MnDOT Resilience Investment Decisions

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DEPARTMENT OF TRANSPORTATION

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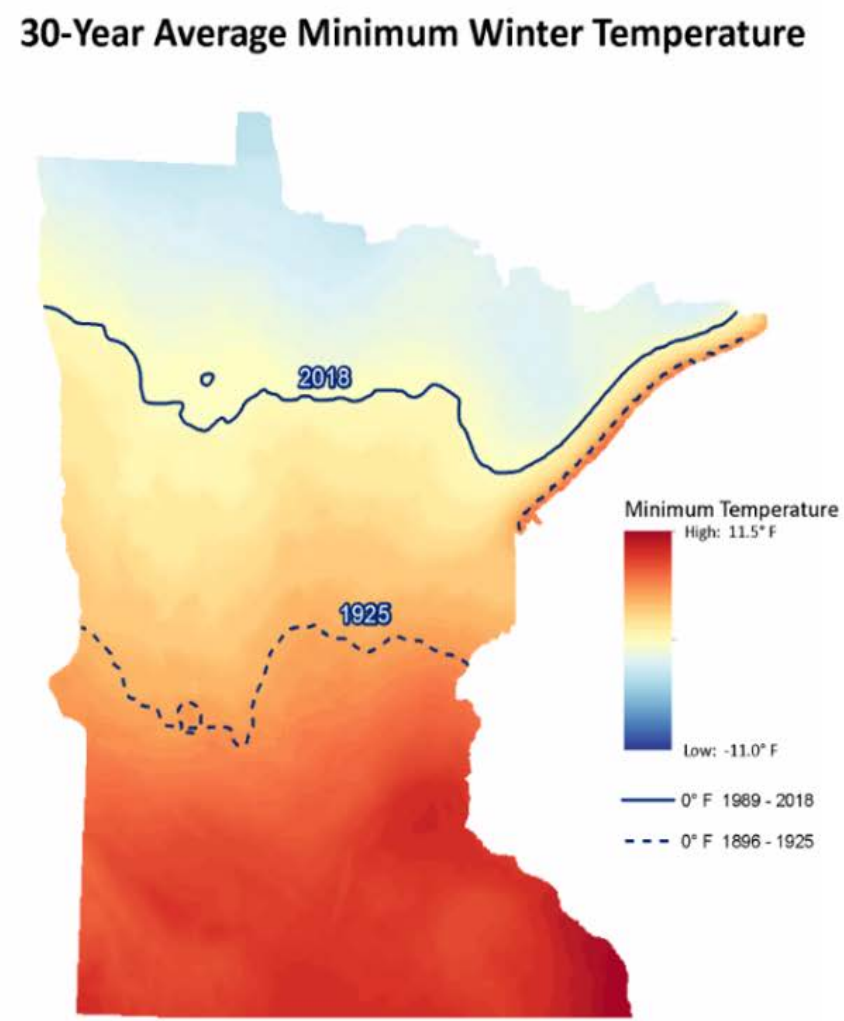
Key takeaways

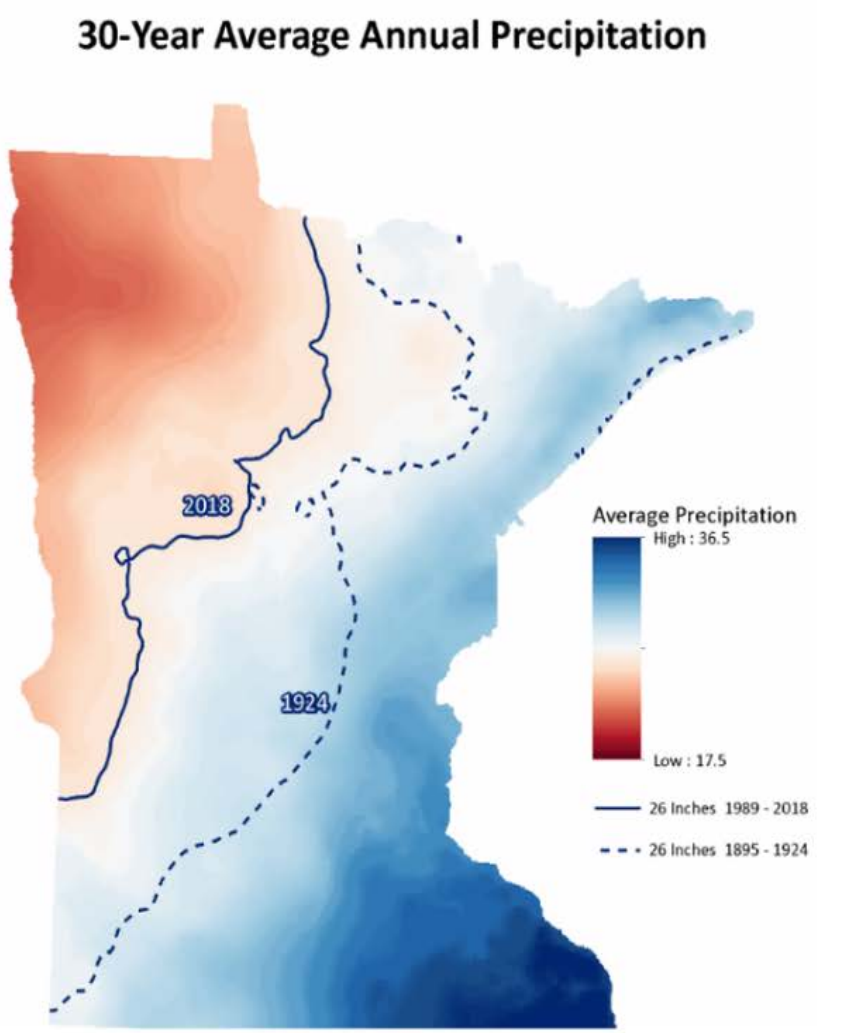
- Shifting from reactive to proactive
- Assess vulnerability of assets
  - Data needs, what is needed to assess risk and vulnerability
- Develop performance measures/metrics
  - Bigger picture of resilience
- Resource it: need both the big picture and technical resource role(s)
- Work in progress – still in early stages in MN

Biggest resilience concerns in Minnesota?

Climate Events	Likelihood of Additional Change	Potential Negative Impacts for the Transportation System
Heavy Precipitation / Flooding	**Very High**	• Damage to infrastructure (highways, rail, airport runways, etc.) • Increase in detours and slowed operations / performance from flooded roads • Slope failures and erosion • More mudslides, sink holes, roadbed failure • Increased large-scale river flooding (bridge scour, roadway erosion, inundation) • More localized flooding due to poor drainage or higher groundwater table • More frequent and extensive inundation of low-lying areas (both temporary and permanent) • Disruption of construction projects, both delays and damage/deterioration to sites
Warmer Winters	**Very High**	• Increase in overnight icing • Likely increase in freeze/thaw cycles (and potentially increased salt use) • Reduced pavement conditions and life cycles • Change in storm track with some extreme storms with higher-than-normal snow accumulation • Increase in average winter precipitation and more extreme precipitation • Change in timing of precipitation (more rain, less snow) • Increase in damage from ice storms and downed powerlines (less certainty)
New Species Ranges *(Mainly due to warmer winters)*	**High**	• Changes in roadside vegetation mixes • Soil erosion from vegetation loss • Increase in invasive species populations • Increased exposure of construction and maintenance crews to vector-borne diseases • Wetland site failure
Drought	**Medium**	• Reduced river navigability for barges • Roadside vegetation stress, reduces rainwater storage and increases soil erosion • Low stream and groundwater flow
High Heat	**Medium-low**	• Pavement and rail buckling • Vehicles overheating • Electrical system malfunctions • Limitations on construction hours • Increase in extreme heat events (heat waves)
Wildfires	**Low**	• Road closures • Immediate and significant threat to human safety • Damage to roadside infrastructure • Increased risk of future flooding and slope failure
Severe Wind	**Low**	• Severe wind-related road closures • Blown-down trees, signs

Biggest resilience concerns in Minnesota?





Resilience Advisory Team

Provides input and guidance on internal resilience efforts

To guide the agency resilience efforts, MnDOT created the internal resilience advisory team in 2019. The multidisciplinary team is comprised of MnDOT staff from several offices throughout the agency, charged with the following tasks:

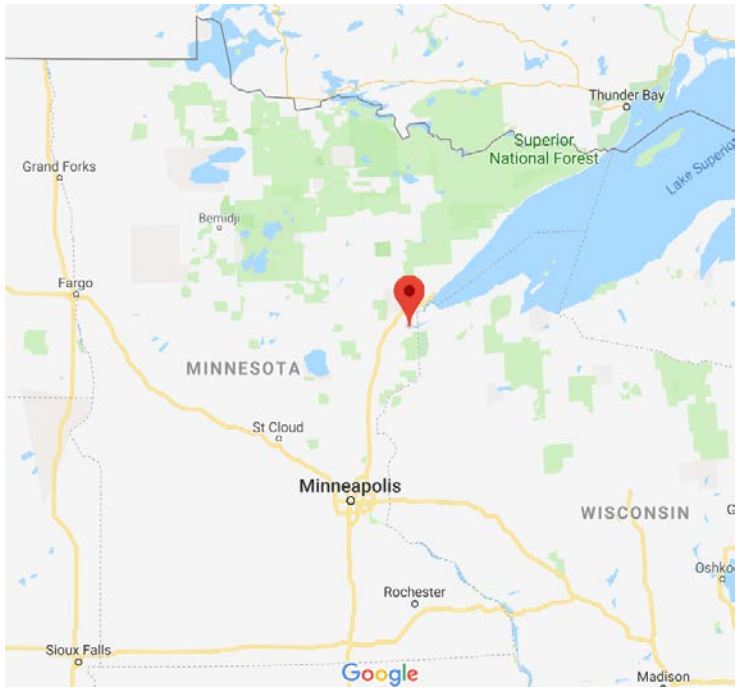
- Identify and recommend resilience priorities for the agency
- Discuss and vet potential barriers and areas of concern
- Refine and expand on how the agency assesses and measures climate resilience

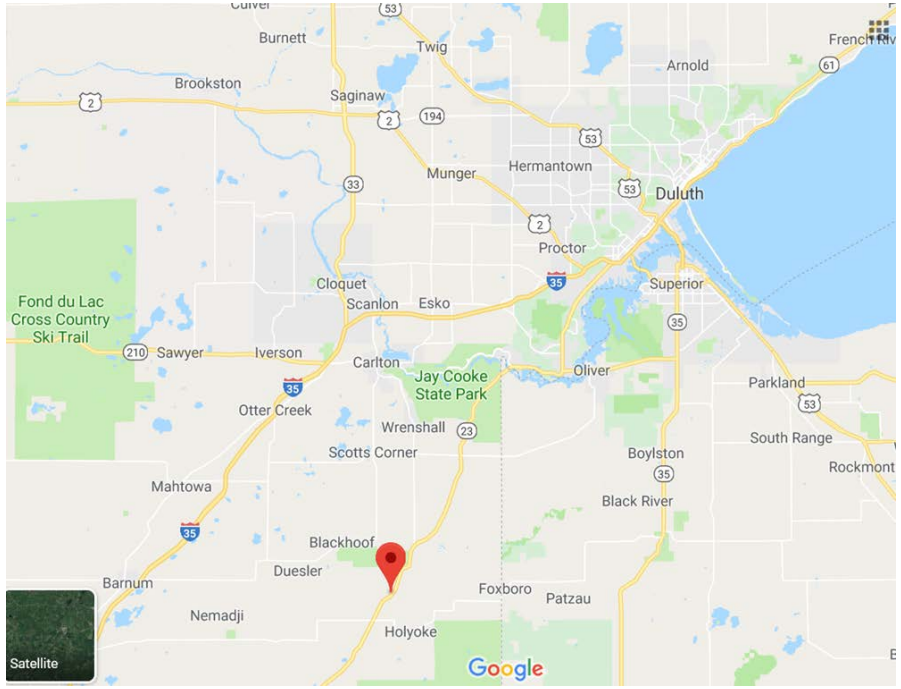
Resilience Advisory Team

- Bridge/Hydraulics
  - 3 staff members
- Environmental Stewardship
  - 3 staff members
- Emergency Management
  - 2 staff members
- Planning
  - 3 staff members
- Sustainability & Public Health
  - 2 staff members
- Office of Chief Council
  - 1 staff member
- Asset Management
  - 2 staff members
- Operations & Maintenance
  - 2 District representatives
  - 1 Central office representative

Shifting from Reactive to Proactive

- Future: want to include vulnerability assessment in project selection
- Early stages of implementation
  - Use of a Vulnerability Assessment to Justify a Betterment for a Flood Damaged Asset

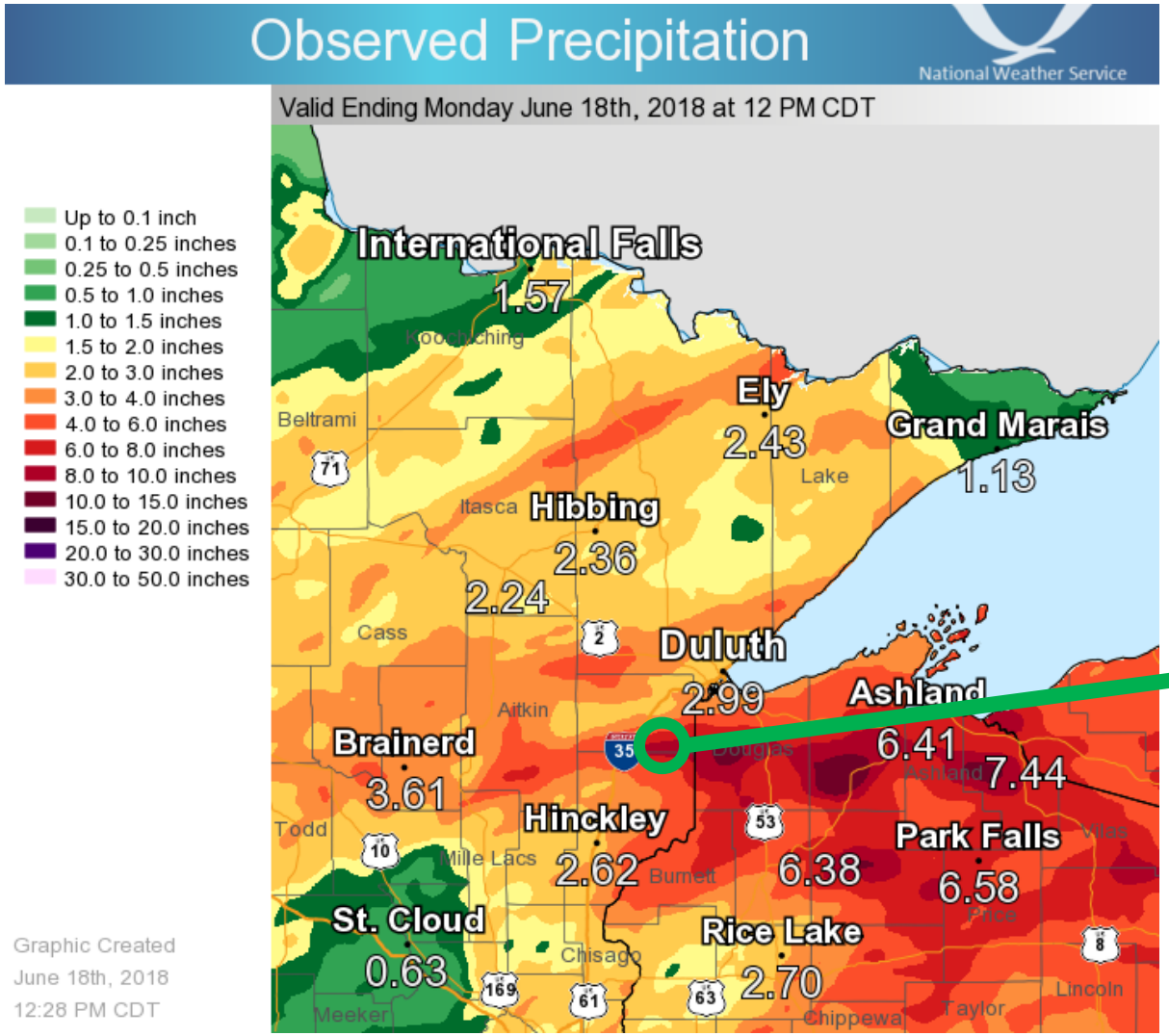




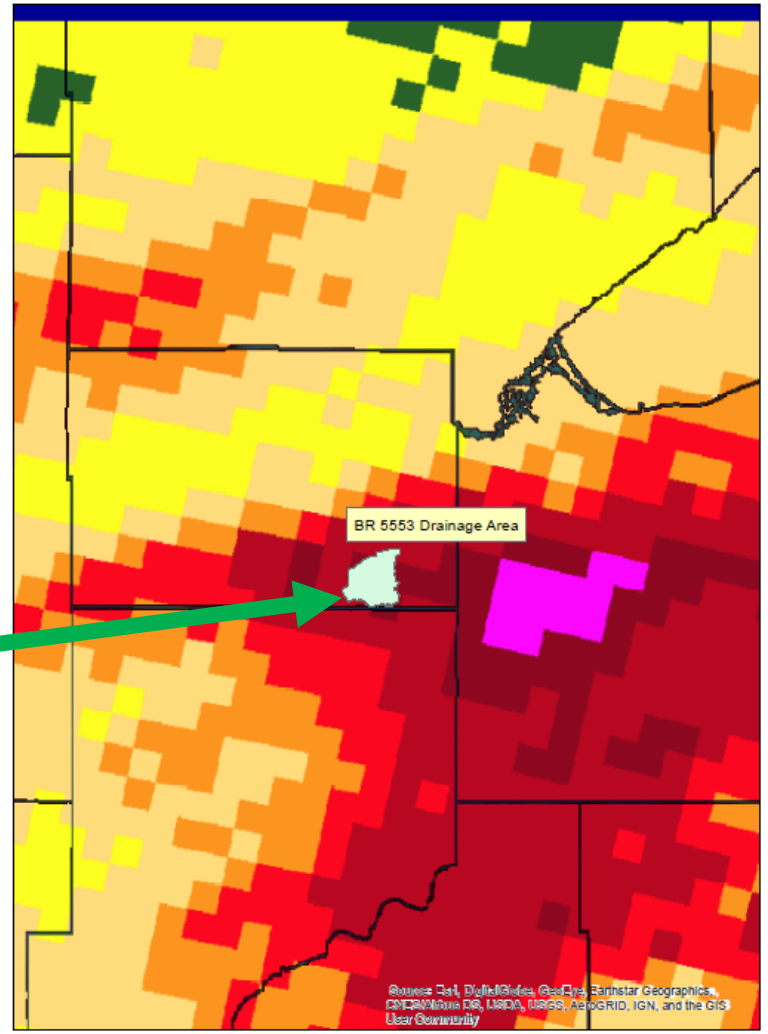
Project Location

Northeastern Minnesota
BR 5553, TH 23 over South Fork Nemadji River

Flooding event - Rainfall



NexRAD Rainfall Data_7Day_18June2018



Flood Damage

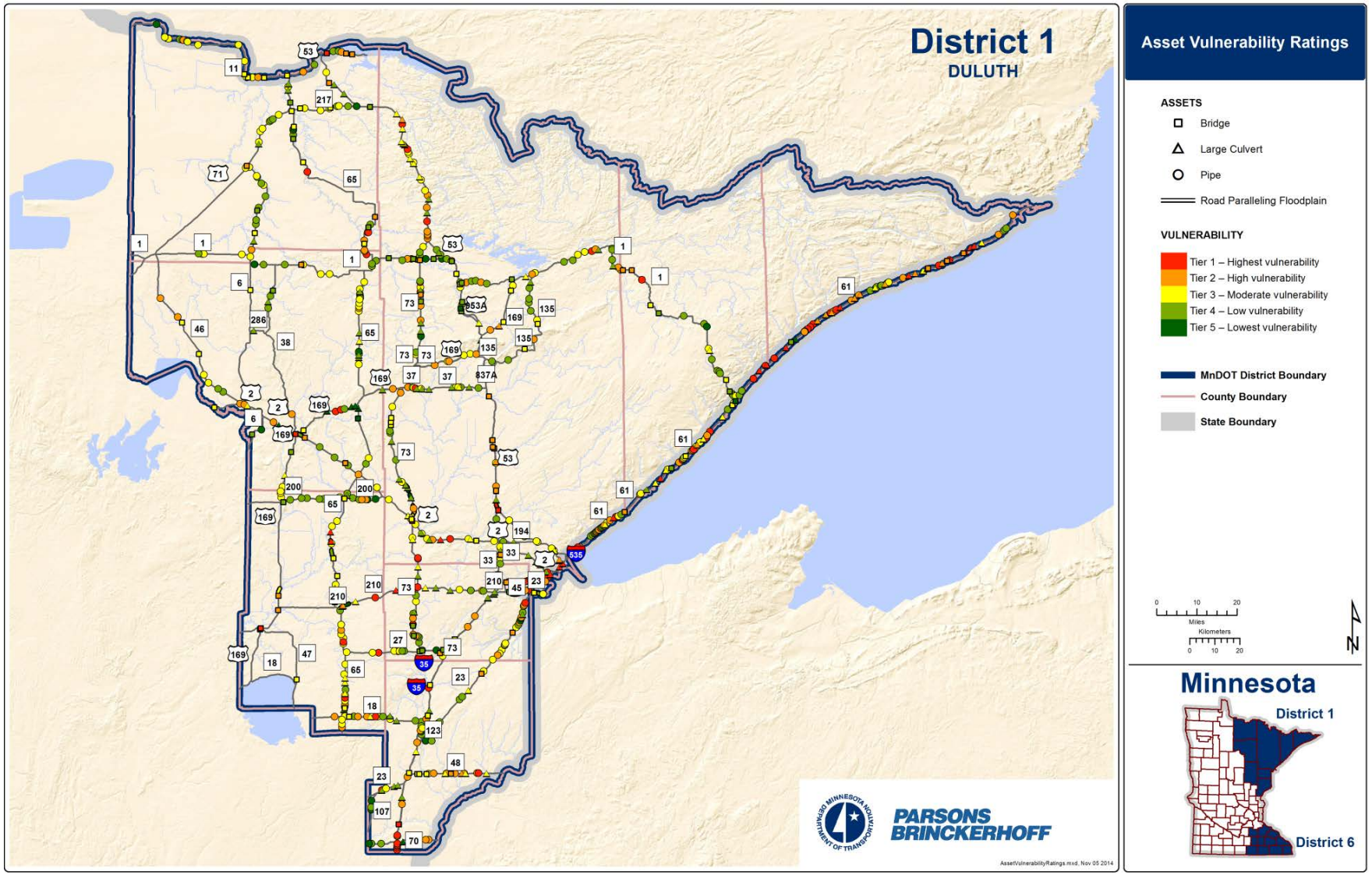
Drone footage of damage from WCCO-TV, CBS Minnesota
https://www.facebook.com/CBSMinnesota/videos/10156719458473825/

Flood damage - photos

Project Recommendation

- Hydraulic analysis:
  - Overtopping between 25-50 yr event
  - Debris significant factor (multiple box culvert)
  - Did not include “climate projected” hydrology estimate
- Recommended replacing the multiple box culverts with a bridge structure – a “betterment scenario”
- Utilized the vulnerability score and rank to justify a betterment scenario
  - Vulnerability Score = 47.96
  - Ranking = 15 in large box culvert section, out of 212
  - Tier 2 – High vulnerability

Asset Vulnerability – Pilot project



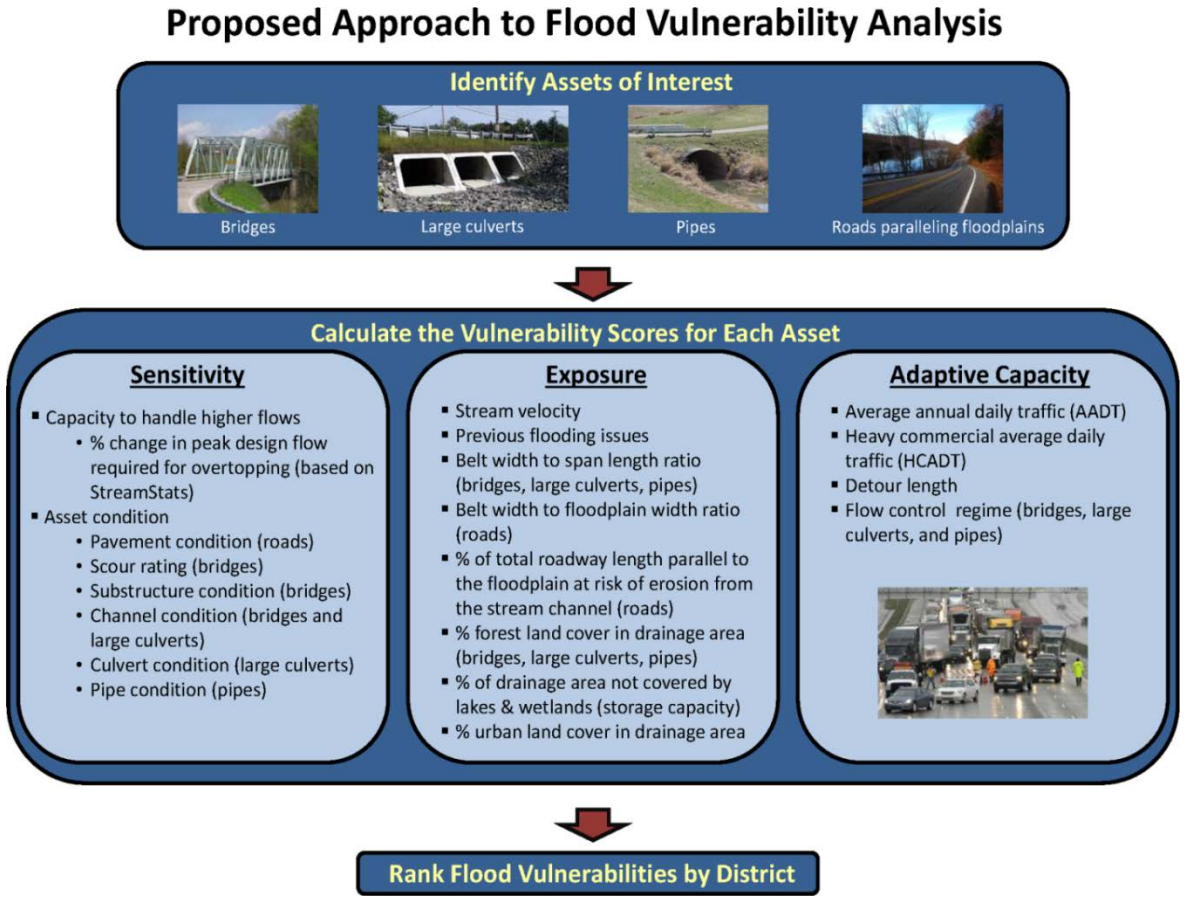
Asset Vulnerability

Data Needs

- Quantitative
- Qualitative

Future

- Corridor planning
  - Vulnerability score along corridors



Impact on project designs

- Project level: challenges around current design vs. future design standards
  - Risk analysis to include potential climate change / vulnerability
    - Extreme flood
    - Slope stability
  - Need updated design guidance
  - A lot of uncertainty

Approach	Adaptation Option	Types of Practices
Protect (Defend)	Provide major structural protection	Plan for overtopping
	Provide protection at existing elevation/locations	Slope armoring; Install bioswales; Install Tree Trenches
Accommodate	Elevate the infrastructure above the impact zone	Raise roadway
	Enhance drainage to minimize closure time and/or deterioration levels	Design for AOP, Use geomorphic design for floodplain culverts, Water storage
Retreat	Abandon infrastructure	Make detour permanent
	Relocate infrastructure (horizontally)	Reroute road further from riverbank
	Temporarily restrict use of infrastructure	Install traffic gates
Changes in policy or practices	Increase the infrastructure's maintenance and inspection interval and continue to monitor/evaluate	Increase debris removal; Guidance on designed submergence (planned temporary closures); ER betterment guidance
	Modify land use and development policies to account for future impacts	Adopt green infrastructure policy
	Increase organizational capacity	Develop training for new guidance

Types of projects

1. Example of a Culvert before and after Aquatic Organism Passage Upgrades

2. Example of Reinforced Slope Armoring

3. Example of elevated roadway (bridge over flooding)

4. Example of Rebuild Slope Regraded (before plants regrew)

Investment planning changes

- Difficult to quantify without performance measures
- Difficult to develop performance measures without data
- Where to start?

Measure of Resilience or Proxy	Tracking Status*
Significant weather-related damage to infrastructure	Currently Tracking
Use of emergency relief funds for repair/rebuild	Currently Tracking
Bridge condition rating	Currently Tracking
Culvert condition rating	Currently Tracking
Bridges with scour plan of action	Currently Tracking
Pavement condition rating	Existing, not tracked with resilience yet
Pavement performance during extreme heat	Not currently tracked
Bridge overtopping location and frequency	Partially existing, not tracked with resilience yet
Wildlife upgraded culverts (aquatic organism passage)	Not currently tracked
Slope failure location and frequency	Not currently tracked
Slope vulnerability rating	Existing, not tracked with resilience yet
Minor flood damage (under $5k) location and frequency	Not currently tracked
Frequency and cost of mobilization and debris removal	Not currently tracked
Weather related construction delays and damages	Not currently tracked
Resilience upgrades (slope armoring, raising of roadway, etc.)	Not currently tracked
Road closure location and frequency (when weather related)	Not currently tracked
Installation of green infrastructure (acres, total $, or projects)	Not currently tracked
Conveyance failures	Not currently tracked
Storm water facility failures	Not currently tracked
Asset vulnerability to projected precipitation events (under development)	Not currently tracked

Climate Resiliency Performance Measures

- 9 draft proposed climate resilience performance measures
  - 1 planned future performance measure: Asset Vulnerability Score
- 3 “Buckets”
  - Adaptation/Natural Environment
  - Asset Condition & Vulnerability Assessment
  - Climate/Extreme Weather impacts

Draft Climate Resiliency Performance Measures

- Stormwater Treatment
- Trees & Shrubs
- Native vegetation – Seeding
- Native vegetation - Planting

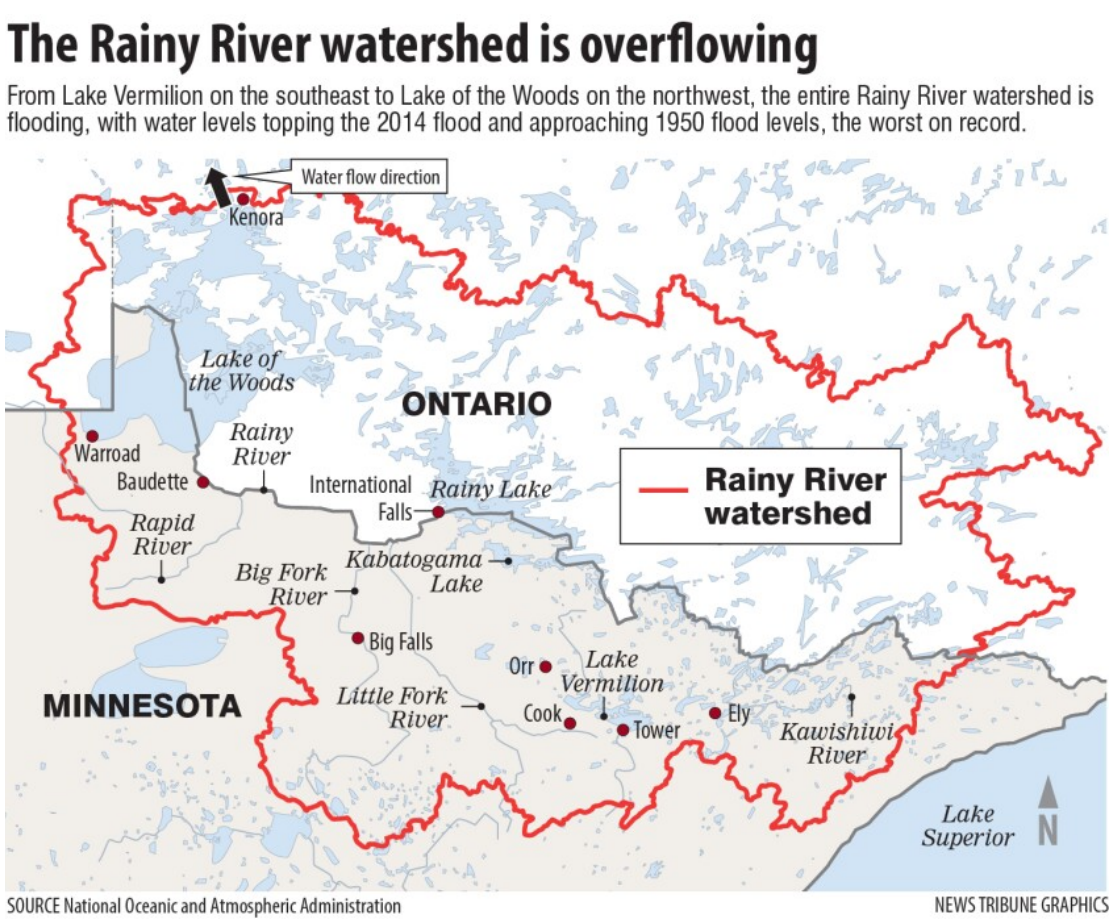
- Highway culvert condition
- Bridge culvert condition
- Scour critical bridges

- $ spent on flooding/washouts
- $ spent on pavement blow-ups

Future Measure:

Asset Vulnerability Score

Recognition that resilience is important



Lessons learned

- Form a multidisciplinary team
- Explain the workplan and needs in plain language
- Assess vulnerability of assets
  - Data needs, what is needed to assess risk and vulnerability
- Develop performance measures/metrics
  - Bigger picture of resilience
- Resource it: need both the big picture and technical resource role(s)

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Thank You!

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