Resilience Improvement Plan

Resilience Improvement Plan: Overview


IOWADOT

RESILIENCE IMPROVEMENT PLAN

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Resilience Improvement Plan: Overview

Resilience Improvement Plan: Overview

38 74 94 100 124

These aren't lottery numbers - these are the total number of days that various highway segments were closed to traffic during 2019 due to widespread flooding that also devastated many homes and businesses and disrupted lives throughout western Iowa.

In March 2019, rapid snowmelt and heavy rain caused widespread flooding and flash flooding events in the Missouri River basin in western Iowa. This event caused parts of Interstate 680, Interstate 29, U.S. Highway 34, Iowa Highway 2, and many local roads to go out of service for weeks or months. Some routes experienced multiple closures for flooding throughout the year as Iowa's transportation system was inundated and heavily damaged in many places along the Missouri River.


March

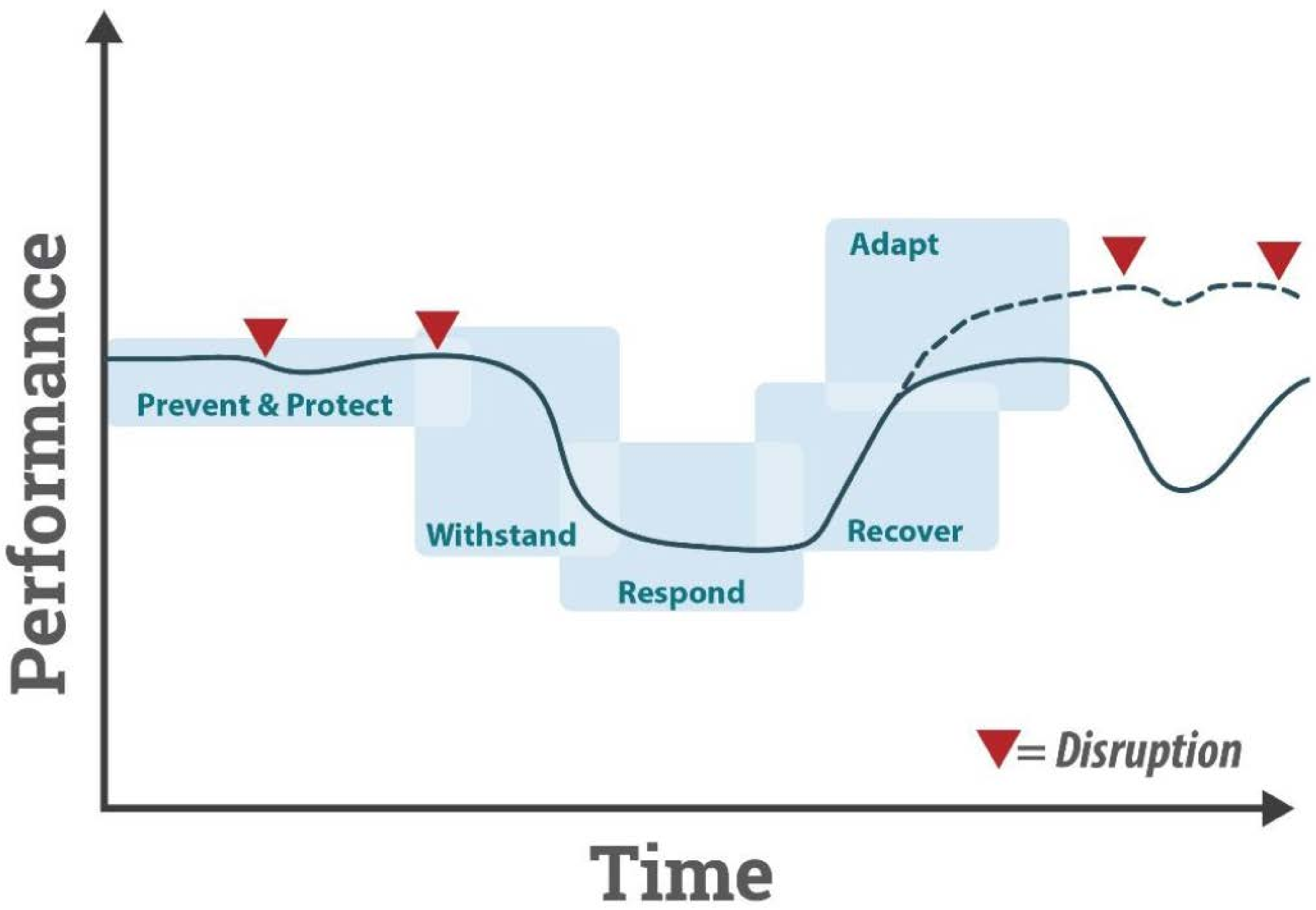

April


June


October

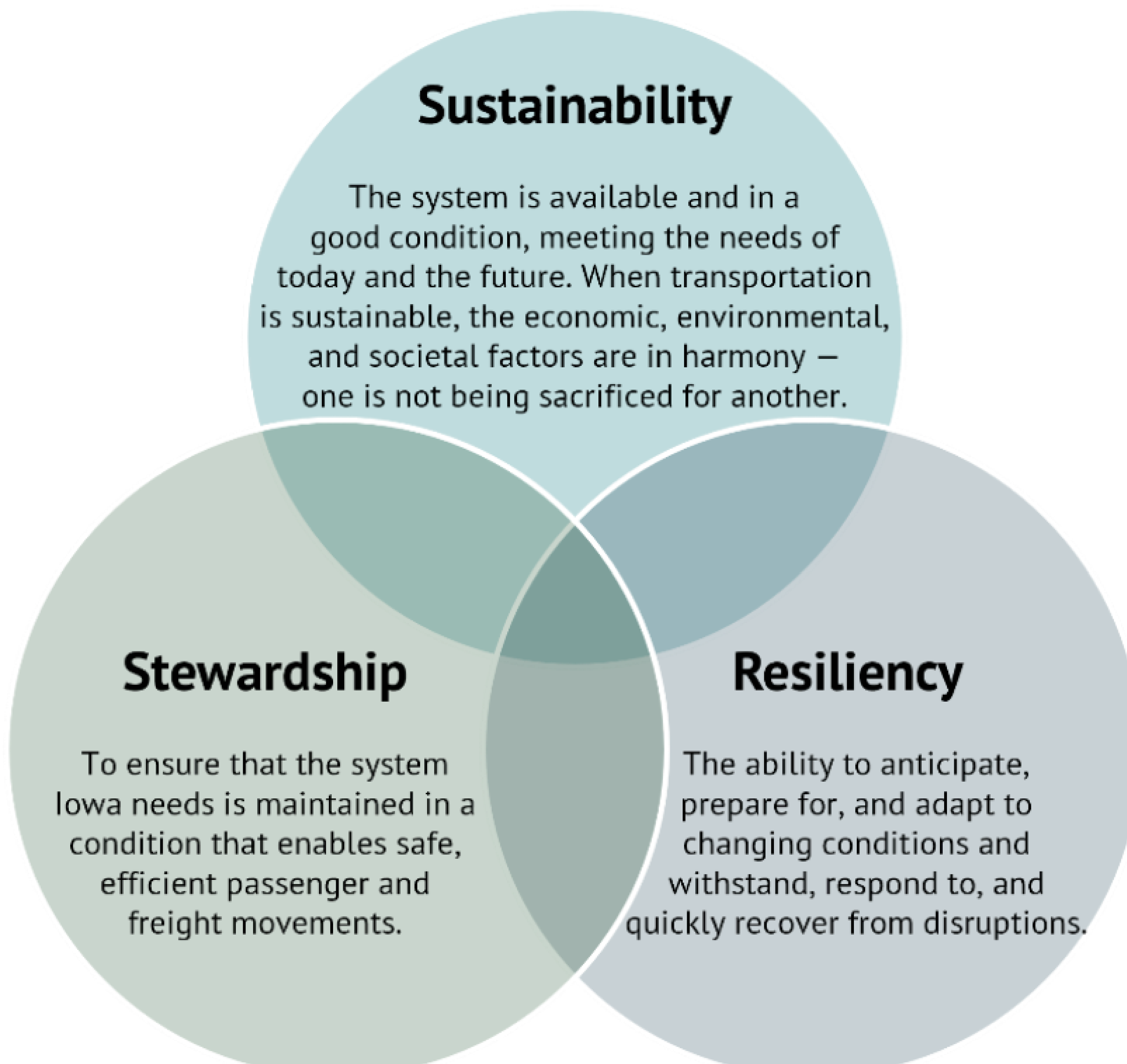
The Great Flood of 2019 was an extreme example of the natural hazards that Iowa's transportation system faces year in and year out. Improving system resiliency is not a new concept for the Iowa Department of Transportation (DOT) – it is a key element in its mission of stewardship for the transportation system and making lives better through transportation. As hazards threaten and countermeasures evolve, the Iowa DOT has routinely incorporated proactive and reactive resiliency measures to mitigate the impact of disasters on the transportation system.

Resilience Improvement Plan: Overview



Robust	The system is strong enough to withstand a given level of stress or demand without suffering degradation or loss of function.
Redundant	Elements of a system exist that are substitutable and capable of satisfying the functional requirements of the system in the case of disruption.
Resourceful	There are resources (e.g., monetary, physical, technological, and informational) available that can be leveraged in the process of recovery.
Responsive	There is capacity to meet priorities and achieve goals in a timely manner in order to minimize losses, recover functionality, and avoid future disruption.

Resilience Improvement Plan: Overview



Resilience Improvement Plan: Overview

2.1 A Blip or a New Normal?

On June 30 and July 1, 2018, a thunderstorm that was producing localized heavy rainfall stalled over parts of central Iowa. During this storm, parts of the Des Moines metropolitan area received rainfall totals of 5-10 inches. At two National Oceanic and Atmospheric Administration (NOAA) weather stations in Ankeny, weather observers recorded 24-hour precipitation totals of 7.2-8.7 inches. While that amount of rain is already extremely high for a 24-hour period, two factors combined to supercharge the impacts of this event. The first was that this event followed the 10th wettest June in Iowa, which had 50% more rain than average. The second factor was the duration and intensity of rainfall. Nearly 9 inches of rain fell in a matter of hours. In the Fourmile Creek Basin near Ankeny, over the span of 6 hours, the discharge stream flow changed from a flow of 29 cubic feet per second (ft^3/s) and a gauge height of 2.4 feet (ft) to its record peak discharge of 10,000 ft^3/s and a gauge height of 16.2 ft. This peak discharge rate lasted for nearly 2.5 hours.

Figure 2.1: Precipitation for July 1, 2018 and the discharge measured by a streamgage near Ankeny

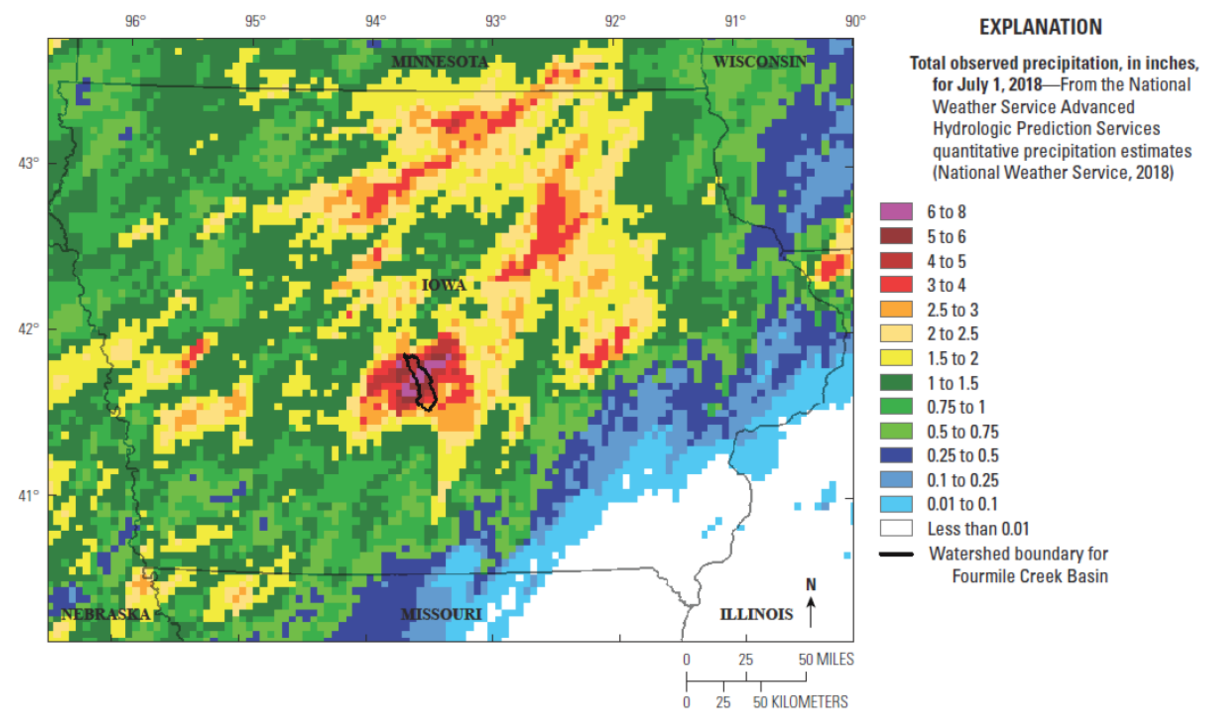
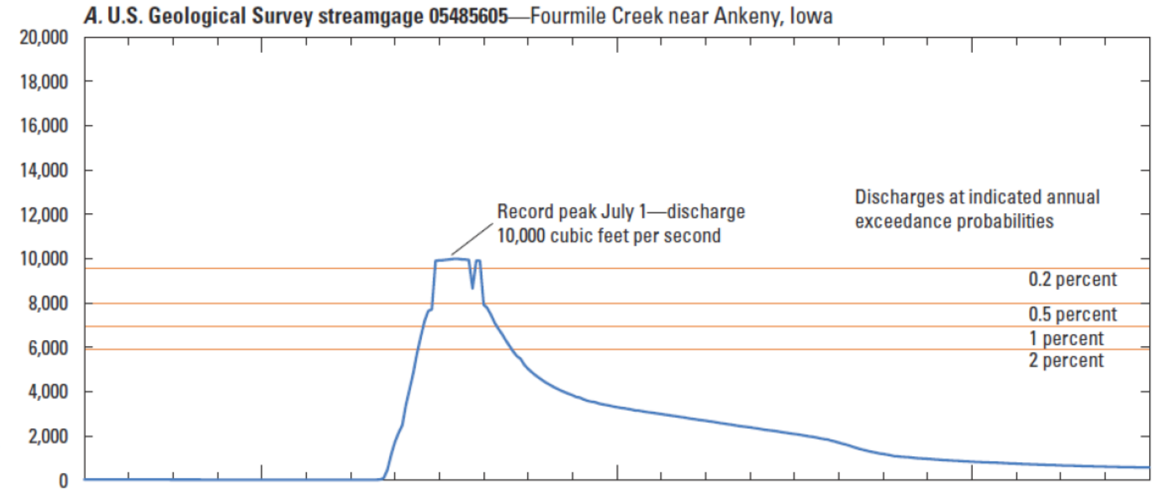
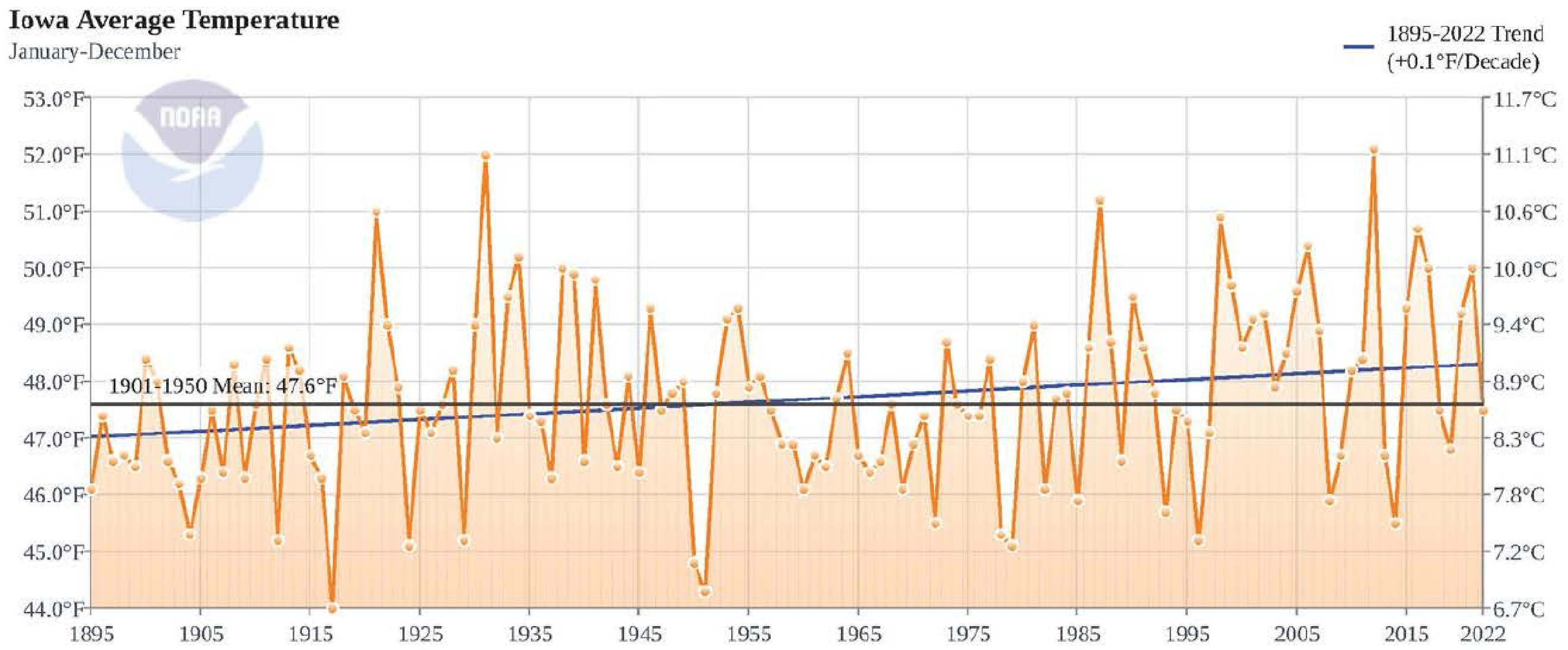


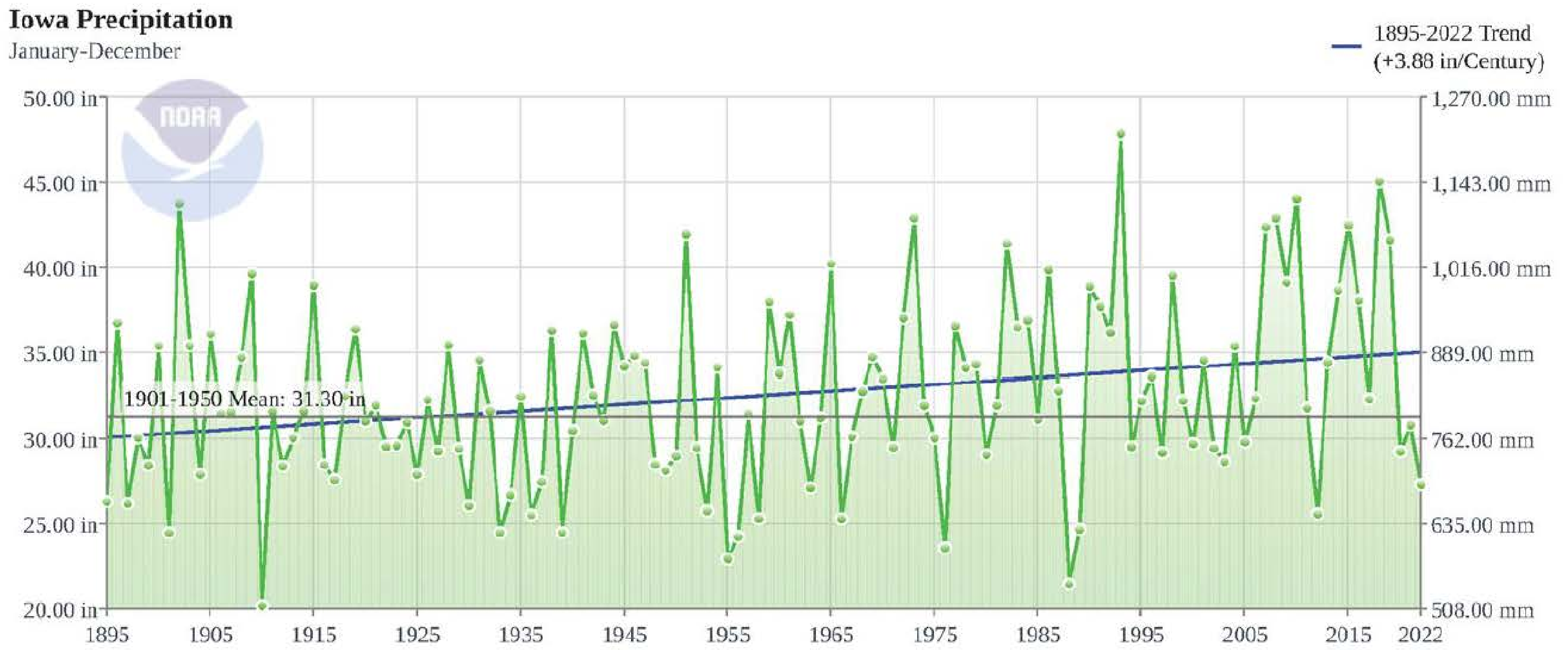
Figure 2. Advanced Hydrologic Prediction Service observed precipitation for Iowa on July 1, 2018, with an inset of the Fourmile Creek Basin watershed boundary (National Weather Service, 2018).



Source: National Weather Service

Resilience Improvement Plan: Overview





Source: National Oceanic and Atmospheric Administration (NOAA)

Resilience Improvement Plan: Overview

BILLION-DOLLAR DISASTERS FROM 1980-2023

Statistics valid as of May 8 2023

1980s (1980-1989)	8 EVENTS OVER 10 YEARS	COST: $5-$10 BILLION	% OF TOTAL COSTS: 9.9%
1990s (1990-1999)	6 EVENTS OVER 10 YEARS	COST: $10-$20 BILLION	% OF TOTAL COSTS: 24.4%
2000s (2000-2009)	15 EVENTS OVER 10 YEARS	COST: $10-$20 BILLION	% OF TOTAL COSTS: 18.5%
2010s (2010-2019)	30 EVENTS OVER 10 YEARS	COST: $10-$20 BILLION	% OF TOTAL COSTS: 23.3%
2018-2022 (Last 5 years)	19 EVENTS OVER 5 YEARS	COST: $10-$20 BILLION	% OF TOTAL COSTS: 28.3%
1980-2023 (All years)	73 EVENTS OVER 42 YEARS	COST: $50-$100 BILLION	

DISASTERS FROM 1980-2023

Flooding	6 EVENTS IN 2022	8.2% PERCENT FREQUENCY OVER TIME	TOTAL COSTS: $20-$50 BILLION	40.3% OF TOTAL DISASTER COSTS
Severe Storm	48 EVENTS IN 2022	65.8% PERCENT FREQUENCY OVER TIME	TOTAL COSTS: $10-$20 BILLION	33.5% OF TOTAL DISASTER COSTS
Drought	14 EVENTS IN 2022	19.2% PERCENT FREQUENCY OVER TIME	TOTAL COSTS: $10-$20 BILLION	25.7% OF TOTAL DISASTER COSTS
Winter Storm	3 EVENTS IN 2022	4.1% PERCENT FREQUENCY OVER TIME	TOTAL COSTS: $100-$250 MILLION	0.4% OF TOTAL DISASTER COSTS
Freeze	2 EVENTS IN 2022	2.7% PERCENT FREQUENCY OVER TIME	TOTAL COSTS: $5-$100 MILLION	0.1% OF TOTAL DISASTER COSTS
ALL Disasters	73 EVENTS IN 2022		TOTAL COSTS: $50-$100 BILLION	

Resilience Improvement Plan: Overview

The Great Flood of 1993

From April through October, Iowa and much of the Midwest was devastated by flooding of both the Mississippi and Missouri rivers and their respective tributaries. There were numerous factors that contributed to the flooding, including above normal soil moisture, persistent precipitation, and snowfall. The flood resulted in over 50 deaths (in Iowa and other states) and damages approached $15 billon ($44.4B CPI adjusted). Over the course of this event, flood waters receded and returned as many as five times in some locations before the disaster was officially over.

Parkersburg Tornado, 2008

On May 25th, a strong supercell developed in northeast Iowa and resulted in one of the strongest tornados in the state's history. After touching down just south of Aplington, the tornado eventually traveled east towards Parkersburg and became extremely violent, intensifying to EF5 strength. As the tornado continued, it leveled much of the town of Parkersburg and the neighboring town of New Hartford. Nine individuals lost their lives and over 70 were injured. The tornado resulted in an estimated $75 million in damages.

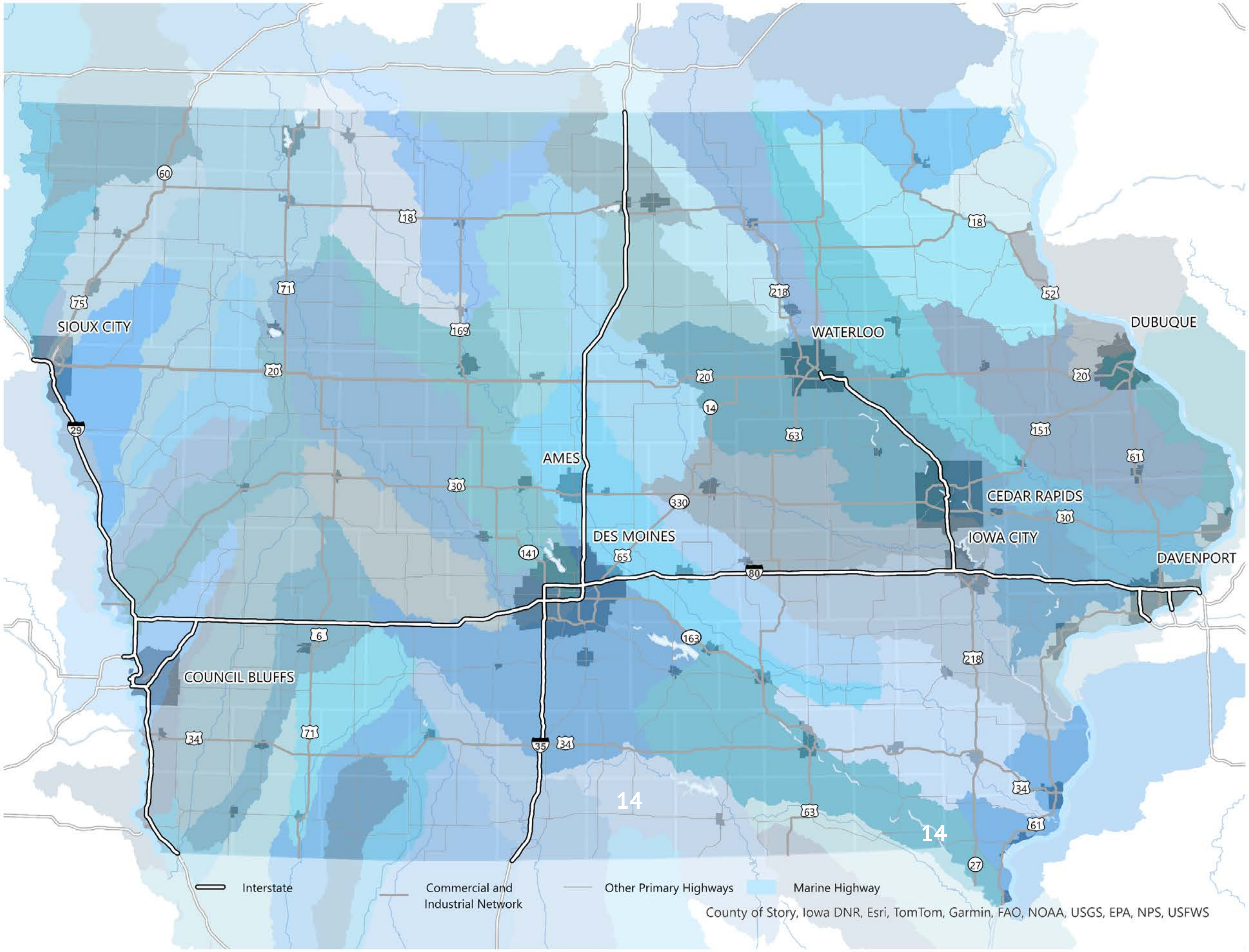
Iowa Flood of 2008

In June, a major flood event impacted most of the rivers and tributaries in eastern Iowa. The most significant flooding occurred in the Cedar Rapids and Iowa City areas. Flooding records in many locations were greatly surpassed, including in Cedar Rapids where the flood waters crested at 31.1 feet on June 13th. This flood event is one of the costliest flooding events in Iowa's history with estimated damages of over $6 billion.

Blizzard of 2009

On December 8th and 9th, a long-lived storm system brought heavy amounts of snow and blizzard conditions to Iowa. Snow totals measured between 8-15 inches and all 99 counties were under a blizzard warning. Drifting snow caused many roadways to be impassable and residents across the state were unable to access vehicles and homes. This was the first of many storms that impacted the state during the winter of 2009-2010.

Resilience Improvement Plan: Overview



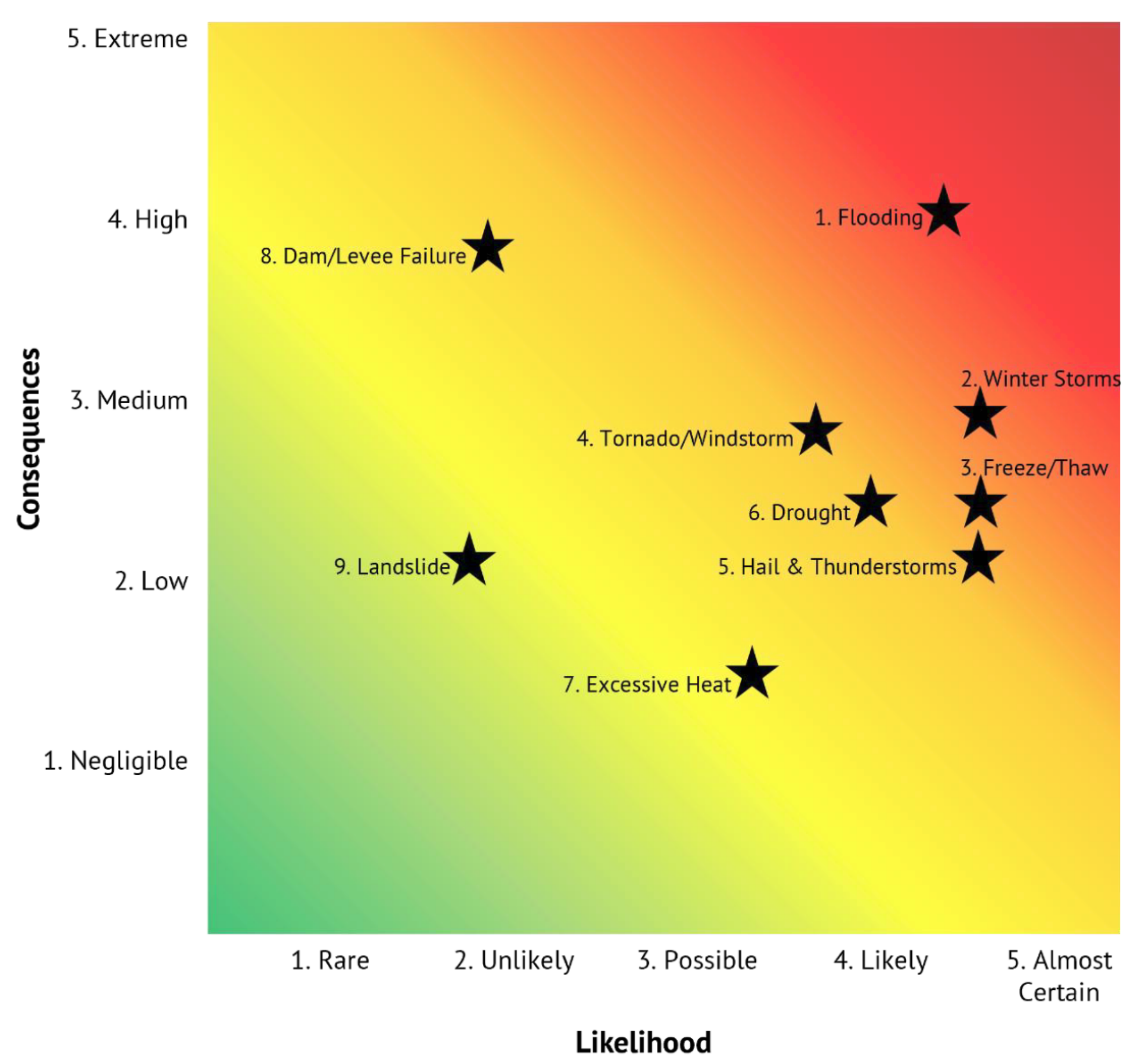
Resilience Improvement Plan: Overview

3.1 Natural Hazard Assessment and Prioritization

Iowa is vulnerable to several natural hazards that can result in various impacts and consequences to the transportation system. The Iowa DOT Resiliency Working Group (RWG) was asked to evaluate and prioritize these natural hazards through a risk-based assessment considering the likelihood and consequence of each. For likelihood, lower response values indicated that the hazard rarely occurred and higher response values indicated a higher probability of occurrence. For consequence, lower values indicated a lower impact to the Iowa transportation system while higher values indicated significant damages. Risk or vulnerability is calculated by multiplying the likelihood and consequence.

Flooding was prioritized as the highest risk hazard to Iowa's transportation system while landslides were the lowest overall risk. Many of the hazards identified are likely to occur (e.g., thunderstorms, drought, and freeze/thaw) but the impact or consequences of these events do not present as significant of a threat to Iowa's transportation system. In other instances, the consequences of an event (e.g., dam/levee failure) would cause significant damage to the transportation system but the likelihood of those events are rare.

Figure 3.1: Risk prioritization matrix



Resilience Improvement Plan: Overview

Tier	Hazard	Likelihood	Consequence	Risk	Preferred mitigation methods
Tier 1	Flooding	4.02	3.94	15.83	Take proactive steps to mitigate the risks of these hazards
	Winter Storms	4.27	2.88	12.28	
	Freeze/Thaw	4.23	2.38	10.04	
Tier 2	Tornado/ Windstorm	3.31	2.77	9.18	Have strategies in place to quickly react when these events occur
	Hail & Thunderstorms	4.23	2.02	8.55	
	Drought	3.6	2.33	8.41	
Tier 3	Excessive Heat	3.69	1.69	6.22	Monitor and conduct prevention activities as appropriate
	Dam/Levee Failure	1.58	3.71	5.87	
	Landslide	1.42	2.02	2.86	

Resilience Improvement Plan: Overview

Winter Storms

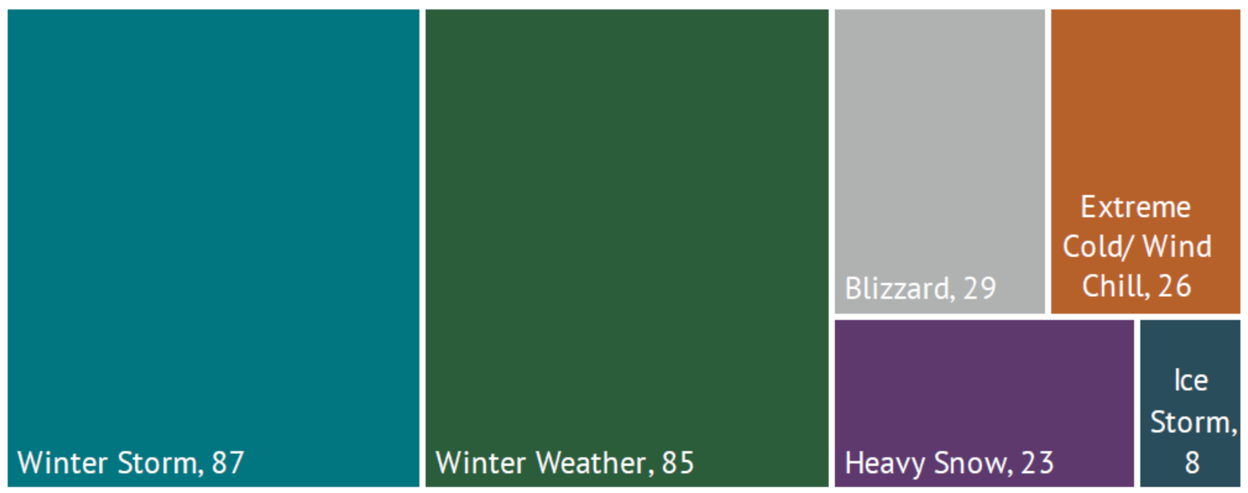
Description

"Winter storms" is a generalized term that includes blizzards, heavy and blowing snow, freezing rain, and extreme cold. Blizzards are storms that last three hours or longer with sustained winds of 35 mph or more, often resulting in reduced visibility of a quarter mile or less or whiteout conditions. Heavy snows are events of six inches of snow or more in a 12-hour period. Blowing snow events occur when loose snow begins to drift, which is more likely in rural areas where there are less objects to obstruct wind. Freezing rain can result in ice storms that cause power outages from downed trees, limbs, and utility poles. Extreme cold occurs when temperatures are near zero degrees Fahrenheit and can be magnified by wind.

Analysis and Mapping

Iowa, like many of the northern Midwest states, experiences time periods with poor weather and/or roadway conditions, especially during the winter season (October through April). These winter weather events are cataloged by the National Centers for Environmental Information (NCEI).

Figure 3.4: Winter weather events from 2018-2022

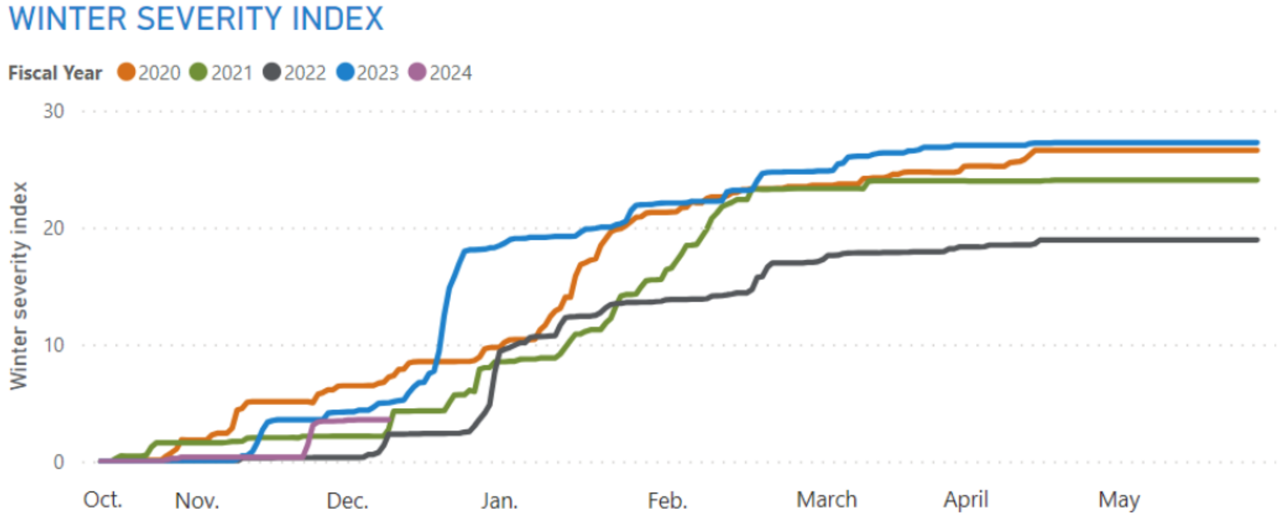


Source: NCEI

From 2018 to 2022, winter weather storms resulted in three deaths directly attributed to the event, 10 deaths and 16 injuries indirectly attributed, and $516,800 in property damage – $377,000 from ice storms alone.

The Iowa DOT has developed a winter severity index that provides a score for locations based on event duration, event frequency, snowfall amount, and temperature. The duration and frequency are normalized by the expected extreme for each event, then scaled by an "importance" factor. Generally, colder pavement temperatures during an event result in higher index scores, which correlate to more severe winters.

Figure 3.5: Iowa DOT winter severity index, 2019-2023



Impacts to Transportation

The mobility and safety of Iowa's transportation users can be compromised during winter weather events. Significant snowfall, extreme cold, high winds, and ice can all immobilize Iowa's transportation system resulting in travel delay, vehicle crashes, and the need for around-the-clock maintenance of the roadways.

Resilience Improvement Plan: Overview

4.1 Iowa's Resiliency Toolbox

A multifaceted approach that includes strategies, countermeasures, and research will be implemented to mitigate the hazards prioritized by the Resiliency Working Group (RWG). Collectively, this combination of activities will represent Iowa's Resiliency Toolbox and will serve as a planning level resource in identifying approaches for each hazard. As discussed in Chapter 3, hazards have been prioritized into three different response categories based on their risk scores and preferred mitigation approaches. The Tier 1 hazards, which have the highest risk scores, are the primary focus of the toolbox. Iowa's Resiliency Toolbox also includes both typical roadway improvements (grey infrastructure) and natural infrastructure improvements (e.g., native plantings and bioretention).

The strategies, countermeasures, and research initiatives align to the 4 Rs first identified in Chapter 2, with each R icon used to designate which topic each tool relates to most strongly.

Figure 4.1: The four Rs of resiliency

Robust	The system is strong enough to withstand a given level of stress or demand without suffering degradation or loss of function.	Redundant	Elements of a system exist that are substitutable and capable of satisfying the functional requirements of the system in the case of disruption.
Resourceful	There are resources (e.g., monetary, physical, technological, and informational) available that can be leveraged in the process of recovery.	Responsive	There is capacity to meet priorities and achieve goals in a timely manner in order to minimize losses, recover functionality, and avoid future disruption.

Many of the ideas listed in Iowa's Resiliency Toolbox benefit the operation of the transportation system beyond mitigation of the specific hazards they are listed for. For example, shoulder improvements may mitigate the impact flowing water has on the roadway, but they also serve as a safety benefit by allowing users space to recover from departing their lane. Stewardship of the transportation system means that increased consideration should be given to the improvements that are co-beneficial to our mission of keeping users safe on the system.

Resilience Improvement Plan: Overview

Tier 2 Hazards

-Medium risk scores
-Preferred mitigation method: Have reactive strategies in place to respond when these hazards occur

Tornado/Windstorm | Hail/Thunderstorms | Drought

Tier 2 Strategies and Countermeasures

S21. Ensure Iowa DOT owned structures and signs are designed to withstand high wind events.

S22. Develop internal guidance or policies on clearing or trimming trees that could fall on the roadway.

S23. Purchase vegetation management equipment specifically for debris removal on the Primary Highway System.

S24. Develop internal plan to pre-stage Iowa DOT assets in support of debris and vegetation removal following tornados or windstorms.

S25. Engage with local communities regarding the resources and assets the Iowa DOT possesses to support debris removal and cleanup after significant events.

C15. Underground utilities – Storage and coordination of utilities underground to ensure continued service during significant tornados and windstorms.

C16. Solar as primary or backup electrical – Installation of solar arrays for traffic controls or facilities as a primary or backup energy source.

C17. Generator backup – Purchase of backup generators to provide energy for traffic controls or facilities during major tornados or windstorms.

S26. Improve roadway design to accommodate increased precipitation events.

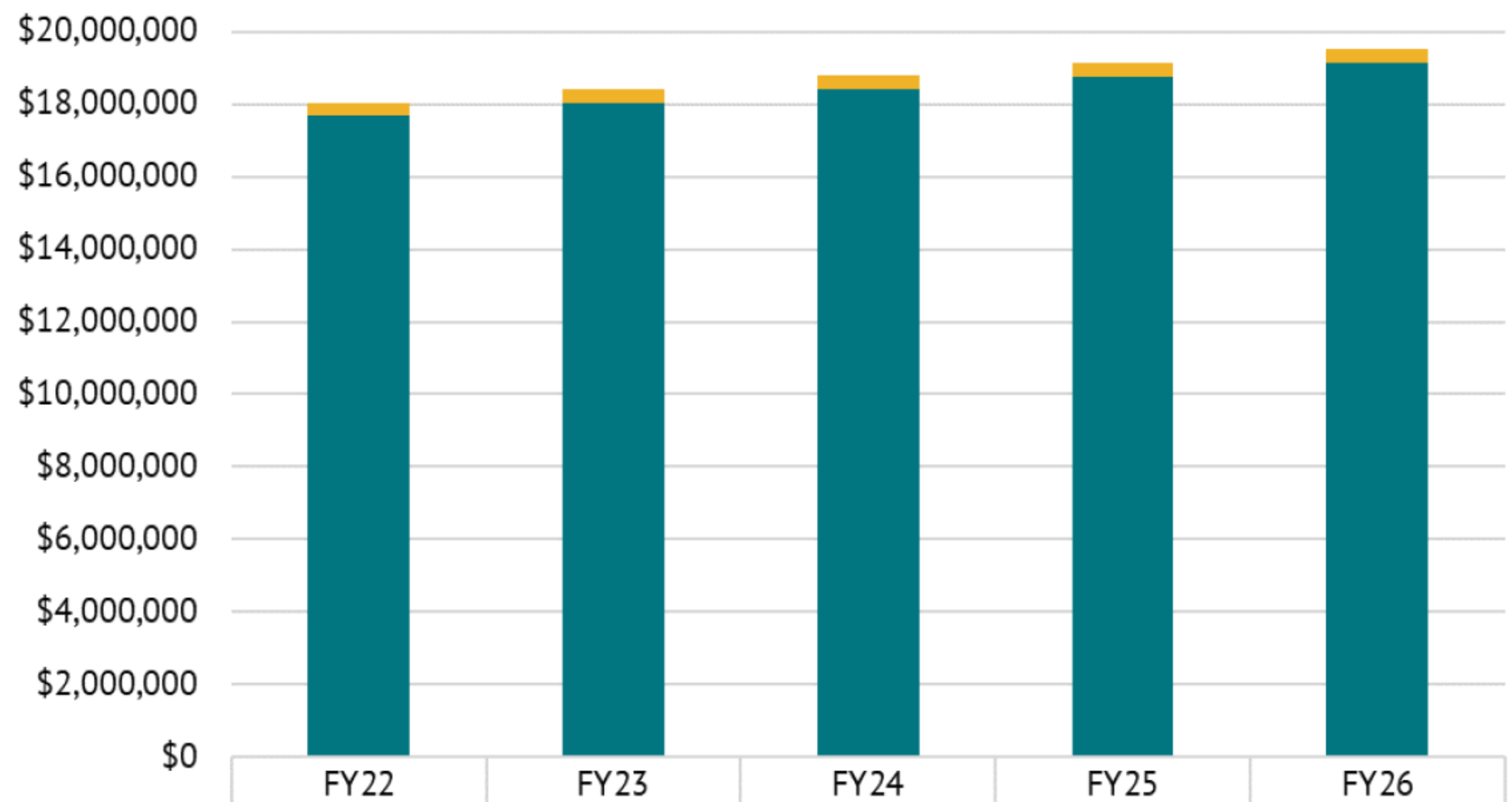
S27. Plan for operational impacts of severe weather and continue to enhance communication of rapid weather changes to the public.

S28. Develop regulations or waivers to ease in the transport of water, livestock feed, etc. during drought conditions.

S29. Coordinate across public and private sectors during times of low water levels to help facilitate shifts of bulk transportation from rivers to railroads or highways.

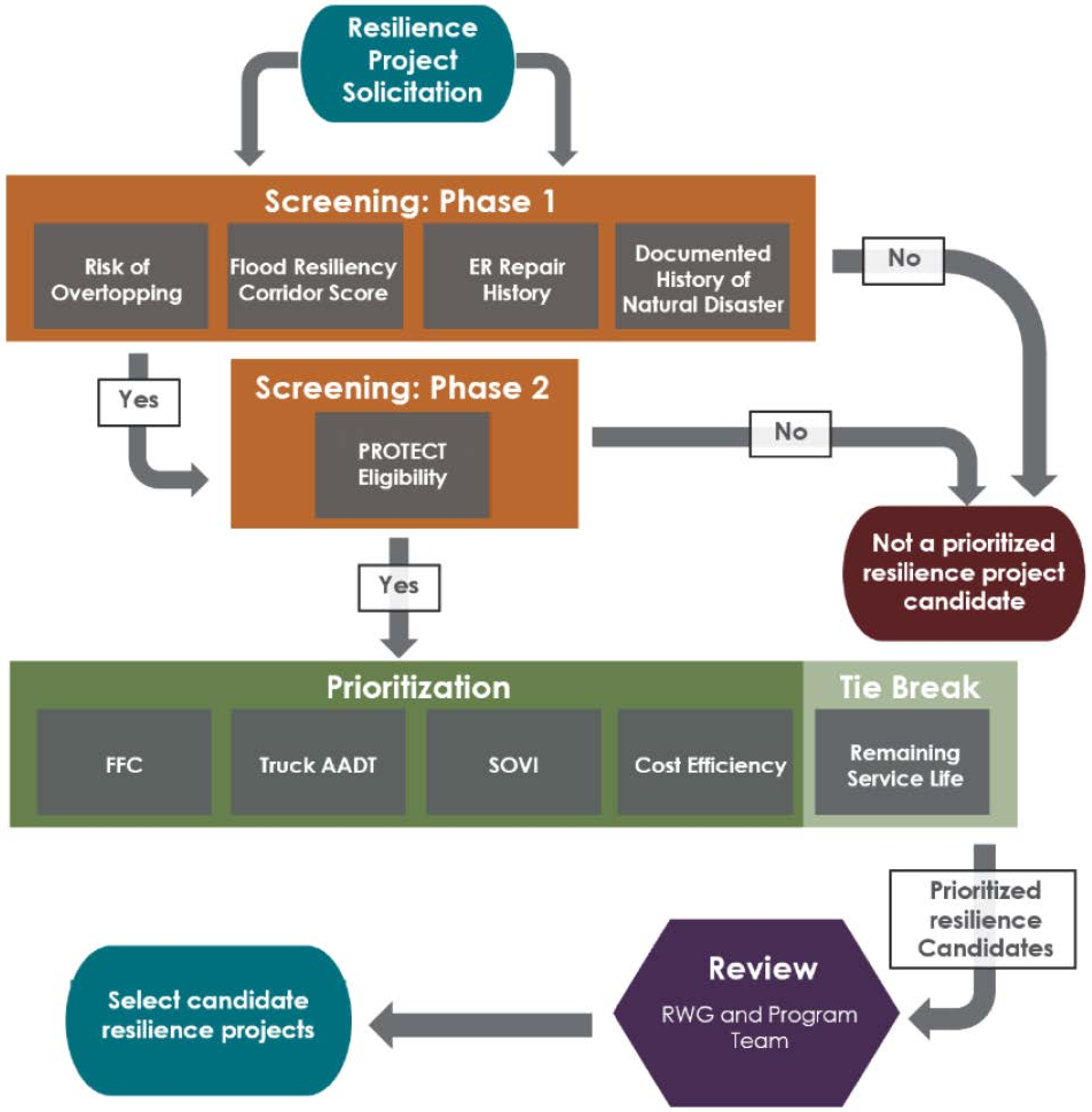
Resilience Improvement Plan: Overview

Figure 4.2: Iowa's PROTECT formula funding for FY 2022-2026, showing the breakout of the 2% set-aside for planning



	FY22	FY23	FY24	FY25	FY26
2% Set-Aside	$360,839	$368,056	$375,417	$382,925	$390,584
Any eligibility	$17,681,109	$18,034,731	$18,395,425	$18,763,334	$19,138,600

Figure 4.3: Resilience project prioritization process



1. Desoto Bend Extension
Construction of Rand-Peterson Levee (flood fight levee) to protect U.S. 30.
Without this levee, U.S. 30 is impacted by 65-year flood events.

2. East/West repair of existing sand levee
Reconstruction and repair of portions of the Rand-Peterson Levee in areas where problematic sand boils exist.
This work will support the continued operations of portions of I-29 and U.S. 30 during flood events.

3. Mitigation Sites 2 and 3 – Modale area
These sites maintain I-29 mobility north of the I-29/I-880 systems interchange through a 200-year event.

4. Mitigation Site 1, U.S. 30/Union Pacific Railroad (UPRR) Overflow
This site prevents 'runaway' scouring at the UPRR overflow bridge in the event of a Rand-Peterson Levee failure.
This improvement will allow for mobility to be re-established at a 20-year flowrate.

Resilience Improvement Plan: Next Steps

- Process from here
  - ❑ All final comments due today!
  - ❑ Present to department leadership
  - ❑ Department leadership review with IGOV
  - ❑ Submit to FHWA Division