, Cole Norgaarden, Shaker Rabban

KEY QUESTIONS

For each climate hazard:

- What asset types have been impacted?
- Any particular geographic "hot spots" for these impacts?
- What have the implications been to MnDOT (costs, reputation, O&M needs, etc.) and system users (safety issues, inconvenience)?
- Are there any datasets that capture where there have been past impacts that we can draw from for the RIP's vulnerability assessment?
- What has MnDOT done to date to address these issues (e.g., design, monitoring, maintenance, and the like)?
- Any success stories that can be shared where these measures have made a difference?
- What gaps remain and are there specific proposals/ideas for filling those gaps?

WHAT NATURAL HAZARDS ARE CAUSING ISSUES ON THE HIGHWAY NETWORK?

- Extreme heat
- Freeze-thaw frequency
- Heavy precipitation and flooding
- Landslides and rockfalls
- Winter storms
- Wildfire

Additional Hazards Mentioned
• Wind hazards (tornadoes, straight-line winds, derechos) • Lightning • Drought combined with extreme heat on vegetation • Coastal erosion • Invasive species (Bugs and insects)
Additional Comments • Highlight the significance of average temperature and precipitation trends increasing over time, as this can affect road materials, maintenance requirements, and overall infrastructure resilience. • Include information about fluctuating lake levels, both low and high, and their navigational impacts on the highway network, particularly around areas like Lake Superior. • District-specific portfolios can provide a comprehensive understanding of the main hazards each district faces, facilitating targeted mitigation and planning efforts. • When addressing landslide hazards, it's important to investigate whether fluctuations in lake levels around Lake Superior are due to climate change or natural variability, as this can influence mitigation strategies. • Collaboration with researchers and institutions specializing in climate modeling tailored to large basins like the Great Lakes can enhance the accuracy of hazard assessments and predictions. • Keep a proactive approach by planning to incorporate preliminary findings from ongoing research (ex. Great Lakes Environmental Research lab).

For each hazard above, discuss…

What asset types have been impacted?	
Extreme Heat	Pavement (both bituminous and concrete), maintenance facilities, HVAC in building facilities, major highways.
	Impacts on maintenance staff and construction workers
	Construction impacts (can’t place certain materials at certain temperatures)

What asset types have been impacted?	
Freeze-Thaw Frequency	Pavement, culverts, bike and pedestrian facilities, foundations for retaining walls, noise walls, mastheads/lighting infrastructure, overhead sign structure bases, signals, lighting. (Compromised foundations leading to tilt and those signs getting flagged.)
	Culverts freeze then block, leading to flooding.
	Mix of precipitation types affects maintenance. Crews are unable to pretreat areas properly, which causes problems throughout the season.
Heavy Precipitation & Flooding	Hydraulics infrastructure - roadways, culverts, bridges, hydraulic infrastructure, bike paths, underneath bridges.
	In general, all asset types at risk, including bikeways.
	Construction projects are susceptible due to erosion and delays.
	Impacts across the board, with no assets completely free from this hazard.
Landslides & Rockfalls	Bike facilities on MN-13, roads, bridges, culverts.
	Main asset classes vulnerable to mudslides are roads, bridges, and culvert clogging.
Wildfire	Maintenance staff assists with wildfires upon request.
	Heavy snow has caused snapping of tree tops, which could cause more fires
	Minimal impact on MnDOT in the past, with no post-fire risks observed yet. But could still pose a threat (e.g., debris flows) and concerns exist.
High Winds	Signs, maintenance facilities, sheds, and truck station structures are susceptible.
	Sign damage and structures blowing over is common during high wind events.
	Bridges and culverts may experience clogging due to downed trees.
	Repairs are often needed before snow and ice, particularly in November/December – more events in these months.
	State disaster declarations could provide insights into high wind events.
Winter Storm	Roads, bridges, bike/pedestrian facilities, public travel routes.
	MnDOT Vehicles crashing. Also, other cars crashing into MnDOT assets.
	Snowplow driver safety could be a concern during blizzards.

What asset types have been impacted?
Additional Comments • Comments suggest limited detailed inspection data available. • MnROADS conducting a research project on the freeze/thaw cycle, to be completed in November 2023.

Any particular geographic "hot spots" for these impacts?	
Extreme Heat	Northwest part of the state experienced pavement blow-ups.
	Metropolitan areas are potential hot spots due to the urban heat island effect.
	Metropolitan Council has maps showing heat spots that might correlate with transportation assets.
Freeze-Thaw Frequency	
Heavy Precipitation & Flooding	District 6 and District 1 have experienced repeated flooding.
	Red River Valley, Minnesota-St. Croix rivers, streams near Lake Superior, and northern parts of the state (District 1 & 2) face flood challenges.
	Flooding can occur anywhere in the state due to spring melts and heavy precipitation. Snowmelt a bigger issue in northern part of the state.
	Lake flooding not as much of an issue – more the streams/rivers.
	Elevation changes and steep slopes impact damage potential.
	Basin flooding has been a concern on the local level in Nicolette County.
Landslides & Rockfalls	Bikeways
	Roads in District 7 (with some impact in District 8 as well) are vulnerable.
	Vulnerability assessments for landslide vulnerabilities have been conducted across different districts.
High Winds	Highways

Any particular geographic "hot spots" for these impacts?	
Winter Storm	Lake-effect snowstorms are more prevalent in certain areas.
	Northern areas received higher snowfall, with supervisors and maintenance staff being familiar with specific hot spots.
	Business intelligence reports help assess the need for snow fences and determine areas requiring anti-icing efforts.
	I-90 closed frequently due to blowing and drifting snow
	D1 gets more snow due to lake effect

What have the implications been to MnDOT (costs, reputation, O&M needs, etc.) and system users (safety issues, inconvenience)?	
Extreme Heat	Health of maintenance crew is a concern, leading to measures such as purchasing electrolyte drinks.
	Implications include additional rest periods for construction crews, as ob-served in Michigan's DOT.
	Construction impacts, especially related to materials and crew well-being, are significant.
Freeze-Thaw Frequency	
Heavy Precipitation & Flooding	Detours are often required due to high water levels or damage, impacting both facility functionality and user convenience.
	Projects involving detours are common, but no main datasets on this.
	Detours due to flooding can highlight design weaknesses in other assets, such as retaining walls failing due to improper water conveyance.
Landslides & Rockfalls	Geo-technical assets are tracked, including retaining walls, slopes, slope failures, special drainage features, and instrumentation.
Winter Storm	Drainage issues and the inability to perform pre-treatment due to precipitation freezing over are concerns.
	Persistent ice poses challenges, prompting responses like tree removal.
	Safety focus on preventing slips and falls from ice for staff.
	Balance of level of service vs sustainability.

Are there any datasets that capture where there have been past impacts that we can draw from for the RIP's vulnerability assessment?	
Freeze-Thaw Frequency	MnRoads doing a study on freeze-thaw that will be available in November
Heavy Precipitation & Flooding	Efforts are underway to develop a comprehensive dataset for heavy precipitation and flooding impacts.
	Multiple sources of information are being used to create this dataset.
	Timeline for availability is not defined, but it's mentioned that the dataset is still in development.
	Follow up with Rachel Pichelmann to obtain the data once it's available.
	Additionally, efforts are being made to acquire a software package for monitoring scour-prone bridges and to develop resilient-focused design guidance for hydraulic infrastructure. However, these efforts are still ongoing and no completion has been achieved yet.
High Winds	Look for FEMA and state disaster declarations

MIDWEST CLIMATE SPECIALISTS

Virtual Community Engagement Session | August 4, 2023 | 12:00-1:00

PROJECT TEAM

Brian Shekleton, Chris Dorney, Sienna Templeman, Linda Spohr, Jaylen Lyles

SESSION ATTENDEES

National Oceanic and Atmospheric Administration (NOAA): Dr. Glenn Kerr

Minnesota State Climatology Office: Dr. Peter Boulay, Dr. Kenny Blumenfeld

University of Minnesota Climate Adaptation Partnership: Dr. Heidi Roop, Amanda Farris

Great Lakes Regional Integrated Sciences and Assessments (GLISA): Dr. Jenna Jorns

Minnesota Association of Floodplain Managers: Roberta Cronquist, Chair

KEY QUESTIONS

- Should any hazards be added/removed from this list?
- What datasets are available for current/ historical conditions?
- What datasets are available for future conditions, given climate change?
- Any other datasets we should be aware of?
- If duplicative datasets are available, which should be used?

FACILITATED DISCUSSION SUMMARY

What hazards should the RIP focus on?

- Extreme heat
- Freeze-thaw frequency
- Heavy precipitation and flooding
- Landslides and rockfalls
- Winter storms
- Wildfire
- Added notes: wind, drought, lightning, tornados, higher average temperature, low lake levels

Should any hazards be added/removed from this list?
• Suggestion to alter high lake levels to lake level variability • Suggestion to remove the hazard "Average Temperature" or change to “higher temperatures” • Alter "Freeze-thaw frequency" to “Freeze-thaw behavior” • Add ground frost as a potential hazard

For each hazard above, discuss…

What datasets are available for current/historical conditions?	
Extreme Heat	Historical Plot Variables and Climate Projection map: https://docs.google.com/document/d/1A3dXmKatTRLtC3sd11NHGuMJUgxcmcC2UYuy6ZN-GDU/edit GLISA (Great Lakes Integrated Sciences and Assessments) uses UW-M CCR dynamically downscaled projections, which are reliable: https://glisa.umich.edu/sustained-assessment/climate-models/
Heavy Precipitation and flooding	MNSCO provides 1991-2020 precipitation monthly normals, including GIS data. This data could be useful as a benchmark for monthly averages: https://www.dnr.state.mn.us/climate/summaries_and_publications/1991-2020-monthly-precipitation-normal-maps.html

What datasets are available for current/historical conditions?	
Landslides and rockfalls	Difficult to assess landslides and rockfalls due to localized soil physics. Washington State might be a helpful resource for information on shifting precipitation and landslides.
Winter storms	Previous projections on snowfall in WI/MN exist, but there are validity concerns. Snow climatologies are complex, especially along the north shore, and existing data needs to be summarized. Old snow rules: https://web.archive.org/web/20170713180617/http://climate.umn.edu/snowRules/
Wildfire	Resource listing the largest forest fires in Minnesota history: https://www.minnesotafunfacts.com/minnesota-lists/largest-forest-fires-in-minnesota-history/
Wind	Historical wind data is challenging to find due to sensors picking up different speeds. Resource: https://www.dnr.state.mn.us/climate/journal/491010_windstorm_anniversary.html

What datasets are available for future conditions, given climate change?	
Extreme Heat	MnTech is working on dynamically downscale projections with anticipated variables. Full list of variables and the tool is being developed with a 6-8 months capacity delay.
Heavy Precipitation and flooding	The state flood plan is frequently changing, with new draft versions for counties. Official D-firm data is under the preliminary phase. Resources are available on the DNR website for flood planning. https://www.dnr.state.mn.us/waters/watermgmt_section/floodplain/index.html Ongoing projects are assessing future flows in the Mississippi River basin and specific watersheds.

Additional Datasets	
Heavy precipitation and flooding	There are two types of flooding to consider: spring runoff and heavy rain. Resource: https://conservancy.umn.edu/handle/11299/209130 Resource: https://conservancy.umn.edu/handle/11299/227187

TRANSPORTATION PARTNERS & ORGANIZATIONS

Virtual Community Engagement Session | September 15, 2023 | 11:00 a.m. - 12:00 p.m.

PROJECT TEAM

Brian Shekleton, Chris Dorney, Mike Meyer, Liz Wiggen, Kara Van Lerberghe

SESSION ATTENDEES

Arrowhead Regional Development Commission: Beverly Sidlo-Tolliver

Carver County: Adriana Atcheson

Hennepin County: John Evans, Jessica Spanswick, Cliff Mountjoy-Venning

City of Mankato: Shawn Schloesser, Chris Talamantez

Metropolitan Council: Bethany Brandt-Sergent

Minnesota Farmers Union: Ariel Kagan

Region 5 Development Commission: Savannah Winkler

Region 10 Regional Development Organization: Fausto Cabral

Scott County: Brad Davis

St. Cloud Area Planning Organization: Alex McKenzie

St. Louis County: Darren Jablonsky

Stearns County: Chelle Benson

Washington County: Daniel Elder

West Central Initiative: Wayne Hurley, Mallory Jarvi

KEY QUESTIONS

- How does transportation resilience impact you and those you represent or work with?
- From experience, do you have any specific examples of transportation vulnerabilities to natural hazards in Minnesota?
  - To the extent possible, please provide location, hazard, and date of event.
  - How have they affected you and/or those you represent or work with?
- What action(s) would you like to see MnDOT take to address these vulnerabilities?

FACILITATED DISCUSSION SUMMARY

How does transportation resilience impact you and those you represent or work with?

- Barriers or challenges
- We are limited in installing resilience in the county's transportation system due to the lack of widely accepted future looking precipitation projections.
- We (Hennepin County) also are limited in our resilience efforts due to the lack of funding for ongoing maintenance of traditional stormwater mgmt systems and green infrastructure
- Challenges for the southern Minnesota way of life.
- Closures because of direct hazards like flooding, or repair needs (e.g. from more freeze-thaw cycles) make mobility harder, but redundancy and multiple modes increase resiliency
- Some of our smaller communities don't have grocery stores, relatively long travel is required. Transportation resilience is needed so people can meet their basic daily needs.
- Costs from bad roads (potholes) end up hitting individuals - have to replace tires or other repairs - better to do public investment to help everyone
- When there's not enough room for snow storage, snow from roads gets put into sidewalks, prioritizing drivers over others
- Impacts
- Transportation resilience impacts everything around us - transportation of goods, visitors to the area etc.
- Transportation resilience impacts our transportation network's ability to provide a system that is in good condition for all users.
- Transportation resiliency is important to maintain access to personal and social needs. With loss of rural city centers, more folks are having to travel further to access these.
- Transportation resilience is critical for the movement of goods, commuters and visitors in and out of our county
- Reliability is important for accessing markets - snow/flood/etc can have big impact on delivery

From experience, do you have any specific examples of transportation vulnerabilities to natural hazards in Minnesota?

To the extent possible, please provide location, hazard, and date of event.

How have they affected you and/or those you represent or work with?

- Rain/flooding
- Flooding during significant rainfall events was preventing emergency vehicles from passage along a county road in Golden Valley.
- Huge rain and wind storm - took out peoples roads/ability to travel with tree blockage and power outages for weeks. Emergency travel was difficult
- Rising groundwater levels due to increased precipitation caused a section of a county road and trail in Bloomington to flood causing bike/peds to veer onto the road.
- Dust
- Dust storm (drought, heavy tillage, etc) forced roads to close, endangered drivers. (S. MN)
- Question
- Will there be a cold weather strategy to enhance resiliency of road foundation and pavement?
- Specific Locations & Events
- 2016 - Waseca receives 14-inches of rain in two days. Area schools close due to flooding.
- Examples of transportation vulnerabilities in Scott Co include Minnesota River crossings during flooding, intermodal (road, rail, barge) at Ports of Savage, local bluff roads
- Henderson, MN hosts a "Flood Fest" in 2019. Highway 19 Eastbound and Highway 93 both directions closed. Flooding 7 of the last 10 years isolates the town.
- 2002: big rainfall in Norman Co. washed out many hwys w/ river/creek crossings. The detour was 30+ mins. https://www.newsline.dot.state.mn.us/archive/02/jun/26.html
- 2016, Waseca receives 14 inches of rain in two days.
- Highway 41 bridge over Minnesota River closed multiple years due to flooding/high water.

What action(s) would you like to see MnDOT take to address these vulnerabilities?

- Funding
- Increased funding to transit and support of transit's role in reducing VMT.
- Increase funding for rural communities that reduces the cost barrier for some grant opportunities. Such as funding engineering studies and admin time
- Increase funding to improve in safer road systems - not only for cars, but also for biking trails, walking etc.
- Increased funding for bike/ped infrastructure since that will also reduce VMT
- Increased funding for green infrastructure and maintenance
- Stop expanding infrastructure and capacity and instead focus solely on maintenance, and investments in walking, biking, and transit
- Access
- Provide guidance or data to be able to identify vulnerabilities that may impact our transportation network so that we can be proactive instead of reactive.
- Accessibility of charging stations around the state in rural areas - not just urban/big city
- Collaboration
- MnDOT should work with other state and local government partners to develop future facing precipitation models
- MnDOT should work with the Met Council and Cities in the metro to promote greater density and transit based development to help increase the effectiveness of transit and its reach.
- Just like we have a statewide system of highways, figure out a statewide transit system, including trains or buses between all major cities

RESILIENCE ADVISORY TEAM: RESILIENCE ENHANCEMENT WORKSHOP

October 6, 2023 | 10:00-11:00

KEY QUESTIONS

We are referencing information from chapter 17 in the NCHRP report to get your input. There are many great ideas but not all may apply to MnDOT. We want your input on whether each action:

1. Doesn't apply to MnDOT or has already been done
2. Is a good idea but needs to be more MnDOT specific
3. A different or new idea you have

FACILITATED DISCUSSION SUMMARY

Asset Management

Action	Doesn't Apply or Has Already Been Done	Good Idea/Make MnDOT Specific
Conduct self-assessments of the asset management function with special emphasis on those relevant to system resilience. Identify actions that can be taken to enhance this linkage.		• Resilience was added to the position description for an AMPO team member, and will be an added point of focus for new hires as well

Action	Doesn't Apply or Has Already Been Done	Good Idea/Make MnDOT Specific
Identify the assets at most risk across hazards and threats.		• Develop quantitative risk models with a consistent result of "Future Damage Cost Risk" across all vulnerable asset types. EFVA Tool is an example. • We are creating a Risk Corridor tool that contains asset data layers that either directly address risk, show condition data, or inventory data • Utilize past extreme rainfall data to assess what exposure has recently (25 years) been experienced by our assets • Currently working to develop a flood-focused dataset for this purpose.
Review staff roles and responsibilities to identify how they relate to enhancing system resilience. Develop strategy for institutionalizing system resilience into staff roles.		• Resilience was added to the position description for an AMPO team member, and will be an added point of focus for new hires as well
Develop and maintain a full and complete asset inventory, including asset location, condition, and use. Over time, this asset inventory should include all assets for which your agency is responsible. Tie asset failures and accelerated deterioration due to resilience stresses into the asset database and analysis.	• I feel like this is lower priority for the RIP because generally we have a full and complete inventory in most asset inventory and condition areas.	• This is in progress; we have an asset management system (TAMS). We are adding more data sets to it. We plan to use this data for planning purposes, esp. resilience

Action	Doesn't Apply or Has Already Been Done	Good Idea/Make MnDOT Specific
Develop quantifiable hazard-to-impact relationships that are tailored to your geographic location and asset class.		• Started with the EFVA Tool, but more asset types need these models developed (this applies to all rows on this sheet) • Need pavement, signs, etc • This is a necessary step, though it will take time to develop data sets and agency expert-endorsed relationships
Increase engagement and strengthen relationships internally with asset managers, engineers, emergency management, and GIS specialists.		• In progress - through groups like this one • This is underway, but we will need more to produce the expert guidance mentioned in the previous action • New Asset Management Specialists are being hired in the Districts by 12/1/23 and can help provide district feedback and communicate resiliency efforts. • Another ongoing effort…trying to improve communication between maintenance, hydraulics and CO hydraulics to improve flood documentation.
Develop a catalog of impact functions for each asset type that may be exposed to identified hazards and/or threats.		• Great idea which will require input from subject matter experts on the probability and consequence of impacts for various assets

Action	Doesn't Apply or Has Already Been Done	Good Idea/Make MnDOT Specific
Develop a menu of costs for each asset type identified as being potentially exposed to system disruptions.	• Work orders in place, may need more data/consistency	• TAMS is helping develop these costs, but they will change over time as more and more data is added to the system • Started with the EFVA Tool, but more asset types need these models developed (this applies to all rows on this sheet)
Examine how O&M data collection efforts can be modified to collect resilience-related data that can be used for asset management.		• This is underway with the cost development from the previous action, but we will need to balance usable data with the effort it takes front line personnel to record it
Collect damage and outage data after hazards/threat events for affected assets. Compare with and revise existing damage and outage data used in the analysis.		• Working to develop better process for collecting flood/ overtopping/damage data now • *Blank Vote*
Collect economic data after hazards/threat events. Compare with and revise existing economic data used in impact analyses.		• *Blank Vote* • *Blank Vote*
Investigate the extent to which resilience-oriented condition and performance measures relating to natural and human-caused disruptions are included in the TAMP and asset management process. Add as appropriate.	• The 2022 TAMP contains info on resiliency efforts but didn't focus on resiliency oriented PM. After the RIP is complete, information from the RIP can be in 2026 TAMP. • Isn't this the RIP	• This is a good idea, and we will need to be sure that changes in one document are reflected in the other

Action	Doesn't Apply or Has Already Been Done	Good Idea/Make MnDOT Specific
When your agency conducts future performance gap assessment as part of the TAMP update processes, ensure that system resilience concerns are part of the risks considered in the assessment.	• Yes in 2026 TAMP and future MnSHIP	• Will include new resilience metrics with TAMP update • *Blank Vote*
Utilize lifecycle costs in the prioritization process and determine which types of costs will be considered as part of the lifecycle analysis.	• I wonder if these efforts could help inform the total cost of operations efforts - loop me in on this. Climate Change will increase future O&M costs.	• This has occurred for some assets, and needs to be updated regularly and expanded to include more asset classes. • This is very beneficial and needs to be further developed
Ensure that all past and future hazards that could potentially disrupt system performance are part of the risk assessment.		• This is a good idea. We will need to determine the reliability of such assessments. We may need to increase resources dedicated to development of supporting info.
Examine and improve the linkage between asset management and maintenance practices in your agency. Consider how tradeoffs in related costs can be considered in agency decision-making.	• Need more Cost Analysis and Actuary Science, deterioration curves, life cycle • Our agency has a great link between AM and O&M. That said, we need to continue to improve data quality, timeliness, and how it can be used for planning purposes.	• We have fully incorporated M&O activities and costs into our EAM system. We have not fully integrated M&O planning or capital funding impacts on M&O
Develop a funding strategy for resilience-enhancing investments in your agency's TAMP financial plan.	• Could be done in 2026 TAMP; sustainability was included in MnSHIP. • RIP/Protect DAMP,	• Underway with the RIP

Action	Doesn't Apply or Has Already Been Done	Good Idea/Make MnDOT Specific
Ensure during your agency reassessment of the TAMP process that resilience concerns and factors are incorporated more effectively into decision-making.	• Could be done in 2026 TAMP; sustainability was included in MnSHIP.	• The RIP and TAMP will be two overlapping plans, so changes in either will need to be reflected in the other
Develop training and professional development opportunities for your agency's asset management staff to enhance the consideration of resilience in asset management practices.		• As one of those staff, this is an excellent idea, and will need to be a point of focus for the future. • T.S yes RIP should include training opportunities
Other Ideas?	• Metrics are very important; do we have the right ones? How do we track? How should TAMS change to accommodate?	

Policy Development/Agency Leadership and Management

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
If you have not done so, develop a business case for resilience investments that can be used to justify more such investments. If such a business case has been developed, update periodically as new information on benefits and costs become available.		• *Blank Vote* • *Blank Vote* • *Blank Vote*
Develop and implement a strategy for securing dedicated funding for resilience actions and project design components. This could be a stand- alone funding program or incremental additions to existing funding programs that allow resilience-related investments.	• *Blank Vote* • *Blank Vote*	

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Involve the agency CEO/director in the resilience program, Periodically reassess the usefulness of the information provided to the CEO with respect to the types of decisions he/ she much make relating to the resilience program.		
Involve department heads in the resilience program. This could be part of a formal coordinating group or frequent meetings to coordinate resilience activities.		• Not sure this is being done- it feels like there's a lot of different people working on resilience - who knows if we are all seamlessly weaving processes and thoughts that will synchronize • *Blank Vote*
Create an institutional mechanism to coordinate resilience efforts. Such a mechanism (e.g., task force, coordinating committee, and the like) would be given a clear mandate and expected products as they relate to your agency's resilience program	• I think we have this started with federal funding and planning - not sure we have an absolute dedicated "mechanism" ?	
Incorporate transportation system resilience into agency plans and policy statements in order to institutionalize a resilience "mindset" into agency staff.	• In the works - building plan as flying it? We are including these emerging/complex concepts - however, is there holistic guidance on how all things work together	• Design standards will need to be assessed as the trends become more extreme, and things like Check Storms to assess other parts of the design will need to be added.
Establish a formal resilience strategy/ program. This might require legislative approval or at a minimum agency directives and guidance.	• *Blank Vote*	

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Assign leadership responsibilities of the resilience strategy/program in your agency. This might be structured as a central authority for all resilience efforts or the assignment of responsibilities for individual components of the program.	• In the middle on this one?	
Undertake a systematic effort/ study to identify "early" wins to enhance system resilience.		
Conduct and document a self-assessment of your agency focusing on how effectively resilience is incorporated into agency functions.		
Conduct self-assessments of specific agency functions that are particularly relevant to system resilience.		
Assign staff to support the resilience strategy/program. Such assignments should be clear in terms of how activities contribute to program objectives, and QA/ QC procedures that should accompany staff efforts.		• Resiliency Engineer (Hydraulic Focused) has been added, but more GIS Analyst positions will be needed for all the work running these Vulnerability Models
Examine best practices from other agencies and organizations.	• AASHTO CTSSR (Committee on Transportation Safety, Security, and Resiliency)	• Keep doing this and get actively integrated
Review threat/hazard exposure and/or vulnerability studies to understand potential disruptions to your transportation system and possible demands on your agency.		• This will be good, but these Vulnerability Assessment models need to be developed much further.

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Review staff roles and responsibilities to identify how they relate to enhancing system resilience.		• Some GIS Analysts could be shifted to the massive amount of role hours needed for vulnerability assessments • Offer internal professional growth development opportunities - many existing staff have added work with resiliency/ghg/etc - support existing staff to professionally devel • *Blank Vote*
Assign resilience-related job responsibilities to agency staff job descriptions and talent profiles. Enhancing transportation system resilience should be part of all relevant staff job activities, both for emergency response efforts and more long-term efforts to improve asset and system resilience.		• Offer internal professional growth development opportunities - many existing staff have added work with resiliency/ghg/etc - support existing staff to professionally devel
Examine your training/ professional development programs for their coverage of resilience.		• Very much lacking in the training/development, but part of this is there isn't an agreed upon approach yet (or even one developed in certain areas)
Improve resilience coordination with local communities so as to place your agency in a leadership position for fostering enhance community resilience.		• Need to do this-centralize/ focus on professional development and internal support-building off existing staff vs only getting new - need to retain org knowledge

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Enhance coordination with federal, state, and local agencies relating to various aspects of your agency's resilience program. This would include not only coordination efforts relating to emergency response, but also actions to include more resilience concerns into agency decision-making.		• *Blank Vote*
Examine your training/ professional development programs for their coverage of resilience.		• *Blank Vote*
Other Ideas?		

Planning

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Conduct self-assessments of current planning functions with special emphasis on those relevant to system resilience. Identify actions that can be taken to enhance this linkage.		• Future vulnerability risk should be incorporated into the scoping process when a corridor is up for their cycle of pavement rehabilitation.
Incorporate transportation system resilience into agency plans and policy statements. This includes all plans that are produced by your agency--- statewide, regional, corridor, project, site, modal, special topic plans and the like.		

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Review threat/hazard exposure and/or vulnerability studies to understand potential disruptions to your transportation system and possible demands on your agency. Provide information to planning staff and other planning agencies in your jurisdiction.		
Apply threat-vulnerability worksheets (TVA) to assess threats to your system.		• *Blank Vote*
Collect and assess hazard and threat data and estimate the likelihood of events occurring in the future (including noting the uncertainty in results as appropriate).		• Key to the process, but important to coordinate with outside agencies to help avoid duplicate work and have a dataset essentially all agencies agree with and use.
Identify susceptibility factors that may worsen or reduce the system disruption caused by expected hazards.		
Produce GIS mapping of hazard exposure across all assets in the transportation system for each hazard and threat.		• *Blank Vote*
Develop transportation-specific vulnerability indices to identify populations that are more adversely affected by service and system outages. Develop a methodology and planning guidance on how socio-economic and environmental impacts will affect different population groups.		

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Identify the assets at most risk across hazards and threats.		• *Blank Vote* • *Blank Vote* • Develop quantitative risk models with a consistent result of "Future Damage Cost Risk" across all vulnerable asset types. EFVA Tool is an example.
For different asset types, develop methodologies for combining physical and socio-economic costs that may occur over the asset life span by scenario, time period, and hazard.		
Provide GIS mapping of entry points where other sectors may impact transportation operations have been identified.		
Increase engagement and strengthen relationships internally among planners, asset managers, engineers, emergency management, and GIS specialists to better understand potential impacts from system disruptions.		• *Blank Vote*
Identify critical agency stakeholders and external partners who are crucial for supporting resilience project strategy prioritization. Establish a means of collaborating with these groups in the assessment and prioritization processes.		• *Blank Vote*

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Improve resilience coordination with local communities so as to place your agency in a leadership position for fostering enhanced community resilience.		
Increase engagement and strengthen relationships externally with governmental and university climate science research centers, state climatologists, health professionals, cyber and terrorist experts, geotechnical experts, and sector experts.		
Develop a list of co-benefits for resilience projects that are important when considering agency priorities.		• *Blank Vote*
Continue to investigate the most appropriate strategy for monetizing resilience benefits. Monitor the literature and examine best practice from other transportation agencies in how this can be done most convincingly.		
Develop and implement a set of prioritization criteria that will result in more investment in resilience projects and strategies. Periodically assess the influence of these criteria in supporting resilience projects. Adjust over time as needed.		

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Assess your agency's use of resilience measures and how this use can be improved and enhanced, making sure all of your agency's relevant units are involved in the process.		• *Blank Vote* • *Blank Vote*
Examine how your agency leadership is using resilience performance measurement information (such as after event reports) to identify how the use of such information can be improved.		
Track the use of resilience performance measure information and how it has been used to adopt changes in the agency. Use this information to illustrate both the usefulness of performance measure information as well as the effectiveness of your agency's resilience program.		• *Blank Vote*
Periodically monitor the trends in system disruptions from both natural and man-made causes. Relate this tracking to the appropriateness of currently-used resilience measures.		• *Blank Vote*
Work with representatives from other sectors that affect and are affected by disruptions to respective networks. Identify potential points of vulnerability and collaboratively identify strategies for minimizing failure.		

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Participate in national conferences and workshops to exchange information on best practices for linking resilience and planning.		
Other Ideas?	• Case studies - with other DOTs	

Project Development/Engineering

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Conduct self-assessments of current project development/ design functions with special emphasis on those relevant to system resilience. Identify actions that can be taken to enhance this linkage.		• Design standards will need to be assessed as the trends become more extreme, and things like Check Storms to assess other parts of the design will need to be added. • Scoping efforts, include data from flood database, hydwatch, • *Blank Vote*
Review your agency's history of project designs withstanding hazards and the likelihood of handling future expected hazards and threats. Assess the effectiveness of design changes made to make assets more resilient.		• Statewide Flood Mitigation Program funded several projects: https://www.dot.state.mn.us/floodmitigation/list.html • More work needed to develop design practices for resilient design (inslope armoring material selection, etc) • *Blank Vote*

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Consider resilience concerns in project development, including natural hazards, climate change, and human-caused threats relating to physical security, crime prevention, personal safety, and emergency management's fire, life and safety requirements. Incorporate this consideration into project development guidance.	• Started with some info in Floodplain Assessment in CATEX and also Risk Analysis for H&H Modeling	• Emphasis on emergency routes in risk assessment. Also which communities have fewer duplicate routes for detours, etc. Red River Valley and MN River Valley communities • *Blank Vote* • *Blank Vote*
Begin to make design criteria more adaptive to expected future hazards and threats. Adopt a project development process like ADAP as the desired project development process. Incorporate into design guidance and manuals.		• This is going to be essential when the climate trends likely raise the design standards. • Drainage Manual is currently being updated to include a "check storm" evaluation, which then is used to identify the need for modifications or adaptive design • Nonstationarity considerations are being added to the Drainage Manual now. Future additional guidance on increasing resilience of hydraulic designs is coming.

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Pursue betterments when reconstructing facilities affected by federally-designated disasters/ emergencies.	• The more we routinely include resiliency in design, the easier it is to make a case for betterments. MN FHWA says they do not fund betterments as part of emergency relief.	• Would appreciate having guidance on how this can be accomplished when funding typically restricts work to "restoration" or "replacement in-kind". • Look at ways to potentially change funding rules to allow for appropriate sizing even if it is better than what was in place at the time of flood damage • Can data showing flood vulnerability (repeat damaging events) be used to support a betterment?
Incorporate resilience "add-ons" to project designs that take into account different types of risks. Document the costs associated with such add-ons and ultimate benefits, and provide to the asset management unit and agency leadership.	• TAMS Work Orders has taken a big step on this area, and recently added other drop downs to help track flood damage costs.	• Examples like inslope armoring for overtopping being added to areas that are assessed as vulnerable. Should have large benefit/cost. • *Blank Vote* • *Blank Vote*
Monitor and record stressor/ hazard/threat impacts on assets and related costs as they occur. Feed this information back into the project development process so that agency staff have the most up-to-date information on likely benefits of adaptive designs. Develop a catalog of impact functions for each asset type that may be exposed to the hazards and/or threats.		• *Blank Vote* • A catalog of impact was started for hydraulic assets in the EFVA Tool, but needs to be expanded to other assets • Working to compile past flood data including date, location, damage, detours, etc. so that the data can be used in the TPDP. • In addition to the TAMS Work Order note, also working with district maintenance+hydraulics to improve flood documentation to data can be used in project development

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Make sure your value engineering process considers resilience measure costs as a valid expense when viewed from a lifecycle cost perspective.		• *Blank Vote* • *Blank Vote* • *Blank Vote*
Identify staff who are capable and interested in integrating resilience into asset-specific analyses. If necessary provide additional training to these staff members.		• *Blank Vote* • *Blank Vote* • *Blank Vote* • Good to identify interested people to help change processes, but ultimately all staff will need to adopt processes once they are ready for use
Where appropriate, conduct pilot studies of the application of an adaptive design process to illustrate key steps and what a resilience- sensitive project will look like.		• *Blank Vote* • *Blank Vote* • *Blank Vote*
Work with partner agencies (e.g., resource agencies) to explain the approach your agency is taking toward adaptive design and identify any changes to existing agreements and interactions that might be necessary to implement desired changes.		• *Blank Vote* • Leveraging involvement in Silver Jackets group to increase collaboration with other agencies on flood resilience strategies. • Flood Center Idea, EQB water Plan
Monitor any activities or strategies already implemented that may serve as guides to future options/measures.		• *Blank Vote* • *Blank Vote*

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Document the overall project development process and in particular how resilience concerns were addressed for each project analysis.		• *Blank Vote* • Future vulnerability risk should be incorporated into the scoping process when a corridor is up for their cycle of pavement rehabilitation.
Develop an internal communications strategy to convey to agency staff what is occurring with respect to resilience-oriented project development and how they can contribute.		• Explaining the value of resilience-enhancing activities will help get buy-in and increase involvement agency-wide.
Other ideas?	• How does an engineer create statement of estimated costs on resilient contract BMPs • Case studies, details and construction specifications to the other of PD/E	

Emergency Response/Agency Preparedness

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
EMERGENCY RESPONSE		
Develop a 24/7 threat and hazard warning system		• Pursuing funding for BridgeWatch to monitor environmental conditions (rainfall forecast) 24/7 that could lead to flooding at vulnerable locations. • Working with Univ. St. Thomas students to develop low-cost stream gages to increase our network of stream monitoring in the future.

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Create or modernize your agency's emergency notification system	• Use Send Word Now for internal notifications. 511 is adding IPAWS capability.	
Implement a multi-year exercise program that includes the conduct of emergency management drills, functional, and full scale exercises.		• Have a multi-year exercise/training program for senior leadership. Pursuing opportunities with other local/state agencies for exercises.
Assess the effectiveness of the multi-agency communications systems and protocols used during emergency response/ management actions. Include in this assessment the effectiveness of the technologies and equipment used in the response.	• ARMER is an effective tool.	• WebEOC is used as a multi-agency common operating picture tool. More exercises with other agencies would improve response. • *Blank Vote*
Improve the coordination with emergency response agencies/ organizations. This might include periodic reassessments of the institutional relationships for handling system disruptions, or after event debriefings to dissect what happened and what improvements should be considered.	• MnDOT participates in after action reviews held by state EM, in regular response and recovery agency working group meetings, and in exercises.	
Develop and periodically update a strategy and mechanism for emergency management and security staff to provide input into the decisions of other agency units.	• EM has point of contact in agency units (example: Assistant Maintenance Engineer is district contact)	

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Develop agreements or understandings with FEMA on procedures and requirements when a disaster has been declared.	• *Blank Vote*	
Monitor the allocation over time of agency budget resources to the emergency response/ management and disaster recovery capacity.	• Districts respond to emergencies with maintenance budgets. The decision to pursue available reimbursement is done at the district level.	
Determine if such allocations are adequate to prepare your agency for dealing with major disruptions.	• *Blank Vote*	
AGENCY PREPAREDNESS		
Publish an agency-wide Continuity of Operations Plan that identifies types of critical incidents or events, emergency activation criteria, and procedural guidelines to ensure safe internal and external operations.	• MnDOT is implementing continuity software to help with this.	
Test the COOP on a periodic basis. Include in this test unexpected variations of likely hazards and threats (e.g., two major disruptions occurring at the same time).	• We did this pre-Covid, but the steps taken are now routine with more telework. Continue to do tests, especially with SLT.	

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
If not already done, locate a COOP secondary site at a traffic management center (TMC), Fusion Center, or Statewide Emergency Management Operations Center	• *Blank Vote*	
If not already done, develop an all hazards response plan and establish an update schedule.	• MnDOT follows the State EOP yearly update schedule	
Develop a strategy to pre-position equipment, materials, and other resources to respond to a disruption and/or support recovery. If such a strategy exists, continue to monitor the viability of this pre-positioning in relationship to different types of disruptions.	• Equipment is pre-positioned for radiological emergency preparedness. MN natural hazards do not lend themselves to pre-positioning.	
Establish a common set of cross-disciplinary criteria for prevention, preparedness, mitigation, disaster management, emergency management, environmental management and business continuity of operations.		
Publish a training calendar and schedule for emergency management introductory level training for all agency personnel.	• Available on EM iHub page.	

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Create and support opportunities for agency staff involved in emergency response/ management, disaster recovery, and cybersecurity efforts to interact with peers in other agencies and in professional organizations' meetings.	• *Blank Vote*	
CYBER SECURITY		
Develop, update, and test your physical and cybersecurity plan. The plans should be coordinated with the other agencies who have primary responsibility for the provision of security services. This includes steps to protect such systems as well as a cyber-incident response and recovery plan developed in collaboration with key internal and external stakeholders.	• MNIT holds tabletops pretty often due to a governor's executive order, and holds monthly briefings on these topics.	
Implement a full range of basic cybersecurity techniques and cyber hygiene practices in your agency.		
Conduct white hat hacker attacks against your agency's IT systems to identify vulnerable access points.		
Back up some mission-critical data, preferably at remote sites with firewalls and other cyber defenses in place that will not allow attacks on my agency's primary IT systems to reach the remote sites.	• *Blank Vote*	

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Develop a training calendar and schedule for cybersecurity awareness for agency personnel and contractors. Update as new threats and vulnerabilities occur.		
Other Ideas?	• Other: what to do with excess rock slide materials, soil slide material, and woody tree debris to rapidly obtain open road • MN does not use the ESF system for planning, and MnDOT does not have the primary responsibility for any hazards under the state plan. That impacts MnDOT's role in exercise/response • We would like to participate in and hold more exercises as an agencies. We would also like the exercises to be given an appropriate amount of schedule time.	

System and Traffic Operations

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Conduct self-assessments of current system and traffic operations functions with special emphasis on those relevant to system resilience. Identify actions that can be taken to enhance this linkage.		.
Develop a process for conducting after-action and after-event reports that can be used to identify corrective actions with respect to improving system operations.		

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Review staff roles and responsibilities to identify how they relate to enhancing system resilience. Develop a strategy for institutionalizing system resilience into staff roles.		
Review your agency's history of traffic operations and traffic engineering designs withstanding hazards and the likelihood of handling future expected hazards and threats. Make traffic operations- related design criteria more adaptive to expected future hazards and threats.		
Assess your agency's system operations strategies with respect to the vulnerabilities identified in the vulnerability assessment. Emphasize the implementation requirements for additional actions that are deemed necessary.		
Develop GIS layers of emergency evacuation routes and other layers that describe critical components of the transportation system.		• *Blank Vote*

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Examine how operations data collection efforts can be modified to collect resilience-related data and information to improve resilience planning.		• New TAMS Work Order subactivity for "flooding" will make flood-related activities easier to track statewide. • New Flood Documentation form will be used by District hydraulics+maintenance staff to track flood events statewide, together with TAMS Work Order form.
Examine how operations data can be used to inform lifecycle costing analyses in the asset management program or in other investment evaluation efforts in your agency.		• *Blank Vote* • *Blank Vote*
Re-examine (or develop) contingency plans for traffic management centers or for other critical assets relating to transportation system management and operations. The contingency plans should reflect the types of disruptions that could occur and the key functions of the centers that might be lost for physical, power, and employee availability disruptions.		
Reassess (or develop) multi-agency training and field exercises that reflect the likely operational circumstances that will be faced in a serious disruption event.		

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Examine your agency's (or jurisdiction's) cybersecurity plan from the perspective of vulnerabilities to operations functions. Investigate the extent to which redundant systems are in place and protected against cyberattacks.		
Examine (or develop) a strategy for backing up critical operations data relating to the functions of traffic management centers. To what extent are these backup capabilities tested to assure uninterrupted traffic operations command and control actions during and following a disruption.		
Document the resilience-related traffic operations efforts of your agency with the aim of informing your own staff as well as key stakeholders of what is in place and being developed on how your agency's operations capabilities will be used during and post-disruption event.		
Other ideas?	Other: how do other DOTs handle prepositioned equipment (e.g. long arm excavator at a culvert inlet) at known debris plugging locations and justify equipment	

Construction

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Conduct self-assessments of current construction functions with special emphasis on those relevant to construction activities. Identify actions that can be taken to enhance this linkage.		.
Develop a process for conducting after-construction reports that identify actions to enhance system resilience in the construction process (or add such a focus in current after-construction reports).		
Provide opportunities for construction staff to recommend construction-related resilience strategies and actions to those in the project development process prior the construction phase (e.g., those developing PS&Es or handling construction zone traffic management).		• *Blank Vote*
If your agency does not do so, examine how electronic as-built plans can be utilized throughout the agency for managing the system and of providing information that can feed into resilience efforts.		• *Blank Vote* • *Blank Vote*
Keep abreast of the latest developments in resilient materials and work with your agency's materials certification unit to allow such materials in future projects.		

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Pre-position construction materials in strategic locations that allows rapid reconstruction of failed assets.		
Put in place new contracts with independent contractors to supplement your own construction resources when responding to emergency situations.	• *Blank Vote*	
Incorporate flexibility into regular construction contracts that allows your agency to assign emergency construction use for disaster recovery.		
Work closely with the traffic operations unit to develop and assess after-project construction zone traffic management strategies. Collect and archive data on the major causes of delay through the construction zone (e.g., movement of construction equipment, lane shutdowns due to construction phasing, crashes, vehicles running out of gas and the like).		

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Examine those construction items and actions that relate to protection of the work zone against extreme weather events (e.g., drainage and erosion control). Assess the adequacy of such actions based on experience. Determine if future environmental conditions will increase the vulnerability of the work zone to such disruptions. Determine when contract provisions might have to change to reflect such threats.		• *Blank Vote*
Consider likely changes to the working conditions of your agency staff and contractor employees given threats from extreme weather (e.g., prolonged high temperatures and frequent high intensity precipitation events). Determine when employee safety steps and contract provisions might have to change to reflect such threats.		
Other ideas?	Would like to see the information from Table 37 (Maintenance) included in the RIP to place focus on leveraging maintenance staff knowledge.	

Maintenance

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Conduct self-assessments of current maintenance functions with special emphasis on those relevant to system resilience. Identify actions that can be taken to enhance this linkage.		• Good to make sure our maintenance practices build things back more resiliently when they are damaged.
Develop a process for conducting after-action and after-event reports that are used to identify corrective actions with respect to system maintenance.		• New flood documentation form will be used by district maintenance and hydraulics staff to add to statewide flood map.
Develop a process for reviewing maintenance data to identify chronic disruptions to location-specific assets or facilities.		• This will be effective as we set-up better ways to document this, but also surveying them to have them note locations of past problems is a good first step. • *Blank Vote*
Review staff roles and responsibilities to identify how they relate to enhancing system resilience. Develop a strategy for institutionalizing system resilience into staff roles.		• *Blank Vote*
Review your history of maintenance responses to hazards and the likelihood of handling future expected hazards and threats. Make changes in standard responses where necessary.		• Extra effort to improve resilience when repairs are made after damage instead of building back the same.

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Assess your agency's maintenance strategies with respect to the vulnerabilities identified in the vulnerability assessment. Emphasize the implementation requirements for additional actions that are deemed necessary (e.g., additional right-of-way vegetation clearance to minimize wildfire damage).		• Extra effort to improve resilience when repairs are made after damage instead of building back the same.
Investigate the extent to which your agency's vegetation management and control program reflects the likely changes in climate that your jurisdiction will face over time or are currently facing.		
Develop or enhance your existing culvert cleaning program. Establish a regular inspection and cleaning schedule, if not already done.		• TAMS HydInfra Inspections have a good record of this, but it is still a challenge to find time to coordinate cleaning efforts.
Examine how maintenance data collection efforts can be modified or enhanced to collect resilience-related data that can be used for improved resilience planning. This includes collecting maintenance records and other cost information for use in identifying likely hazards and the costs of responding.		

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Examine (or implement) your maintenance management systems in terms of how they can assist in communication with the public and determine what work needs to be done and at what frequency. Also investigate how the systems track repair history that feeds into other agency processes.		
Examine how maintenance data can be used to inform lifecycle costing analyses in the asset management program or in other investment evaluation efforts in your agency.		
Collect damage and outage data after hazards/threat events for affected assets. Compare with and revise existing damage and outage data for use in the vulnerability analysis.		
Document the resilience-related maintenance efforts of your agency with the aim of informing your own staff as well as key stakeholders of what is in place and being developed on how your agency's maintenance capabilities will be used during and post-disruption event.		
Other ideas?		

Public Outreach/Communications

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Make sure your agency's communication strategy for major incidents/disruptions is clearly understood by agency staff. If not already, evolve the point(s) of contact for incident response into your point of contact for overall resilience information.		
Examine the possibility of creating a coordinating mechanism (or participating in an existing one) among partner agencies to coordinate the resilience message and in producing common resilience material.		
Prepare a written document describing your resilience external communications strategy (e.g., a communications plan). This documentation should describe the rationale for the program, how it will be structured, target audiences, action items, and implementation responsibilities.		
Develop documentation that clearly outlines the intent, benefits and expected outcomes of your agency's resilience program and ensure that all agency personnel are aware of the key messages in this material.		

Action	Doesn't Apply Or Has Already Been Done	Good Idea/Make MnDOT Specific
Prepare and utilize graphic material to summarize the benefits of resilience programs that can be used in social media outreach efforts.		
Establish a social media account that is clear and telling on relating information relating to resilience.		
Other Ideas?		

MNDOT METRO DISTRICT PUBLIC MEETING

October 17, 2023

Roseville Public Library, 2180 Hamline Ave N, Roseville, MN 55113

GOALS

- To share project information about the Resilience Improvement Plan
- To get input on hazards, vulnerabilities, and actions MnDOT can take from stakeholders that will be used in the plan.

PROMOTION

- MnDOT's social media calendar
- Emails target to stakeholders

How many people attended: 7

Engagement Activity #1: Demographic sticker board

Place a sticker on which you identify with most:	
MnDOT Staff	
Member of the public	1
Transportation Professional	
Environmental/organization/professional	3
Other	1

Place a sticker below to show where you live and travel to often:
Minneapolis
Saint Paul (3)
St. Louis Park

Place a sticker below to show where you live and travel to often:
Edina

Engagement Activity # 2: Natural hazard's plot

Other Hazards
Flooding issues – Ditches #2, #3, #5, in Ramsey County South of 694, North of 36
Icy bridgeways
Power Outages
Transformers insufficient during major weather shifts. Humidity, storms, lightning, winds

Engagement Activity # 3: Natural hazard's impact

How have natural hazards impacted you and your travel plans? ***Place a sticker next to the impact that applies. If another impact comes to mind, please write it on a sticky note.***	
Impacted my commute to work	3
Impacted being able to get my children to school or my family to where they need to go	2
Delayed the movement of goods/freight I was delivering or having delivered	1
Impacted my safety while traveling	4
Other impacts (add a note!)	• I stay home during weather events • Wind causing power outage • Icy bridgeways, training for younger/new plow drivers • Buckling roads, pot holes • Delay of goods/services, but not highway's/MnDOT's fault • Emergency sand bag transport

Engagement Activity # 4: Actions MnDOT Can Take - Priority Exercise

What actions would you like MnDOT to take to address these vulnerabilities/hazards?	
Prioritize agency-wide planning for increased resilience	2
Expand data collection to strategically increase resilience	3
Prioritize funding to respond to existing vulnerabilities	2
Prioritize funding for areas with projected vulnerabilities	1
Other actions (add a note!)	2 • Look forward with climate/global warming for engineering (NOAA, ATLAS 15, VAL II, First Street Institute) • Could be helpful to reference for each county's multi-jurisdictional hazard mitigation plan (suggestion for sharing this data) • Data will help counties, cities, watersheds get a sense of the spectrum of impacts/costs, etc. • Maintain accessible contingency/rainy day funds to pay for unforeseen extreme events damages/ impacts • Teach bicyclists to obey stop signs • More collaboration between county, city, state data base info already collected. Keeps us from duplicate spending over decades.

MNDOT DISTRICT 6 PUBLIC MEETING

Rochester | October 18, 2023

Event Location: MnDOT Rochester Office, 2900 48th Street NW, Rochester, MN 55901

PUBLIC MEETING GOALS

- To share project information about the Resilience Improvement Plan
- To get input on hazards, vulnerabilities, and actions MnDOT can take from stakeholders that will be used in the plan.

EVENT PROMOTION

- MnDOT's social media calendar
- Emails targeted to stakeholders

How many people attended: 1 MnDOT staff, 1 reporter

KMIT 3 News did a story on RIP and interviewed Brian Shekleton. News links are below.

https://www.kimt.com/video/mndot-works-to-develop-new-natural-hazard-plan/video_5acba441-a240-50e1-94a4-aacb211118c2.html

https://www.kimt.com/news/mndot-seeking-public-input-for-natural-hazards-planning/article_580afdf0-6dfb-11ee-910b-4300b91c4aca.html

RESILIENCE ADVISORY TEAM: PERFORMANCE MEASURES WORKSHOP

December 1, 2023 | 10:00-11:00

PROJECT TEAM

Brian Shekleton, Chris Dorney, Mike Meyer, Liz Wiggen, Kara Van Lerberghe

WORKSHOP ATTENDEES

MnDOT Resilience Advisory Committee: Nicole Bartelt, Nathan Braman, Kenneth Graeve, Andrea Hendrickson, Katherine Kowalczyk, Kristoffer Langlie, Katherine Lind, Liz Wiggen, Douglas Maki, Erin Meier, Nicholas Olson, Rachel Pichelmann, Shaker Rabban, Brian Shekleton, Siri Simons, Ashley Zidon

FACILITATED DISCUSSION SUMMARY

Organize for Success

Action	Keep As Is	Good Idea, Modify	Remove
Effectiveness of MnDOT's organizational structure and leadership in fostering a more resilience-oriented focus in decision-making. (Target: ___% effectiveness as determined by internal survey; ___% effectiveness as determined by external survey. Survey would be of MnDOT staff selected by agency leadership, and would be collecting subjective opinions of how effected the structure and leadership is. The period between surveys would be the decision of MnDOT leadership, but should not be more than three years.)		• *Blank Vote* • The RAT should be used more frequently for strategic planning • Agree w/ comment on leveraging RAT for this purpose.	• *Blank Vote* • *Blank Vote* • *Blank Vote* This seems really nebulous to me, hard to measure?

Action	Keep As Is	Good Idea, Modify	Remove
Periodic assessment of MnDOT staffing needs in support of resilience efforts. (Target: Assessment of resilience staffing needs conducted every ___ years.)	• *Blank Vote* • *Blank Vote* • *Blank Vote*	• *Blank Vote* • Especially GIS Analyst Roles • We could incorporate resilience into employee position descriptions as a responsibility • Assessment of existing staff in groups/functional areas in making resilient decisions in their work. Make existing staff more resilience focused. • Especially maintenance staff - how will we respond to severe storm events if we are understaffed even for standard conditions? • Should be minimal, enough to have a clear data picture to assist in adjusting new standards. Some roles could be adjusted to maintain long term consistent monitoring.	

Action	Keep As Is	Good Idea, Modify	Remove
Level of coordination between the RIP and other MnDOT plans and program documents. (Target: ___% stated coordination as determined through internal MnDOT survey.)		• How would we measure this? Whether or not each document discusses resilience? What counts as sufficient discussion within a document? • This is a great idea, and very important, but how would it be done?	• *Blank Vote* • *Blank Vote* • *Blank Vote* • This is fine to do, but not sure it needs to be a PM.

Action	Keep As Is	Good Idea, Modify	Remove
Level of coordination between RIP and external planning processes/programs (e.g., metropolitan planning organization [MPO] and tribal transportation planning processes, Minnesota's Statewide Hazard Mitigation Plan (SHMP,) and similar). (Target: ___% stated coordination as determined through external survey of Minnesota's planning and MnDOT partner agencies. Survey would be of agency staff selected by MnDOT leadership, and would be collecting subjective opinions on the level of coordination between the RIP and their agency's plans and programs. The period between surveys would be the decision of MnDOT leadership, but should not be more than three years. Target: 100% of external agency plans and program documentation are cross-referenced to and in the RIP.)		• Not sure I'm following what the PM is, but think coordinated efforts are very important to track.	• MnDOT already leads in local design standards. If we are clear and credible we will continue to lead.

Action	Keep As Is	Good Idea, Modify	Remove
Number of MnDOT staff who have resilience concerns as part of their job description. (Target: ___% of staff positions)		• I would like this one if it was easy to pull this info. But I suspect it wouldn't be that easy. So likely prefer the training metric. • Everyone's job could be related to resilience, so could reach further in the organization if we focus on helping all groups relate what they do to resilience.	• The training focus metric is better than this one in my opinion • *Blank Vote* • *Blank Vote*
MnDOT's resilience self-assessment score as determined by the NCHRP 970 guide. (Target: ___% increase in self-assessment score (in terms of the points awarded for current status of MnDOT resilience efforts).)	• *Blank Vote* • *Blank Vote* • *Blank Vote* • *Blank Vote*	• Measure increase in score over what period of time?	

Action	Keep As Is	Good Idea, Modify	Remove
Proportion of MnDOT staff who have taken resilience-oriented training courses or who have participated in resilience-oriented professional development meetings or workshops. (Target: ___% of MnDOT staff participating in such training, professional development meetings, or workshops.)	• *Blank Vote* • *Blank Vote* • Agree that this is better than the position description one	• Good, but does this belong in the Communications area? • Have one training PM either here or in communications. Identify what type of training each staff member should have completed. Or have the initial "training" also be info gathering.	• Difficult to tally in all training venues, resilience not applicable for all positions. • Already part of general engineering education.
Missing Anything?	• What is the goal for the overall # of performance measures? There is a lot here, and I would advocate for fewer (less is more). Or maybe have only some public facing.		

Improve Communications

Action	Keep As Is	Good Idea, Modify	Remove
Stated (and written) business case for why resilience concerns need to be part of MnDOT's mission, goals, and objectives; and supported by key constituencies. (Target: Written business case updated every ___ years.)	• *Blank Vote* • *Blank Vote*	• Emphasizing the overall benefit/cost of these efforts is very helpful • Yes, I support the comment about having ROI shown for resilience improvements. Would help support funding requests, engagement statewide, etc. • Explicitly calling out resilience as a core business goal • Doesn't seem like a performance measure. Good idea though	• *Blank Vote* • Is this a performance measure or just a task?
Stated (and written) strategy for including resilience concerns into MnDOT's overall communications strategy, updated on a periodic basis. (Target: Written strategy exists and updated every ___ years.)	• *Blank Vote* • *Blank Vote*	• *Blank Vote* • Seems like these first 3 could be combined, or at least first 2. • Doesn't seem like a performance measure. Good idea though	

Action	Keep As Is	Good Idea, Modify	Remove
Incorporation of resilience topics and concerns in internal communications outreach efforts with MnDOT staff; assessment of the effectiveness in terms of staff awareness. (Target: Assessment of the effectiveness of internal communications efforts every ___ years. Assessment to be based on MnDOT internal staff surveys that subjectively assess the level to which staff believe resilience is part of MnDOT's internal communications and outreach efforts.)	• *Blank Vote* • Yes, we have work to do to gain support agency wide. Internal communication/ outreach on this topic would be helpful.	• Doesn't seem like a performance measure. Good idea though • A MnDOT Resilience Conference might be good for broadcasting the completed RIP (including lots of Maintenance Forces, so maybe it would need to be a traveling conference) • Doesn't seem like a performance measure. Good idea though	

Action	Keep As Is	Good Idea, Modify	Remove
Incorporation of resilience topics and concerns in joint communications efforts with MnDOT partner agencies (or creating such joint communications if they do not exist); assessment of their effectiveness. (Target: Assessment of the effectiveness of joint communications efforts every ___ years. Assessment to be based on internal and external surveys. The selection of MnDOT staff and of the external agency staff to be surveyed would be done by MnDOT leadership The survey would solicit subjective ratings of the perceived effectiveness of joint efforts.)		• Not a bad idea, but hard to implement	• *Blank Vote* • Takes a lot of capacity - lower priority

Action	Keep As Is	Good Idea, Modify	Remove
Incorporation of resilience topics and concerns in communications outreach efforts to key MnDOT constituencies; assessment of their effectiveness. (Target: Assessment of the effectiveness of resilience communications efforts every ___ years. Assessment to be based on internal and external surveys.)		• I think this is an interesting idea. But this seems like it would naturally come out of the other communication strategies - include as a question in the omnibus survey? • Present on resilience to various district and statewide functional groups, such as maintenance supervisors workshop, design engineers workshop, etc. # of people reached	• *Blank Vote* • Takes a lot of capacity - lower priority
Missing anything?	• Should communication with the general public have their own PM? • All the communication efforts are one direction. How do we receive input from staff who are already making the system more resilient without the title?		

Increase Understanding of System Risks

Action	Keep As Is	Good Idea, Modify	Remove
Progress in completing the Extreme Flood Vulnerability Assessment statewide. (Target: District __ assessment completed by the end of year ____.)	• *Blank Vote* • *Blank Vote* • *Blank Vote* • *Blank Vote* • *Blank Vote* • *Blank Vote*	• Some credit for screening out areas that may have had recent exposure too (real world vulnerability assessment) • If district-level analyses will be part of this work, remove district assessment as a performance measure here •	
Progress in expanding the quantitative risk assessment approach to other hazards and asset types. (Target: Quantitative risk assessment of the ____ asset-hazard combination (identified in the RIP) completed by the end of year ____.)	• *Blank Vote* • *Blank Vote* • *Blank Vote* • *Blank Vote* • *Blank Vote*	• *Blank Vote* • Consider how this aligns with plans/ tools outside the RIP • Focus now on making current approach better. Reevaluate at later date. • Identify other categories of hazards	

Action	Keep As Is	Good Idea, Modify	Remove
Number of MnDOT engineering, planning, environmental, and capital programming staff who have taken training courses or participated in professional development meetings or workshops focusing on quantitative risk assessment. (Target: At least ___ MnDOT staff per year participating in such training, professional development meetings, or workshops.)	• *Blank Vote* • *Blank Vote* • *Blank Vote*	• *Blank Vote* • *Blank Vote* • Is this already being measured in other performance measures in the department? Might be useful for overall asset management?	• Don't see as key of a metric. • Put all training in one PM and include a way to receive feedback for 2-way communication. • I agree that all of the training PMs could be combined
Missing anything?	• What about all the performance measures the RAT identified over the past 18 months? Some of those belong in this category. • Need to bring more actuary science into process. • Evaluate equity needs tools to layer in system evaluations.		

Strengthen Emergency Response

Action	Keep As Is	Good Idea, Modify	Remove
Effectiveness of MnDOT's organizational structure and leadership in supporting emergency response efforts. (Target: ___% effectiveness as determined by internal survey; ___% effectiveness as determined by external survey. MnDOT leadership will select those to be surveyed. Survey will solicit subjective assessments of the emergency response program.)		• Decisions/changes may come about as result of other metrics. Not sure we need a specific one to track this topic	• *Blank Vote* • *Blank Vote* • *Blank Vote* • *Blank Vote* • Identification of vulnerabilities in org structure and methods to improve response within system
Quantitative assessment of MnDOT's emergency response (by hazard type)For hazard ____ (for example, flooding, wildfire, winter storms, etc.) (Target: ___% change in average response time to disruption per year (trajectory of the change))	• *Blank Vote* • *Blank Vote* • Response time may be a difficult comparison between years depending on severity/timing of events.	• Could use TAMS work orders and get reports. • The objective should be short term dramatic improvement. Not documenting long term trends. • May need to modify TAMS to record and report on response times	

Action	Keep As Is	Good Idea, Modify	Remove
Level of coordination among MnDOT units (such as Emergency Response, Assets/ Operations/ Maintenance, Executive Office, and Communications) involved in emergency response. (Target: Number of coordination meetings, training exercises, etc. held each year.)	• 100% Support these 2 performance measures. It will be a critical component of our ability to improve response and identify mitigation needs.		

Action	Keep As Is	Good Idea, Modify	Remove
Level of coordination among MnDOT and other emergency response partner agencies such as local police and fire agencies, etc. (Target: Number of coordination meetings, training exercises, etc. held each year.)	• *Blank Vote* • 100% Support these 2 performance measures. It will be a critical component of our ability to improve response and identify mitigation needs.	• I would change to % of relevant staff that have completed the training, not the total number of things (unless we can safely assume all relevant staff attends) • Agree with note above • Can this be adjusted to describe the process/ coordination for ER at MnDOT and how it improves? I'm not sure how to describe that. • Change how coordination is measured. Not sure meetings are as effective as communication tools and other informal methods used by field responders. • Some of this is part of statewide EM planning already - do we want to spend resources on things HSEM is already tracking as part of their planning requirements? • Is number of meetings the best target? • Ask people if they and their agency/field is under prepared for current situations. Immediate needs should outweigh future uncertainty.	

Action	Keep As Is	Good Idea, Modify	Remove
Implementation of (or updating) MnDOT's use of post-event data obtained from MnDOT staff and emergency response partner agencies in assessing the effectiveness of future emergency response efforts and possible use in risk assessments. (Target: _____% of post-event data being used to assess effectiveness of emergency response by the end of year _____; _____% of post-event data being used in risk assessments by the end of year _____.)	• *Blank Vote* • *Blank Vote* • *Blank Vote* • We are nearly done developing the database of past flood events. This will continue to be updated so that it can be a valuable source for project planning, design, response, etc.	• We would need clarity on all that is considered post-event data (i.e. what is our denominator?) • This should also assess how well we captured the damage and impact observations. • Methods to collect event data to supplement human reports. Flooding could have sensors installed, or RTMC camera footage reviewed.	
Proportion of MnDOT emergency response staff who have taken training courses or who have participated in development meetings or workshops focusing on future climatic and extreme weather challenges. (Target: ___% MnDOT emergency response staff who have participated in such training, professional development meetings, or workshops within the last five years.)		• Seems like the timeframe should be annual (not 5 years), maybe every 2 years at the longest • Combine in single training PM • Agree with pink note • This is already part of EM staff job performance and reported as part of HSEM/FEMA training reports. Internally, we have training requirements with FHWA PA.	• *Blank Vote* • First aid and emergency preparedness are for immediate emergencies. Climatic challenges are not emergencies, they are trends.

Action	Keep As Is	Good Idea, Modify	Remove
Missing anything?	• Methods to automate preparedness and response efforts • Response times in vulnerable or high risk population centers compared to overall. • Need to clarify who you mean by "emergency response" staff. Are you talking about emergency management? Are you talking about maintenance staff?		

Enhance Operations and Maintenance Activities

Action	Keep As Is	Good Idea, Modify	Remove
Proportion of the total length of major roadways having pre-planned detour routes/ closure plans (and similar measures for other modes). (Target: Increase the proportion of the total length of major roadways having pre-planned detour routes/closure plans by __% by the end of year ____.)	• *Blank Vote* • *Blank Vote* • *Blank Vote*	• Support comments that rather than having pre-defined routes, better to have tool to be able to quickly identify and deploy viable detour routes based on the specific situation. • Need to change to develop a PROCESS to come up with a detour quickly and have the equipment and materials on hand to respond dynamically • Agree with note above	

Action	Keep As Is	Good Idea, Modify	Remove
Proportion of the total length of major roadways having detour route signage (or plans for rapid reaction temporary signage). (Target: Increase the proportion of the total length of major roadways having detour route signage (or plans for rapid reaction temporary signage) by __% by the end of year ____.)	• *Blank Vote*	• *Blank Vote*	• *Blank Vote*
Proportion of operations-oriented assets (such as road weather information systems, traffic cameras, automated traffic recorders, intelligent transportation system devices) that are hardened against future climate changes over their anticipated lifespans.(Target: ___% by the end of year ___.)	• Getting climate change safe cameras is over-prepping	• Replacement cycle? Quantity of upgrades or innovative pilots to test in our climate? • Not sure how useful this will be. Equipment should be selected to withstand MN Climate; maybe a better target is around level of redundancy?	• *Blank Vote*

Action	Keep As Is	Good Idea, Modify	Remove
Existence of updated O&M emergency response plan, including existence of on-call support contracts to provide assistance given the types of disruptions being faced. (Target: O&M response plans updated at least every ___ years.)		• *Blank Vote* • May need to adjust for specific disruptions. For example: scour critical bridges have Plans of Action with these items. It would be good to understand how these plans work together. • Might need to prioritize	
Existence of updated vegetation management and control strategies reflecting changing environmental conditions. (Target: Vegetation management and control strategies updated at least every ___ years.)	• Yep	• Example: response to tree die-off related to introduced pest species; Early Detection & Rapid Response capability for newly introduced invasive plants • This seems vague. Is this existing vegetation needs or re-establishment after modifications? Amount of native/drought resistant/other goal converted/ established	

Action	Keep As Is	Good Idea, Modify	Remove
Existence of updated MnDOT COOP that reflects the latest understanding of the changing weather-related stresses and system risks. (Target: Updated MnDOT COOP at least every ___ years.)	• *Blank Vote* • *Blank Vote*	• *Blank Vote* • I don't know what this means and who the audience is. • COOP is focused on continuing business operations and should be flexible for all hazards. Are you talking about how things are prioritized in the COOP?	
Missing anything?	• Part 1: If you are looking for improvement on the emergency response measures, they are very dependent on what weather we get (have to have a hazard to respond to it). • Part 2: Sometimes we have four disasters in a year, and sometimes we go four or five years without a declared event. • Sufficiency of staffing levels. Maintenance often has trouble hiring enough plow drivers for normal conditions; what about ability to respond to big storms? • Standards for assessment of assets. Eg, all pipes >XX age have had inspection assessment and prioritization done. AM replacement schedule informs project selection • Planning team for AM needs to supplement/support transportation focused planning • Identify needs for maintenance of green infrastructure assets. In conjunction with partners and community members.		

Consider Climate Change During Project Development

Action	Keep As Is	Good Idea, Modify	Remove
Updated guidance incorporated into project development standard operating procedures and design standards reflecting changing environmental conditions. (Target: Incorporate and update every _____ years risk-based analysis procedures and recommended design alternatives. Initial incorporation to be completed by the end of year ___.)		• *Blank Vote* • *Blank Vote* • *Blank Vote* • This is underway for hydrology/hydraulics right now, but a critical piece will be ALSO developing data to support the guidance. • First need to develop the updated design standards • I like this goal, but would like to see a stronger goal more focused on result. Do we have guidance and reporting requirements now?	
Proportion of projects in each year using a risk-based design approach. (Target: Increase the proportion of projects in each year using a risk-based design approach by __% by the end of year _____.)	• *Blank Vote* • *Blank Vote* • *Blank Vote*	• This needs to be more specific. In a sense, we use a risk-based approach for every H&H model we complete, as well as other areas too. • Sounds good, establish the standard, design to the standard.	

Action	Keep As Is	Good Idea, Modify	Remove
Proportion of design projects in each year that consider climate change projections. (Target: Increase the proportion of design projects in each year that consider climate change projections by __% by the end of year ____.)	• *Blank Vote* • *Blank Vote*	• How will this be done? Needs to be reported by the highest levels of management in districts. And they need to know what their goal is and what CC incorporation looks like. • Maybe needs clarification on what it means to "consider climate change projections" • Projects should not consider climate change projections, standards should.	
Proportion of high-risk existing assets for which a detailed adaptation analysis has been conducted. (Target: Increase the proportion of high-risk existing assets for which a detailed adaptation analysis has been conducted by __% by the end of year ____.)	• *Blank Vote* • *Blank Vote*	• Sounds like this belongs in the Understanding category, Category 3 • Will need to define and prioritize high risk • As the pink note suggests, we need to do a lot of work before we could implement such a PM • We need to know the specific high risk assets. • Do we have high risk assets identified?	

Action	Keep As Is	Good Idea, Modify	Remove
Number of MnDOT project development staff who have taken training courses or who have participated in development meetings or workshops focusing on future climatic and extreme weather challenges and how to handle in project development. (Target: At least ___ MnDOT project development staff per year participating in such training, professional development meetings, or workshops.)	• *Blank Vote*	• Combine into the other training related PMs from earlier	• *Blank Vote* • *Blank Vote* • *Blank Vote*
Missing anything?	• Part 1: How do we plan for temporary impacts of extreme weather during construction? • Part 2: Examples: floods delaying construction, drought restricting access to water for compaction, heat waves unsafe for workers… • …Smoke-driven air quality alerts unsafe for workers… • What part of climate change should be considered? Emissions from construction, reduced end user emissions, resilience/adaption measures? • Where are we incorporating environmental and transportation equity? • Where are we incorporating environmental and transportation equity?		

Integrate Climate Change Into Asset Management

Action	Keep As Is	Good Idea, Modify	Remove
Incorporation of resilience and RIP concerns into TAMP updates. (Target: The 2026 TAMP will reference and include resilience concerns, strategies, priorities, and needs. Target: Resilience-specific metrics will be incorporated into the 2026 TAMP.)	• *Blank Vote*	• *Blank Vote* • Need more guidance on resilience • Seems vague • Adjust as needed by engineers developing the TAMP. • This is a necessity, but it's more of a checkbox than a PM	

Action	Keep As Is	Good Idea, Modify	Remove
Implementation of data collection and analysis recommendations in the RIP report and in cooperation with partner agencies in support of such an approach. <u>For roads</u> Target: Incorporate dual carriageway roads as two separate lines in the Highway Performance Monitoring System (HPMS) data by the end of year ____. Target: Update attribute data in the GIS to avoid stacked lines and have route information for concurrent routes handled in the attribute table by the end of year ____. Target: Identify where improved locational accuracy is needed for road segments as matched to the latest LIDAR data and indicate in the road line data file whether it is located on an embankment and the characteristics of that embankment (e.g., material, volume, etc.) by the end of year ____. Target: Integrate pavement data on condition and other attributes (including condition metrics, when last updated, pavement type, pavement thicknesses and design characteristics, and so forth) into the road linework in the GIS database by the end of year ____.	• *Blank Vote*	• Are these already agency objectives? • This is important. We may need to spend time thinking about the right targets, and we will want to make sure they overlap/ agree with other agency plans	

Action	Keep As Is	Good Idea, Modify	Remove
Implementation of data collection and analysis recommendations in the RIP report and in cooperation with partner agencies in support of such an approach. <u>For bridges and large culverts</u> Target: Develop new database variables that reflect changes in the National Bridge Inventory (NBI) by ___ months after publication of NBI data. Target: Collect information on and include in GIS database on bridge low chord (bottom) elevations, included as an attribute, by the end of year ____. Target: Create bridge lines in the GIS database (instead of points as is currently done) within the road file that are referenced to each bridge ID by the end of year ____. Target: For large culverts (bridge-culverts) and pipes, collect and include in the GIS database an indication of the presence of outlet scour protection by the end of year ____.	• This is great and will help support better vulnerability assessments • YES!	• This is important. We may need to spend time thinking about the right targets, and we will want to make sure they overlap/ agree with other agency plans	

Action	Keep As Is	Good Idea, Modify	Remove
Implementation of data collection and analysis recommendations in the RIP report and in cooperation with partner agencies in support of such an approach. <u>For Pipes</u> Target: Examine the GIS database and rectify where the length of the pipe is not shown accurately by the end of year ____. Target: Provide a common indicator to show where multiple pipes are used to handle a single stream crossing by the end of year ____.	• Some partners are leading and we are trying to keep up to respond. How do we build responsiveness into partner efforts, especially those that could benefit from more innovation.	• Looks great! If any of these are new objectives, they need to be useful and not unnecessary duplications of effort. • This is important. We may need to spend time thinking about the right targets, and we will want to make sure they overlap/ agree with other agency plans • Important to do, but does this really need to be a measure? • Identifying Sag Culverts as a function of vulnerability	

Action	Keep As Is	Good Idea, Modify	Remove
Implementation of data collection and analysis recommendations in the RIP report and in cooperation with partner agencies in support of such an approach. <u>For Ponds, Catch Basins, and Pumps</u> Target: Include stormwater ponds accurately in rural areas in the GIS layer (instead of simple circles) by the end of year ____. Target: Include the capacity of flow handling ability of ponds, catch basins, and pumps in the GIS databased by the end of year ____.		• However this is done, it needs to be useful, and not just an excessive amount of data collection.	
Implementation of data collection and analysis recommendations in the RIP report and in cooperation with partner agencies in support of such an approach. For Slopes Target: Include in the MnDOT database for slopes adjacent to the state road network the types of data that would be needed for a risk-based analysis, such as soil types, existence of rock outcrops, protection measure put in place, vegetation type, and so forth within ___ years of completion of the slopes study.		• Also add: near waterway at toe of slope	

Action	Keep As Is	Good Idea, Modify	Remove
Implementation of data collection and analysis recommendations in the RIP report and in cooperation with partner agencies in support of such an approach. <u>For Electronic Equipment</u> Target: Include in MnDOT's GIS database the data on temperature thresholds for the equipment (in particular the maximum temperature allowed), whether the asset is air conditioned, shaded, and its potential solar gain (based on its color and reflectivity) by the end of year ____.		• See note regarding combining AM measures at the bottom of slide 20 from Part 1	• Let the equipment start to break before we begin replacement.
Implementation of data collection and analysis recommendations in the RIP report and in cooperation with partner agencies in support of such an approach. <u>For Buildings</u> Target: Include in the GIS database data on heating, ventilation, and air conditioning specifications by the end of year ____.			• This is far outside the scope of MnDOT

Action	Keep As Is	Good Idea, Modify	Remove
Enhancing MnDOT capabilities in providing risk-based information for asset management decision-making.(Target: Incorporate systems-level risk information into asset management databases for each asset to each relevant hazard within six months of it initially becoming available or being updated. Target: Update asset management decision-making processes (including written documentation) to incorporate climate risk information for each asset to each relevant hazard within one year of it initially becoming available.)	• *Blank Vote*	• Identify methods to prioritize equitable resilience response and approaches • The pink note here has a good idea, we will need to figure out how to put all assets on the same playing field • Change start to "Consider & formally decide on..." i.e. new precip projections do not have same rigor as the ones currently used (another source published after Atlas 15) • Not a bad start, but we may need to adjust those suggested deadlines once a few cycles elapse to see how reasonable they are • Written documentation and short timelines may be unnecessary.	

Action	Keep As Is	Good Idea, Modify	Remove
Enhancing resilience capabilities of asset management staff. (Target: __% of asset management staff exposed to training and professional development activities by the end of year ____.)		• Work with AM staff to increase resilience focus, reporting, and improvements. • Could be combined with training measures mentioned earlier, as a subsection	
Missing anything?	• Overall comment: Part 1: could the training piece be swept under a more organizational approach that is supported under a broader umbrella / not directly within the RIP? • Part 2: - may be more a q for Brian / his group to offer space for with help from others (like the NHIS course that was discussed earlier in the mtg) • Agree with the (crooked) yellow note. Also all of these AM measures could be combined into one, with subsections, to avoid overwhelming people • Overall comment on these: Less is more. It's a lot to track. Is there a way to prioritize metrics once we get a better idea of what people want to keep/don't. Keep the quality. X 2 people • Agree - was thinking how many should we be overall trying to target? We don't want to get overwhelmed. • Overall comment: Goal is to get resilience through the entire organization so all staff are involved. • Overall comment: As we narrow down these, to me it would make sense for certain categories of metrics to use a similar method to assess. Example: all the staff training ones • Life is complex, and some AM/Maint. data may only be good and useful in the short term.		

Enhance Consideration of Resilience Needs in Project Programming

Action	Keep As Is	Good Idea, Modify	Remove
Incorporation of hazard ratings into MnDOT's prioritization processes and decision-making. (Target: Hazard ratings formally included in MnDOT's prioritization by the year ____.)	• *Blank Vote* • *Blank Vote* • *Blank Vote* • *Blank Vote*		
Incorporation of risk-oriented criteria into MnDOT's prioritization processes and decision-making. (Target: Risk-related criteria formally included in MnDOT's prioritization process within one year of the data becoming available for a given asset-hazard combination.)	• *Blank Vote*	• Also needs to be more specific to Climate Resilience Risk • Not just at one point… Year may be too specific. Need in MnSHIP, in CHIP, in STIP. • May need to revisit deadline for feasibility	

Action	Keep As Is	Good Idea, Modify	Remove
Implementation of resilience-focused projects identified in the RIP and by MnDOT in other processes. (Target: __% of the projects completed by the year _____ are resilience-focused; __% of the projects completed by the year _____ are resilience-focused projects.)	• *Blank Vote* • *Blank Vote*	• p1: I think this will be limited, and probably should stay limited. It is most efficient to improve resilience within the standard pavement rehab project rotation (15-20yrs). • p2: But, need to have vulnerability ratings and risk criteria developed and implemented in the project process to avoid missing those opportunities • Suggest changing to % available funding utilized (rather than project #/%). Unless looking for all projects with any resiliency items incorporated in the project.	

Action	Keep As Is	Good Idea, Modify	Remove
Proportion of MnDOT annual capital program having climate change considerations incorporated. (Target: __% of the projects having climate change purposely incorporated into the project design.)		• Might be better to focus on changing the design process officially, than tracking what projects use it. Once officially adopted, all projects need to use it • Agree with orange note • Yes Orange • Not sure how this would be measured?	
Monitoring the use of resilience factors in allocating non-capital dollars for other MnDOT services, not administrative or overhead. This would include budgets relating to operations, maintenance, emergency response, etc.) (Target: __% of non-capital budget considering resilience factors by the year ____.)	• *Blank Vote*		• *Blank Vote*

Action	Keep As Is	Good Idea, Modify	Remove
Perceived importance of resilience factors in establishing investment priorities. Target: __% of MnDOT staff perceiving resilience as being important in establishing priorities (determined through surveys of project development staff and the staffs/members of the MPOs and Area Transportation Partnerships [ATPs]).)		• Require teams at certain levels to provide summary/ checklist of resilience incorporated in their work. • Done through an annual(?) survey of employees? • Results of a survey may be too unreliable to provide any takeaways or actionable items	
Missing anything?	• To get resiliency into programming, need to have project selection criteria that pushes those projects to be selected. Vulnerability or hazard ratings are key.		

MONITOR AND MANAGE SYSTEM PERFORMANCE

The candidate resilience performance measures are presented in four categories---enhancing the resilience monitoring system, safety, service continuity, and maintenance/repair costs. Some output measures have been identified initially that relate to setting up and implementing the resilience-oriented monitoring and performance measurement.

Action	Keep As Is	Good Idea, Modify	Remove
ENHANCING THE RESILIENCE MONITORING SYSTEM			
Incorporation of resilience-related performance measures into MnDOT's performance management system. (Target: Candidate performance measures are selected and fully incorporated into MnDOT's performance management system by the year ____.)	• *Blank Vote* • *Blank Vote*		• Combine these. Not sure employee performance is the right place for this, but not sure what the right place is.
Given the continuing updates in knowledge and understanding of climate change, establishing and using a formal re-evaluation process of the resilience performance measures. (Target: A re-evaluation process is in place with such re-evaluations occurring every ____ years.)	• *Blank Vote* • *Blank Vote*		

Action	Keep As Is	Good Idea, Modify	Remove
Incorporation of the results of resilience performance monitoring in MnDOT reporting and in communications strategies. (Target: Results are incorporated into MnDOT reporting and communications no later than one year after adoption of the resilience performance measures.)	• *Blank Vote* • *Blank Vote*	• Many of the PMs may need to be revisited to see how feasible they are. I would advise waiting on reporting on them until they have time to work themselves out to the right level	
SAFETY			
Number of injuries attributable to extreme weather events on the MnDOT system per year, normalized by the number and intensity of weather events. (Target: Reduce the number of injuries attributable to extreme weather events on the MnDOT system by ___% by the year ____, normalized by the number and intensity of weather events.)		• *Blank Vote* • Agree with the blue note • Could be a double edge sword. Incident reports can have multivariate causes	

Action	Keep As Is	Good Idea, Modify	Remove
Number of deaths attributable to extreme weather events on the MnDOT system per year, normalized by the number and intensity of weather events. (Target: Reduce the number of deaths attributable to extreme weather events on the MnDOT system by __ % by the year ____, normalized by the number and intensity of weather events.)		• *Blank Vote* • Change to "related to MNDOT system", as MNDOT could contribute to adjacent issues. • Modify to say "primarily attributable" or "attributable in part" • Add employee safety measures	

Action	Keep As Is	Good Idea, Modify	Remove
SERVICE CONTINUITY			
Number of facility closures (or capacity limitations) attributable to damage from flooding, extreme heat, or landslides/rockfalls (separate measure for each hazard) on the MnDOT system per year, normalized by the number and intensity of events. Break down by facility type and whether a full closure or just a capacity limitation. Also, specifically track the results for facilities designed with future climate projections vs. those that are not. (Target: Reduce number of facility closures (or capacity limitations) attributable to damage from flooding, extreme heat, or landslides/ rockfalls on the MnDOT system by __% by the year ____, normalized by the number and intensity of events (break down by facility type and whether a full closure or just a capacity limitation).)		• From discussion at mtg: utilizing "Extreme Weather Severity Indexes" in the same idea as the "Winter Severity Index". Need multiple indexes (precip, wind, spring flood, temp…) • Which one or several would be relevant to different asset types • This seems similar to other O&M PMs for road closures. Combine	

Action	Keep As Is	Good Idea, Modify	Remove
Average duration of facility closures (or capacity limitations) attributable to impacts from extreme weather events on the MnDOT system per year, normalized by the number and intensity of events (break down by facility type, cause of event [flooding, landslide/rockfall, etc.], and whether a full closure or just a capacity limitation). (Target: Reduce average duration of facility closures (or capacity limitations) attributable to damage from extreme weather events on the MnDOT system by __% by the year ___, normalized by the number and intensity of events (break down by facility type, cause of event [flooding, landslide/rockfall, etc., and whether a full closure or just a capacity limitation).)			

Action	Keep As Is	Good Idea, Modify	Remove
MAINTENANCE/REPAIR COSTS			
Maintenance/repair costs attributable to various hazards (flooding, extreme temperatures, landslides, etc.) and asset types (breakout by asset-hazard combo). (Target: Reduce maintenance costs __% by the year ___ for asset-hazard combinations, normalized by the number and intensity of events.)	• *Blank Vote* • Great measure, but need to be aware of quality of data used to calculate these cost comparisons		
Missing anything?	• Re-evaluate prioritization of other assets with similar risk factors		

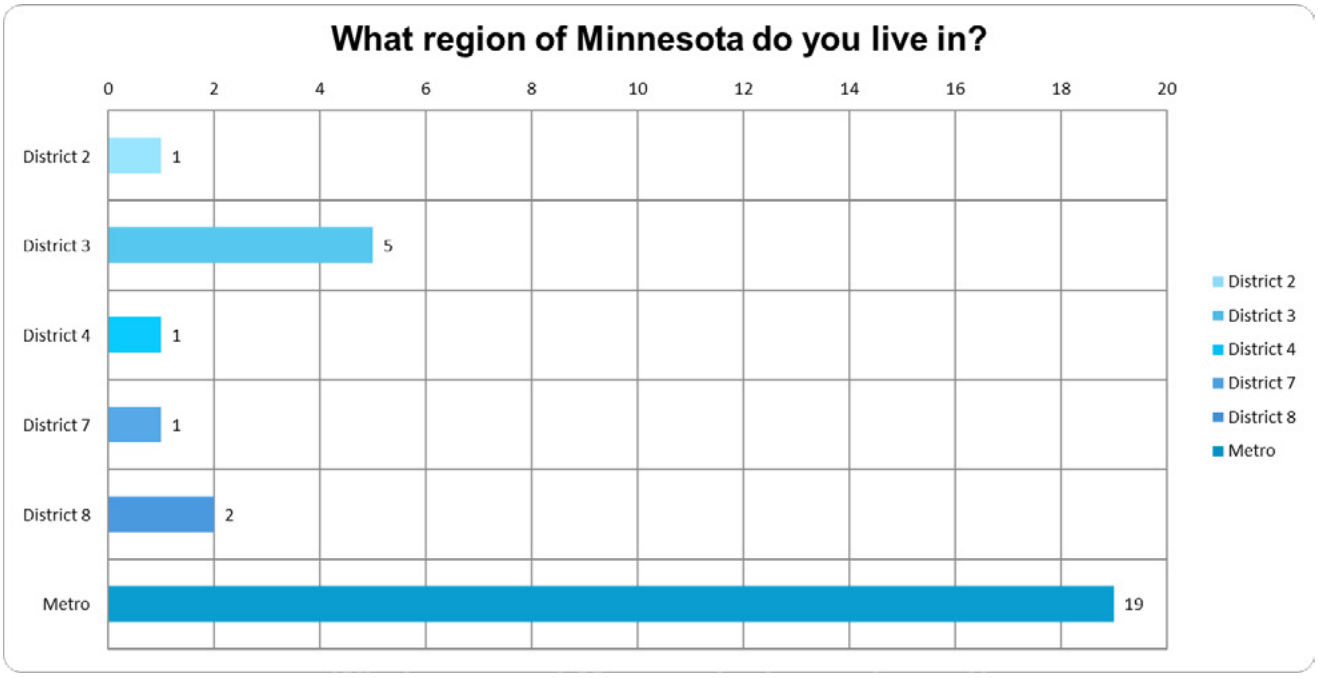
ONLINE CLIMATE HAZARDS SURVEY

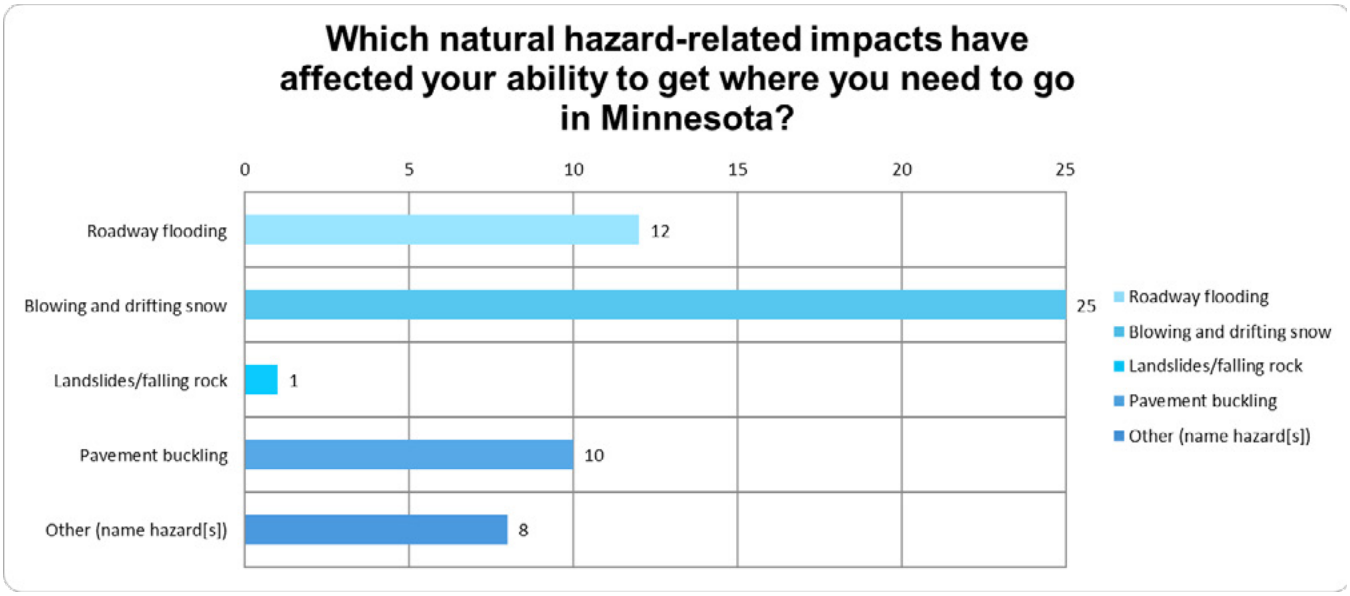
26 January 2022 - 15 February 2024

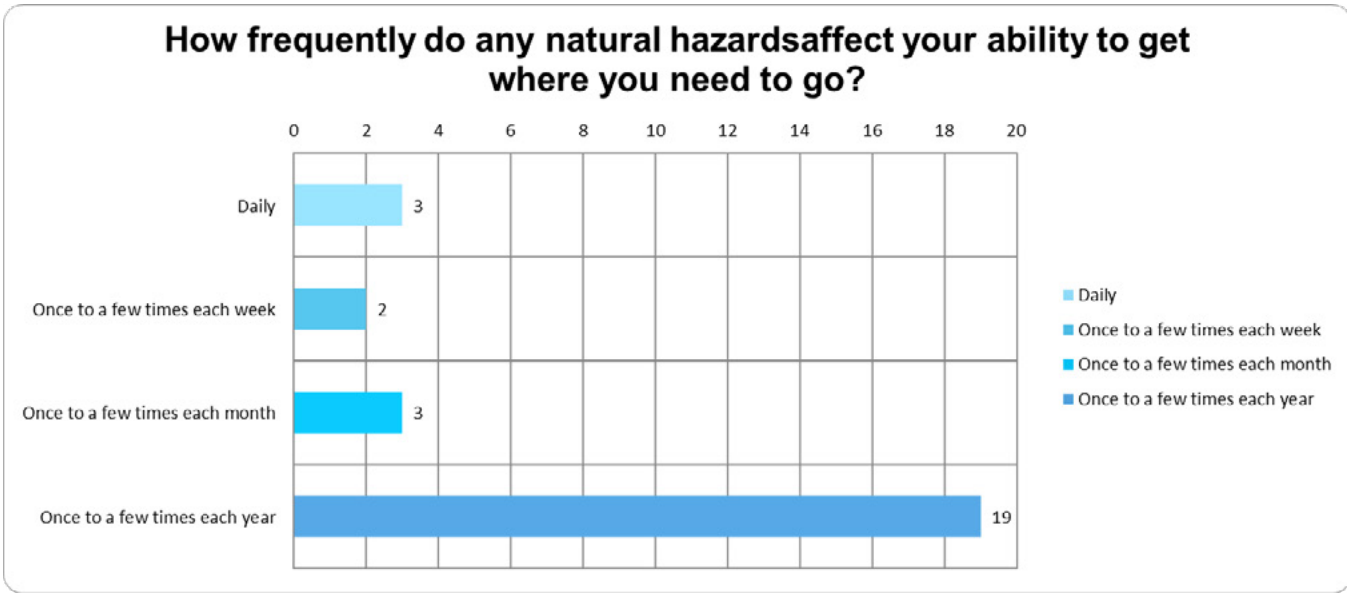
LET'S TALK TRANSPORTATION – MNDOT PROJECT: RESILIENCE IMPROVEMENT PLAN

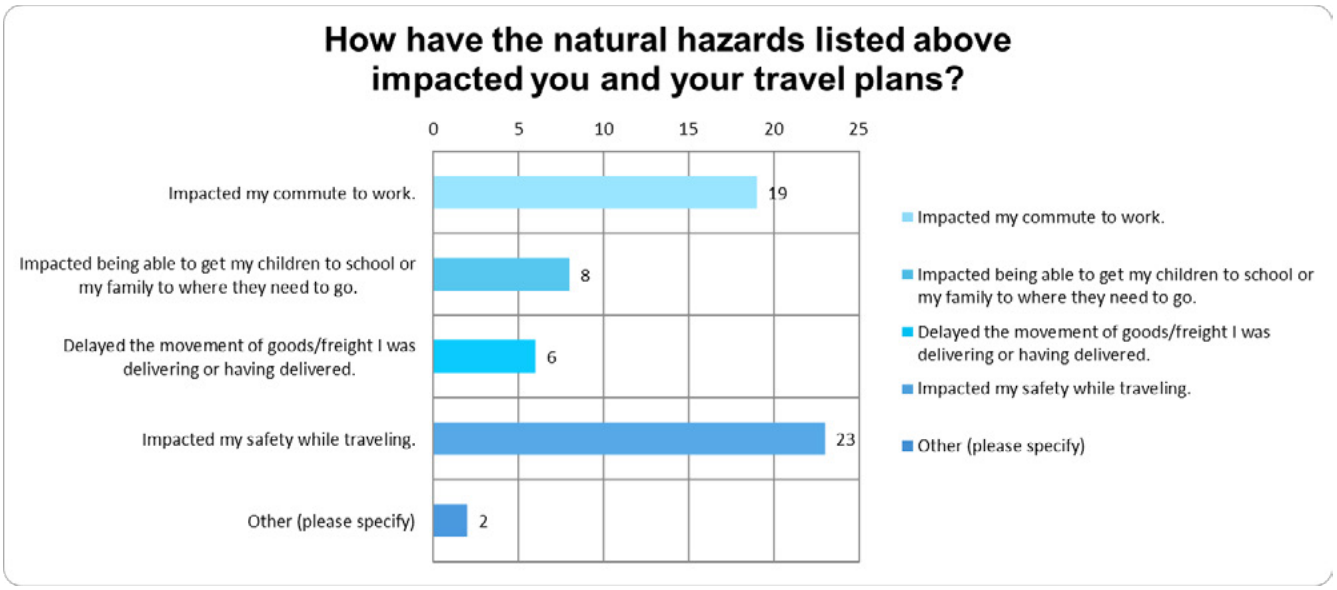
BANG THE TABLE engagementHQ

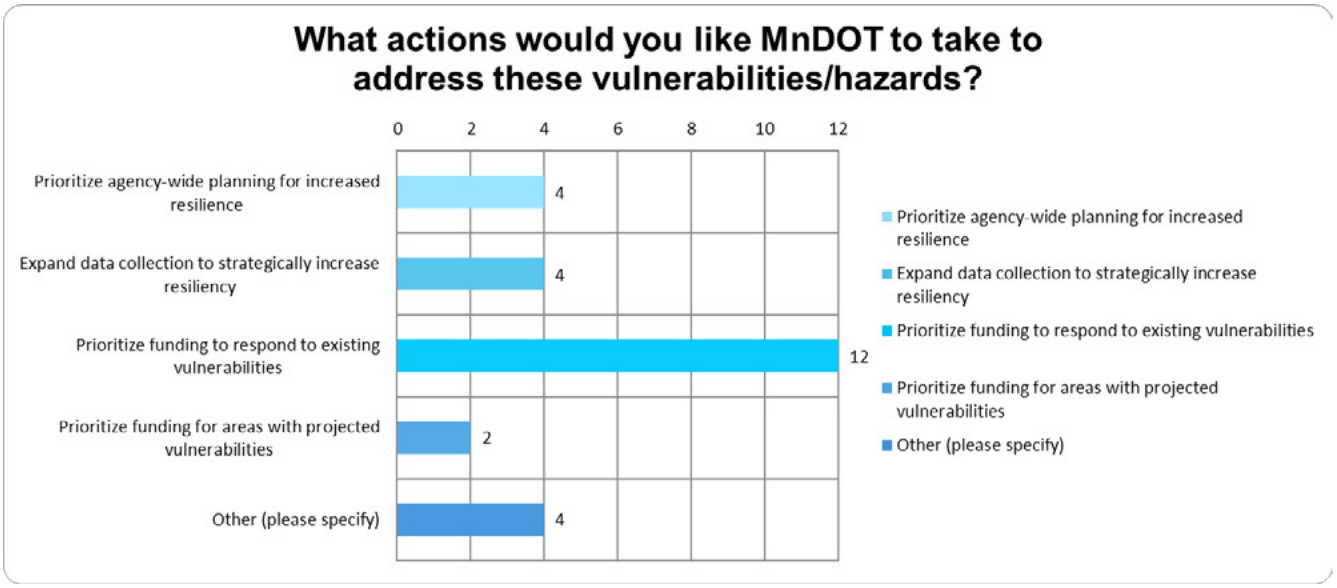
VISITORS	
50	
CONTRIBUTORS	**RESPONSES**
29	29
1 Registered	1 Registered
0 Unverified	0 Unverified
28 Anonymous	28 Anonymous




Which natural hazard-related impacts have affected your ability to get where you need to go in Minnesota?
0
5
10
15
20
25
Roadway flooding
12
Blowing and drifting snow
25
Landslides/falling rock
1
Pavement buckling
10
Other (name hazard[s])
8
Roadway flooding
Blowing and drifting snow
Landslides/falling rock
Pavement buckling
Other (name hazard[s])


How frequently do any natural hazardsaffect your ability to get where you need to go?
0
2
4
6
8
10
12
14
16
18
20
Daily
3
Once to a few times each week
2
Once to a few times each month
3
Once to a few times each year
19
Daily
Once to a few times each week
Once to a few times each month
Once to a few times each year


How have the natural hazards listed above impacted you and your travel plans?
0
5
10
15
20
25
Impacted my commute to work.
19
Impacted being able to get my children to school or my family to where they need to go.
8
Delayed the movement of goods/freight I was delivering or having delivered.
6
Impacted my safety while traveling.
23
Other (please specify)
2
Impacted my commute to work.
Impacted being able to get my children to school or my family to where they need to go.
Delayed the movement of goods/freight I was delivering or having delivered.
Impacted my safety while traveling.
Other (please specify)


What actions would you like MnDOT to take to address these vulnerabilities/hazards?
0
2
4
6
8
10
12
Prioritize agency-wide planning for increased resilience
4
Expand data collection to strategically increase resiliency
4
Prioritize funding to respond to existing vulnerabilities
12
Prioritize funding for areas with projected vulnerabilities
2
Other (please specify)
4
Prioritize agency-wide planning for increased resilience
Expand data collection to strategically increase resiliency
Prioritize funding to respond to existing vulnerabilities
Prioritize funding for areas with projected vulnerabilities
Other (please specify)

MNDOT DISTRICTS 1, 2, 3, 4, 7, 8 VIRTUAL SESSIONS

February and March 2024

Audience: District planners and local water management professionals

Topic: RIP Priorities Feedback

Takeaways: Thirty-three people from six MnDOT DISTRICTS participated in local, virtual engagement sessions to offer feedback a survey on priority areas for the RIP.

TABLE A11: RIP PRIORITIES SURVEY PARTICIPANTS BY DISTRICT

Breakdown of Votes by MnDOT District	
District 1	6
District 2	3
District 3	4
District 4	11
District 7	6
District 8	3
Total Voters	33

TABLE A12: AVERAGE LEVEL OF SUPPORT FOR PROJECT TYPES IN THE RIP – (1) STRONGLY OPPOSE; (2) OPPOSE; (3) NEUTRAL; (4) SUPPORT; AND (5) STRONGLY SUPPORT.

Strategy	Average Numeric Level of Support per Strategy
Bridge reconstruction and elevation of roads in at-risk flood zones	4.3
Culvert replacements or repair where appropriate	4.15
Drainage area enhancements	3.85
Landslide protection measures	3.33
Armoring strategies and Nature Based Design	3.67

Strategy	Average Numeric Level of Support per Strategy
Floodplain conservation/preservation	3.63
Drought-tolerant/fire-resistant landscaping and implementation of clear zones	3.39

TABLE A13: ANTICIPATED BARRIERS OF DELIVERING FLOOD PRESERVATION PROJECTS.

What barriers (if any) do you anticipate to MnDOT and partners delivering flood preservation projects?
Funds, costs, and matching
Local staff time and capacity
Local perception and support
Collaboration with partners
Agreement from the project's beginning
Understanding who is responsible for what
Focusing on immediate problems more than long term solutions
Involving landowners
Knowledge of systems/education
Interests of varied groups
Focusing on projects with the highest "rate of return"
Permitting

TABLE A14: HOW MNDOT AND PARTNERS CAN OVERCOME BARRIERS OF DELIVERING FLOOD PRESERVATION PROJECTS.

How can MnDOT and partners overcome those barriers?
Develop a communication/outreach/media campaign
Education and engagement
Early, coordinated planning with partners
Demonstrate cost-effective solutions like working with legislature for more residency funds, pooling statewide funds, and incorporating work with future MnDOT projects in local communities
Be flexible
Find key, diverse players who can represent varied groups and subjects
Simplify process

TABLE A15: ANTICIPATED BARRIERS TO MNDOT COLLABORATING WITH PARTNERS TO DO DRAINAGE AREA ENHANCEMENTS.

What barriers (if any) do you anticipate to MnDOT collaborating with partners to do drainage area enhancements?
Cost, funding, matching, and who will pay
Whose land is going to be used
Permitting
Coordination with partners
Understanding Minnesota's landscape and best plant selections on county, township, and city roads
Long range planning.
Understanding the local context
Going outside what has always been done
Complex process
Efficiency

What barriers (if any) do you anticipate to MnDOT collaborating with partners to do drainage area enhancements?
Equity

TABLE A16: HOW MNDOT AND PARTNERS CAN OVERCOME BARRIERS OF DRAINAGE AREA ENHANCEMENTS.

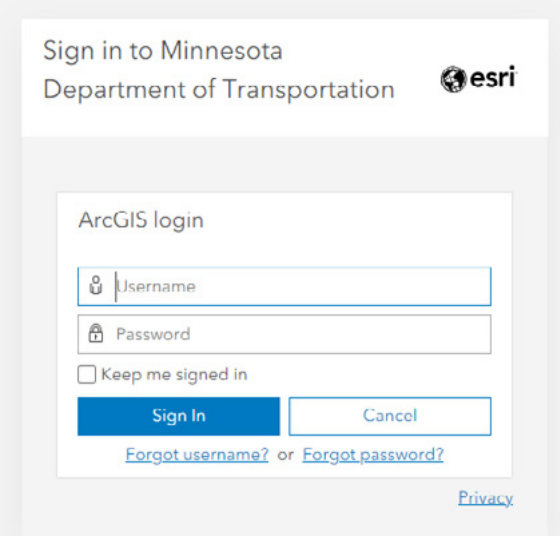
How can MnDOT and partners overcome those barriers?
Early and continuing communication with partners and individual impacted.
Coordination
Be open to adjusting projects
Changes in reduced complexity should come from leadership
Simplify the funding as much as possible

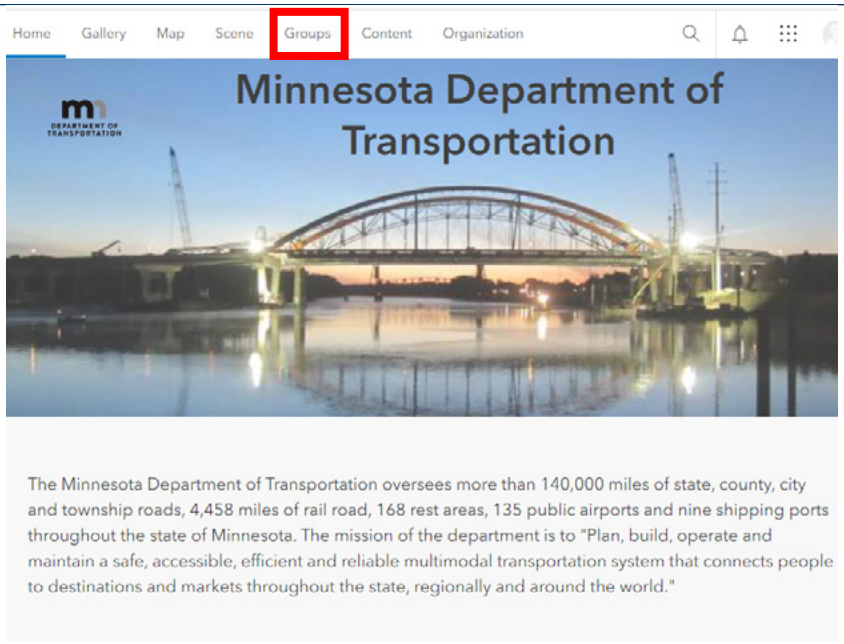
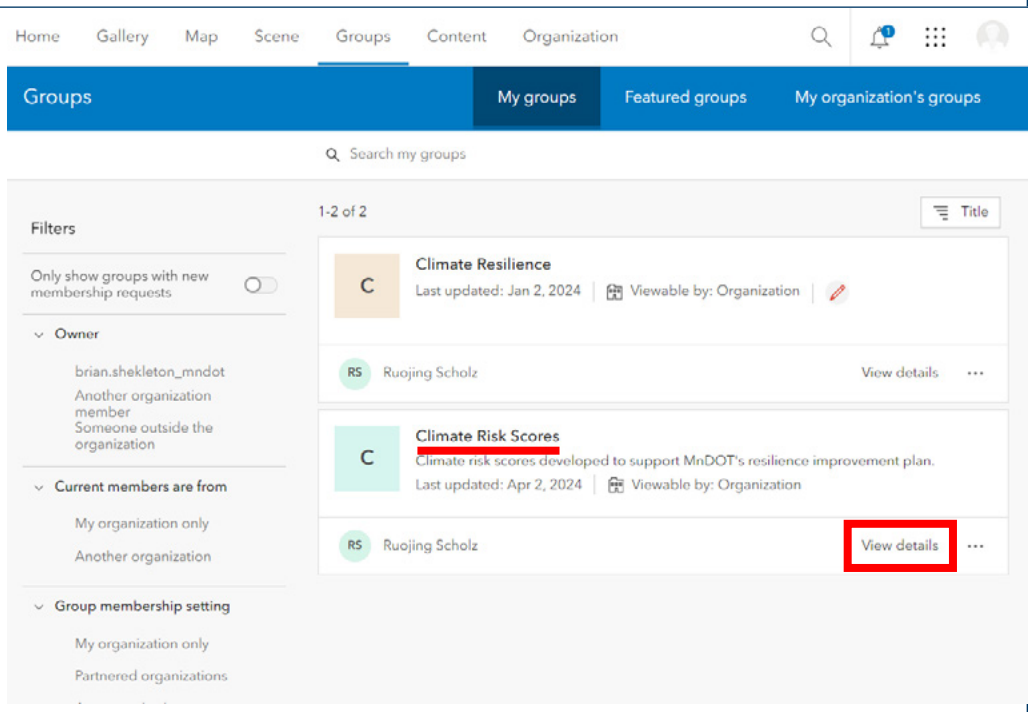
APPENDIX E

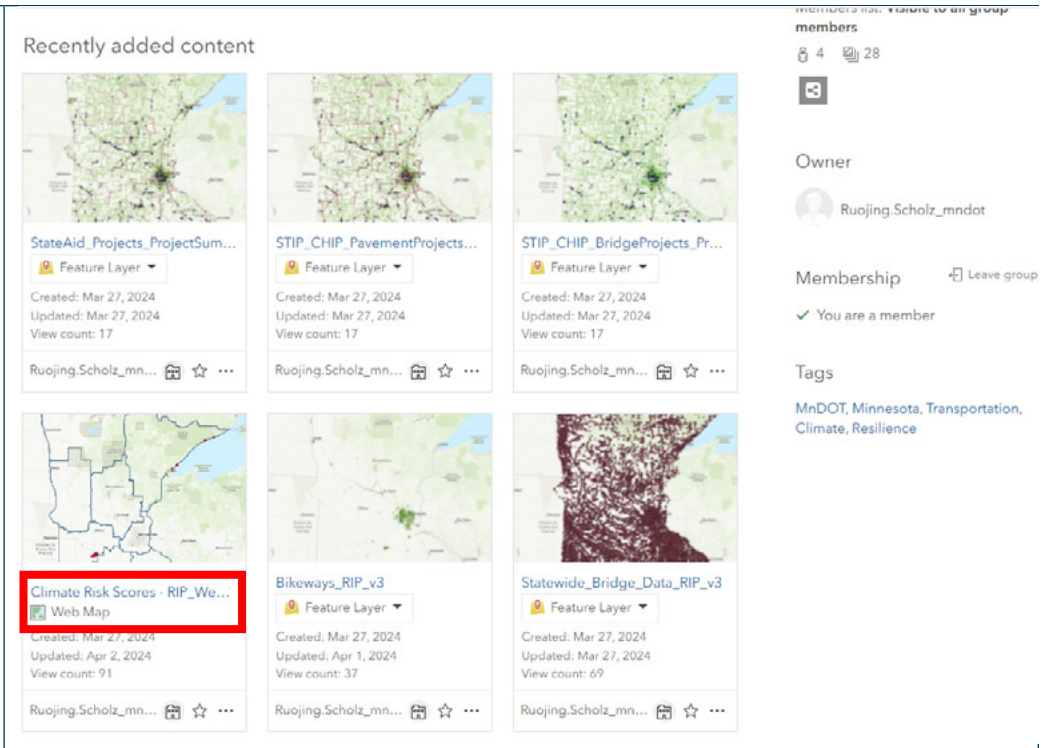
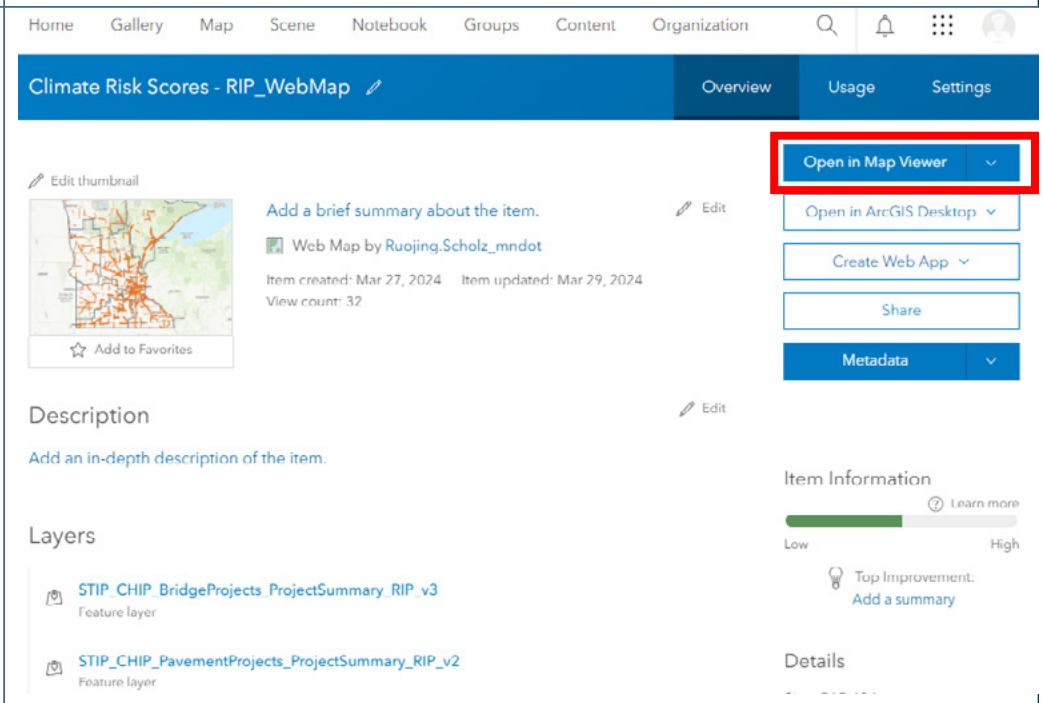
INTERACTIVE CLIMATE RISK SCORES MAP GUIDANCE

Web Map: Minnesota Transportation Climate Risk Scores

Climate data were developed to create MnDOT's Resilience Improvement Plan. Climate risk scores were calculated for each of Minnesota's PROTECT-eligible roadways to better understand how key climate hazards may affect the transportation system within low and high greenhouse gas emissions scenarios by mid-century and late century.

Sign in to ArcGIS Online using your MnDOT account credentials. Your ArcGIS Online username should be: FirstName.LastName_mndot. Your password was user generated. Note: If you forgot your password, use the Forgot password? link below the Sign In button. If you have issues signing in, you can also reach out to Ruojing Scholz or Bob Diedrich for additional assistance.	

After you have signed in, in ArcGIS Online, at the top, click Groups.	
Find the Climate Risk Scores group, click View details.	

Find the Climate Risk Scores web map. If necessary, scroll to the bottom and click View all group content. On the left in the Filter pane, under Item type section, filter the content by Maps. Click the title to open the web map. As of April, 2024 there is one web map in this group and 27 feature layers. Feature layers will be added as additional climate data is processed.	
On the web maps Item details page, click Open in Map Viewer to view the map.	

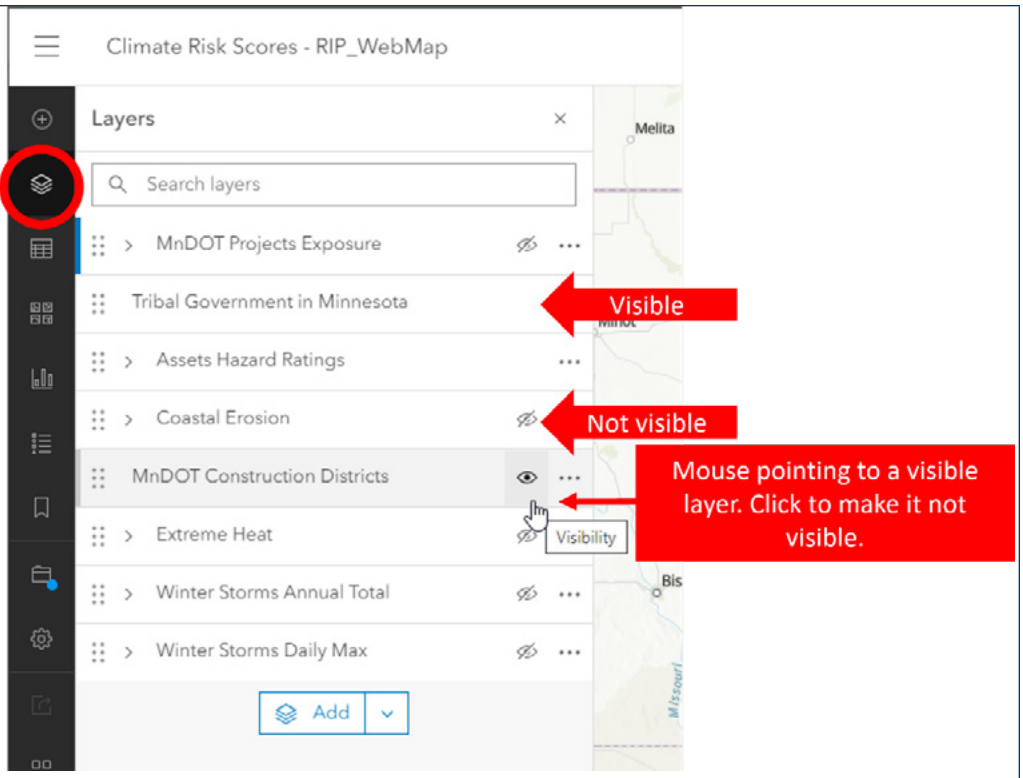
After the Climate Risk Scores web map opens, on the left, in the dark Contents toolbar. Click the layers button.

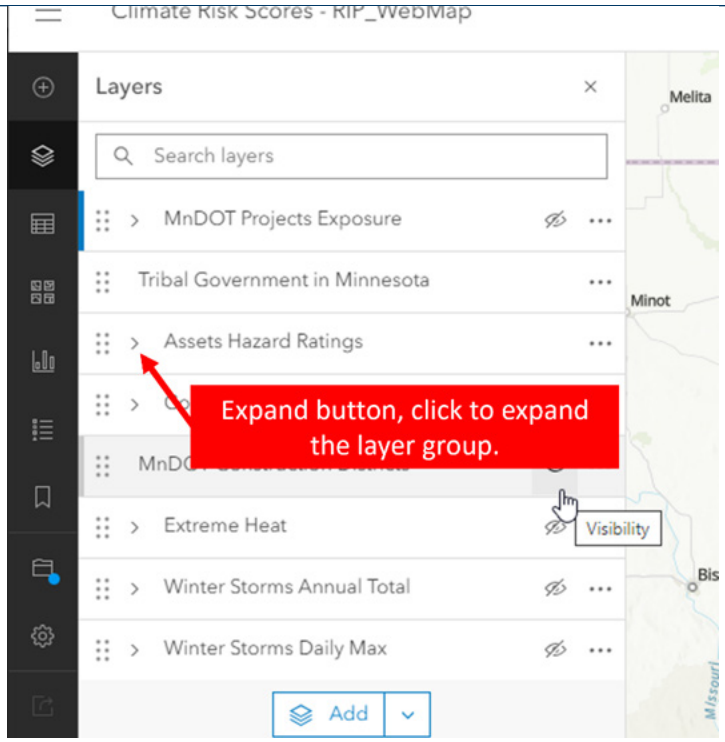
The Layers pane opens, listing the layers available in the web map.

Two layers are turned on:

- Tribal Government in MN
- MnDOT Construction Districts

Notice the layers that are not visible are denoted with the visibility button icon. When the layer is not visible the icon has a slash through the eye.



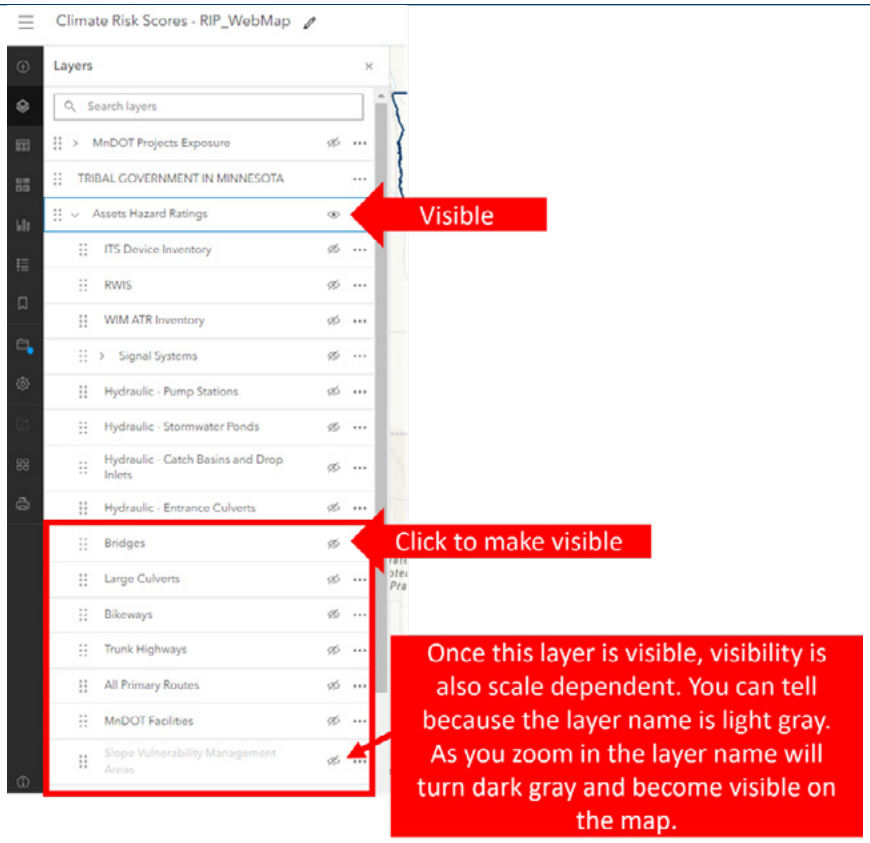
Statewide Climate Risk Scores are available by choosing a layer nested within the Assets Hazard Ratings layer group. Click the expand button to expand the Assets Hazard Ratings layer group. Warning: Other layers outside of this layer group have information, but data processing is ongoing. It is best to wait for additional guidance before using these layers in your work.	

The Asset Hazard Rating layer group is visible by default. Click the visibility button to make each of the nested layers visible in the map.

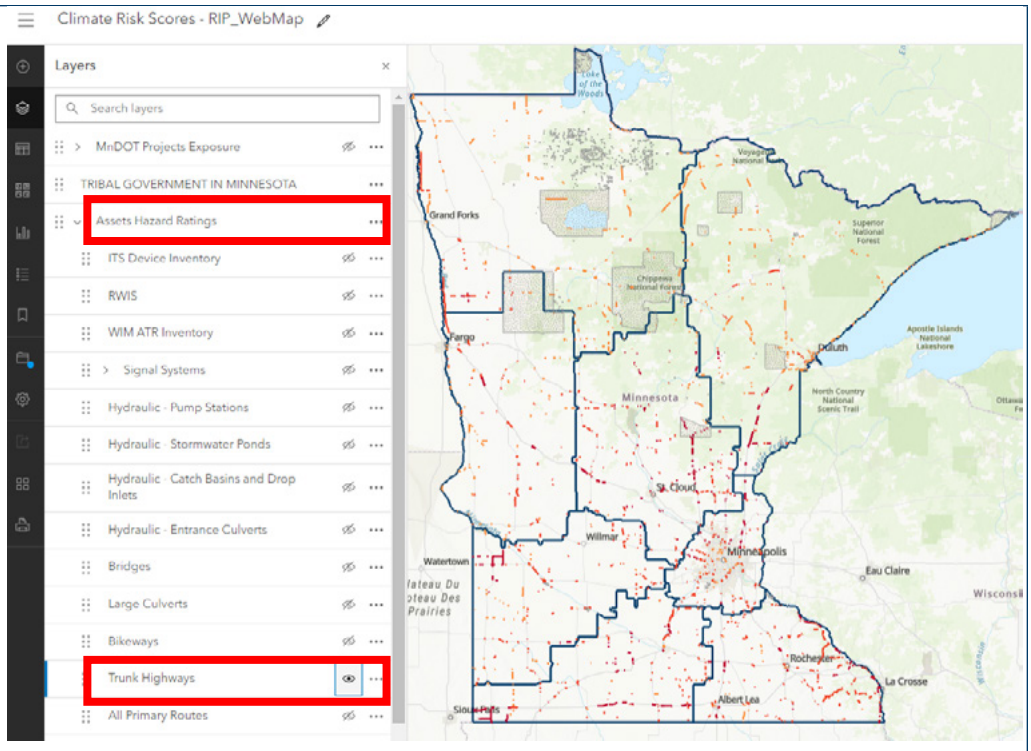
Five layers appear as maps in the Resilience Improvement Plan and the same data are ready and available to inform project programming:

- Bridges,
- Large culverts
- Bikeways,
- Trunk highways,
- All primary routes (local roads)
- Slope Vulnerability (landslide potential)

* For this GIS analysis Bridge Culverts were separated into Bridges and Large Culverts



Turning on a layer within the Asset Hazard Ratings layer group will provide insights into the climate risk score for that layer. In the image to the right, you can see the Trunk Highways layer is visible on the map in this example.



On the map, click on a Highway segment feature to select it. After a feature is selected, it will turn teal on the map, and information about the selected feature is displayed in a pop-up window.

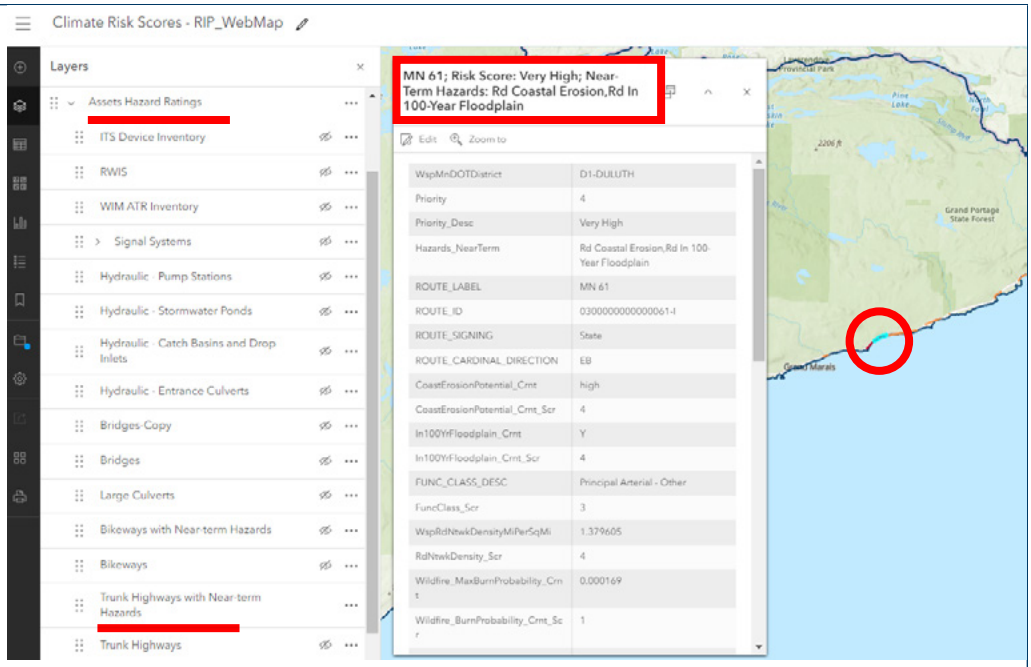
The pop-up window's format and content are still being refined.

In the pop-up window, The feature's title will highlight:

- Asset Name
- Climate Risk Score
- Near term climate hazard(s).

Near term climate hazards were calculated by identifying hazards that:

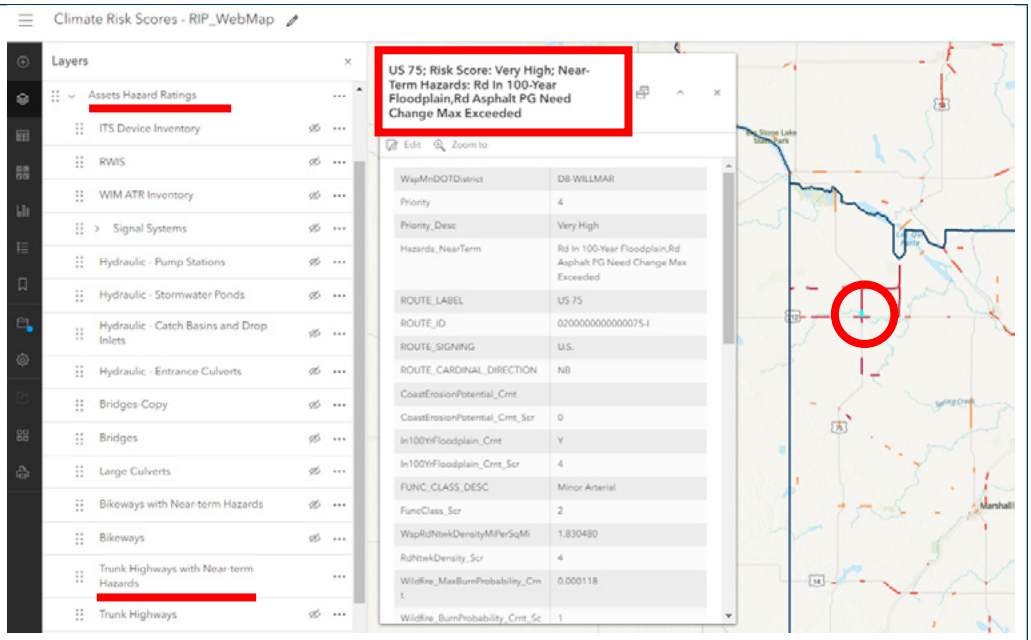
- Are currently experienced
- Are projected within a mid-century climate scenario
- Risk scores range from Very High to Very Low, from 4-0.



Near Term Hazards data can help prioritize hazard exposure. This section of US75 crosses the floodplain of the west branch of the Lac qui Parle River with a bridge over the river. The river is ditched to go under and along the US highway before crossing US212.

Today the roadway and the bridge are exposed to flood hazards. Those get worse in projections.

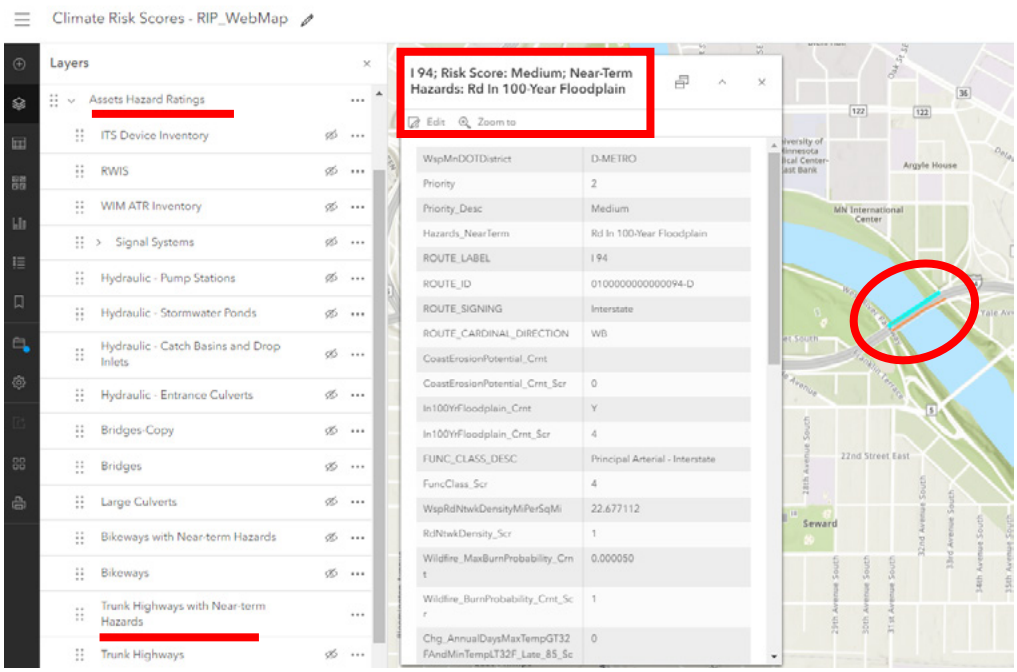
Extreme heat is projected to be an issue by the 2050s in a high-GHG emissions scenario with impacts to the maximum rating for current binder grades.



Precipitation is a climate hazard already experienced statewide. Assets within the 100-year floodplain are exposed to the potential for flooding.

Hazard scores are meant to highlight the issue, not to indicate probability of failure.

The I-94 bridge over the Mississippi River in Minneapolis will not be overtopped. The bridge abutments are in the Mississippi River and the entire structure should be designed and maintained to be resilient to the water-driven challenges that may exist within the 100-year floodplain.

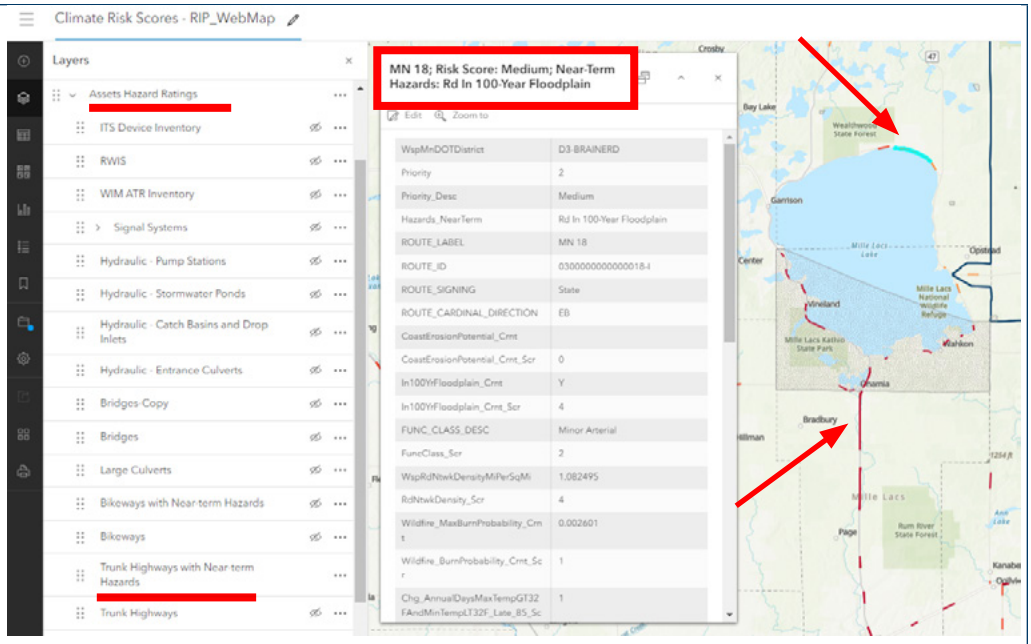


Risk scores may be different in locations with very similar climate hazards.

Potential traveler impacts, traffic volume, and projected exposure to extreme heat in a late-century, high GHG emissions scenario are the key difference between these sections of MN18, with a Medium risk score, and US169, with a Very High risk score.

Both roadways have similar exposures to: the 100 year floodplain, wildfire potential and projected increases to freeze-thaw cycles.

The section of US169 is projected to experience levels of extreme heat that would affect current binder grades.



APPENDIX F

FY25-28 PROTECT FORMULA PROGRAM PROJECTS AND PROTECT DISCRETIONARY PROGRAM APPLICATIONS

2025

DISTRICT 1

1603-55PRO; HIGHWAY MN 61

ACPROTECT**: MN 61 REPLACE BOX CULVERTS BR. 8298, 8299, 8301, 8302, AND AT OTIS CREEK NEAR HOVLAND (AC PROJECT, PAYBACK 2026)

PROTECT funds: $1,400,000

Total Costs: **$2,850,000**

3604-80M; HIGHWAY MN 11

PROTECTAC**: MN 11 RAINY RIVER SLIDE DIVERSION FROM 1.0 MI S OF INDUS TO 2.0 MI S OF INDUS (DIRECT PROTECT GRANT FUNDS) (DESIGNED BY DIST 2, FUNDED BY ATP 1 $3,200,000 UNDER SP 3604-80M) (AC PROJECT, PAYBACK IN 2036)

PROTECT funds: PROTECT Discretionary Project

Total Costs: **$2,560,000**

DISTRICT 3

222-090-003; Local Streets

PROTECT: CSAH 39, CONSTRUCT OUTLET FOR DRAINAGE POND S OF CSAH 39 IN THE CITY OF MONTICELLO

PROTECT funds: $575,000

Total Costs: **$1,800,000**

1810-120; Local Streets

PROTECTMN 371/DESIGN ROAD, FROM MN 371 TO GOLF COURSE DRIVE, STORM WATER IMPROVEMENTS

PROTECT funds: $2,400,000

Total Costs: **$3,465,861**

DISTRICT 4

014-611-055; HIGHWAY CSAH 11

ON CSAH 11, FROM CSAH 18 TO CSAH 26, CONCRETE REHABILITATION

PROTECT funds: $539,498

Total Costs: $930,020

DISTRICT 6

8501-74; HIGHWAY US 14

ACPROTECT** US 14 AT STOCKTON HILL DRAINAGE IMPROVEMENTS (AC PAYBACK IN 2026)

PROTECT funds: $2,799,400

Total Costs: $7,000,000

5508-130; HIGHWAY US 52, US 63

DISCRETIONARY RESILIENCE IMPROVEMENT GRANT APPLICATION: GRADE RAISE AND SNOW FENCING, US 52 FROM PINE ISLAND TO ROCHESTER AND US 63 SOUTH OF ROCHESTER FROM CR 16 SOUTHEAST TO I-90

PROTECT funds: PROTECT Discretionary Project

Total Costs: $7,000,000

DISTRICT 7

007-640-009; HIGHWAY CSAH 40

PROTECTCSAH 40, 2.25 MILES SOUTH OF TH 30, STABILIZE RIVERBANK AND SLOPE

PROTECT funds: $320,000

Total Costs: $400,000

008-610-034; HIGHWAY CSAH 10

PROTECTCSAH 10, 2.5 MILES WEST OF TH 4, STABILIZE STREAMBANK

PROTECT funds: $320,000

Total Costs: $400,000

017-070-014PRO; HIGHWAY CSAH 15, CSAH 17

PROTECTCSAH 15, FROM CSAH 5 TO CSAH 13 AND ON CSAH 17, FROM CSAH 26 TO CSAH 2, LINE CULVERTS (ASSOC. 017-070-014)

PROTECT funds: $60,000

Total Costs: $75,000

4012-44PRO; HIGHWAY CSAH 21, MN 22

ELLEFLEX24**PROTECT** MN22, FROM APPROXIMATELY 1600' SOUTH OF CSAH 57 TO MN RIVER BRIDGE IN ST PETER, INSTALL SNOWFENCE, EROSION CONTROL AND TURF ESTABLISHMENT (ASSOC. 040-070-007, 0714-35, 4012-44CRP, & 4012-44) (AC PROJECT, PAYBACK IN 2026 AND 2027)

PROTECT funds: $1,152,000

Total Costs: $1,440,000

8827-423; HIGHWAY I 90

DISCRETIONARY RESILIENCE IMPROVEMENT GRANT APPLICATION: DRIFTING AND BLOWING SNOW CONTROL, I-90 IN NOBLES COUNTY

PROTECT funds: PROTECT Discretionary Project

Total Costs: $12,300,000

DISTRICT 8

037-631-013; HIGHWAY CSAH 31

PROTECT CSAH 31, 0.9MILES S. OF CSAH 20 TO 1.0 MILES S. OF CSAH 20 & 13 MILES E. OF MADISON, RIVER BANK STABILIZATION

PROTECT funds: $544,000

Total Costs: $680,000

064-620-011; HIGHWAY CSAH 20

PROTECT CSAH 20, WALNUT GROVE TO TRACY, REPLACE CULVERTS

PROTECT funds: $456,000

Total Costs: $580,000

8828-139; HIGHWAYS

PROTECTAC**: DISTRICTWIDE CULVERT REPAIRS (AC PROJECT, PAYBACK IN FY 2026)

PROTECT funds: $700,000

Total Costs: $1,625,000

METRO DISTRICT

010-596-016; HIGHWAY MN 5

ACPROTECT**PRS**: MN5 (ARBORETUM BLVD) FROM 0.3 MI E MINNEWASHTA PKWY TO 0.25 MI W OF MN41 IN CHANHASSEN - TWO TO FOUR LANE CONVERSION, MEDIAN, BR # (ASSOCIATE TO 010-596-014, 010-596-019, 241-090-001, 1002-124) (AC PROJECT, PAYBACK IN FY26)

PROTECT funds: $6,278,400

Total Costs: $16,144,000

6221-107PRO; HIGHWAY US 61

PROTECT: US 61 (ARCADE ST) FROM E 7TH ST TO 0.2 MI S ROSELAWN AVE IN MAPLEWOOD AND ON MN 5 FROM E END BRIDGE 62703 TO MINNEHAHA AVE IN ST PAUL - IMPROVE PAVEMENT CONDITIONS, STORMWATER DRAINAGE, CORRIDOR SAFETY, WALKABILITY, TRAFFIC SIGNALS, LANDSCAPING, TRAILS, BUS STOPS, LIGHTING, AND SIDEWALK CURB RAMPS (ASSOCIATE TO 6221-107, 6221-107CRP AND 6221-107P)

PROTECT funds: $11,740,800

Total Costs: $14,676,000

8825-1260; HIGHWAY 999

PROTECT: DISTRICTWIDE - POND PRESERVATION AT VARIOUS LOCATIONS

PROTECT funds: $1,200,000

Total Costs: $1,500,000

8825-1260; HIGHWAY 999

PROTECT: DISTRICTWIDE - POND PRESERVATION AT VARIOUS LOCATIONS

PROTECT funds: $800,000

Total Costs: $1,000,000

6220-96; HIGHWAY US 61

DISCRETIONARY RESILIENCE IMPROVEMENT GRANT APPLICATION: SLOPE STABILITY IMPROVEMENTS, US 61 IN SAINT PAUL FROM I-94 TO LOWER AFTON ROAD

PROTECT funds: PROTECT Discretionary Project

Total Costs: $30,000,000

1902-103; HIGHWAY MN 13

DISCRETIONARY PLANNING GRANT APPLICATION: SLOPE FAILURE STUDY, MN 13 IN MENDOTA HEIGHTS FROM LEXINGTON AVENUE TO ANNAPOLIS STREET

PROTECT funds: PROTECT Discretionary Project

Total Costs: $2,000,000

MNDOT BRIDGE OFFICE

PLANNING ACTIVITY

FLOOD MONITORING SOFTWARE APPLICATION

PROTECT funds: $150,000

Total Costs: $300,000

NORMAN COUNTY

HIGHWAY CSAH 2

DISCRETIONARY PLANNING GRANT APPLICATION: PLANNING AND DESIGN TO ADDRESS BRIDGE AND EMBANKMENT FAILURE, CSAH 2 AT WILD RICE RIVER

PROTECT funds: PROTECT Discretionary Project

Total Costs: $300,000

OTTER TAIL COUNTY

HIGHWAY CSAH 6

DISCRETIONARY RESILIENCE IMPROVEMENT GRANT APPLICATION: GRADE RAISE, EMBANKMENT ARMORING AND DRAINAGE IMPROVEMENTS AT NELSON LAKE, CSAH 6 FROM 0.8 MILES EAST OF CSAH 65 TO 2.2 MILES WEST OF TH 29

PROTECT funds: PROTECT Discretionary Project

Total Costs: $7,849,000

RENVILLE COUNTY

LOCAL STREETS

DISCRETIONARY PLANNING GRANT APPLICATION: CITY OF MORTON RESILIENCY IMPROVEMENT PLAN

PROTECT funds: PROTECT Discretionary Project

Total Costs: $549,700

SCOTT COUNTY

HIGHWAY US 169, MN 25, MN 41, CSAH 9, CSAH 101

DISCRETIONARY PLANNING GRANT APPLICATION: MINNESOTA RIVER CROSSING AND FLOOD RESILIENCY STUDY

PROTECT funds: PROTECT Discretionary Project

Total Costs: $1,575,000

2026

DISTRICT 2

170-109-012; LOCAL STREETS

PROTECT: IN THIEF RIVER FALLS ON 6TH ST, STORM SEWER IMPROVEMENT

PROTECT funds: $400,000

Total Costs: $575,000

DISTRICT 3

7314-41PRO; HIGHWAY MN 55

PROTECTMN 55, BR 5545 OVER N FORK CROW RIVER WEST OF PAYNESVILLE, REPLACE

PROTECT funds: $250,000

Total Costs: $307,050

DISTRICT 4

8480-40; HIGHWAY I 94

PROTECT: ON I94, NEAR ROTHSAY, INSTALLATION OF SNOWFENCE

PROTECT funds: $1,200,000

Total Costs: $1,500,000

METRO DISTRICT

082-596-010PRO; HIGHWAY CSAH 19

ACPROTECT**: CR19A (KEATS AVE) FROM 1.2 MI E OF JAMAICA AVE TO US61 IN COTTAGE GROVE - RECONSTRUCTION, BRIDGE #82538 OVER RR, MULTI-USE TRAIL (ASSOCIATE TO 082-596-010) (AC PROJECT, PAYBACK IN FY27)

PROTECT funds: $987,200

Total Costs: $5,648,500

2027

DISTRICT 4

8824-261; HIGHWAY I 94

WEST CENTRAL MINNESOTA, I-94, FROM MOORHEAD TO ALEXANDRIA, BLOWING AND DRIFTING SNOW CONTROL PROJECT

PROTECT funds: PROTECT Discretionary Project

Total Costs: $13,736,000

2028

METRO DISTRICT

880M-PRO-28C; LOCAL STREETS 999

PROTECT: CHISAGO COUNTY ATP: SETASIDE FOR PROMOTING RESILIENT OPERATIONS FOR TRANSFORMATIVE, EFFICIENT, AND COST-SAVING TRANSPORTATION PROGRAM FY2028 PROJECTS

PROTECT funds: $122,720

Total Costs: $153,400