

Freight Impacts to Natural Resources and the Environment in State Freight Plans



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About the Mid-America Freight Coalition (MAFC)

The industries and farms of the Mid-America region can compete in the marketplace only if their products can move reliably, safely and at reasonable cost to market.

State Departments of Transportation play an important role in providing the infrastructure that facilitates movement of the growing amount of freight. The Mid-America Freight Coalition was created to support the 10 states of the Mid America Association of State Transportation Officials (MAASTO) region in their freight planning, freight research needs and in support of multi-state collaboration across the region.

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Top: Ernie Perry, MAFC: Trailer Chassis.

Bottom (middle): Ernie Perry, MAFC: Green Tree Frog.

Bottom (right): Ernie Perry, MAFC: Oversize Truck Load.

TECHNICAL REPORT DOCUMENTATION

1. Report No. MAFC 36	2. Government Accession No.	3. Recipient's Catalog No. CFDA 20.701	
4. Title and Subtitle MAFC 36. Freight Impacts to Natural Resources and the Environment in State Freight Plans		5. Report Date April 2026	
		6. Performing Organization Code	
7. Author/s Ernest Perry, Glenn Vorhes, Anupam Srivastava, and Soyoung Ahn		8. Performing Organization Report No. MAFC 36	
9. Performing Organization Name and Address Mid-America Freight Coalition University of Wisconsin-Madison 1415 Engineering Drive, 2205 EH Madison, WI 53706		10. Work Unit No. (TRAIS)	
		11. Contract or Grant No. TPF-5(509) POH 395-0097-23-95	
12. Sponsoring Organization Name and Address Wisconsin Department of Transportation Division of Transportation Investment Management PO Box 7913 Madison, WI 53707		13. Type of Report and Period Covered Final Report 01/01/2025 – 03/31/2026	
		14. Sponsoring Agency Code <u>TPF-5(509) 395-0097-24-95</u>	
15. Supplementary Notes			
The objective of this project is to identify a range of freight planning and operational best practices that reduce the natural resource impacts of freight development and movement. Impacts to freight movement from natural events are also included. The best practices for assessing and limiting impacts are identified through state freight plans, and through 4 case studies. The case studies were developed in coordination with freight and environmental professionals and provide an expanded review of the environmental and resiliency planning requirements.			
17. Key Words Freight plans, environmental impacts, freight resiliency, multimodal freight planning, MAASTO, flooding, air quality, wildlife habitat.	18. Distribution Statement No restrictions. This report is available to the public through the National Transportation Library Digital Repository.		
19. Security Classification (of this report) Unclassified	20. Security Classification (of this page) Unclassified	21. No. of Pages 43	22. Price -0-

Form DOT F 1700.7 (8-72) Reproduction of form and completed page is authorized.

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1. INTRODUCTION

Transportation systems plans provide the basis for selecting and developing transportation projects. The elevation of freight planning into this system reflects the growing awareness of the importance of freight movement to our economy and society. And while large trucks have always been a planning consideration, multimodal freight was not included in early planning systems.

Recognition of freight in planning began with MAP-21 (MAP-21, the Moving Ahead for Progress in the 21st Century Act (P.L. 112-141) [1], [2]) with establishment of the national freight network, National Strategic Freight Plan, state freight plans, and recommended freight advisory committees. Additional regulations were prescribed in 2015 with the passage of the FAST ACT (Fixing America's Surface Transportation (FAST) Act (Pub. L. No. 114-94) [3], [4]). The freight planning process has been increasing in sophistication and breadth each year.

In terms of regulatory experience, freight planning and state freight plans are a relatively new state responsibility. The FAST Act recommended state freight advisory committees, and required development of freight performance measures, as well as the following minimum criteria:

- the plan must cover a five-year forecast period
- be fiscally constrained
- include a "freight investment plan" with a list of priority projects
- describe how the State will invest and match its National Highway Freight Program funds. (Guidance on State Freight Plans and State Freight Advisory Committees [5])

Table 1 displays the criteria and content from the state freight plan guidance from 2012 and 2015. The information is from a previous MAFC project designed to support the freight planning elements of the FAST Act and MAP-21 Act across the MAASTO states. The column titles list the required practices based on legislation.

FAST ACT	Significant system trends, needs, and issues	Policies, strategies, and performance measures	How plan will help meet national freight policy goals	Innovative technology considered	Description of work to reduce road damage caused by heavy vehicles	Inventory of facilities with freight mobility issues, and solutions	List of multimodal critical facilities and corridors (if applicable)	Consideration of congestion or delay caused by freight movements, and strategies to mitigate	Freight investment plan	Consultation with FAC (if applicable)
MAP-21	X	X	X	X	X	X				
IL 2012	X	X								
IN 2014	X	X	X	X	X	X				X
IA 2016	X	X	X	X	X	X	X	X		X
KS* 2016	X	X	X	X	X	X	X	X	X	X
KY 2007	X	X								
MI 2013	X	X	X	X	X	X				
MN 2016	X	X	X	X	X	X				X
MO 2014	X	X	X	X	X	X				X
OH 2013	X	X	X	X			X		X	
WI* 2016	X	X	X	X	X	X	X	X	X	X

* Planned efforts

Table 1: MAFC State Freight Plan Compliance with FAST and MAP-21 Requirements (source: MAFC 15 – From the Ground Up [6]).

IIJA Additions to Freight Planning

The Infrastructure Investment and Jobs Act (IIJA) was signed into law by President Biden in November of 2021. The law authorized \$1.2 trillion for transportation and infrastructure spending with \$550 billion allocated for “new” investments and programs. The Act also added or altered requirements to state freight planning [7].

In addition to requiring freight plan updates every four years rather than five, the IIJA also included environmental or resilience directives for state freight plans. Environmental impacts to and by freight modes are specified in new requirements for state freight plans in the IIJA and are the focus of this report. The legislation directs states to develop strategies and goals to eliminate or minimize impacts in the following specific areas.

- The severity of impacts of extreme weather and natural disasters on freight mobility
- The impacts of freight movement on local air pollution
- The impacts of freight movement on flooding and stormwater runoff
- The impacts of freight movement on wildlife habitat loss

The addition of resilience and environmental components to freight plans is significant. Because of their long-time frames and broad scopes, system plans often are developed without detailed consideration of how plan implementation will affect the built and natural environments.

Including freight in the planning process has been critical to freight development as the transportation system plans provide the basis for selecting and developing transportation

projects. Including freight in the planning process provides two immediate benefits. First, it demonstrates the economic and operational importance of freight movement in the transportation system. Second, the inclusion moves multimodal freight projects into the state DOT project selection processes.

Project Purpose and Scope

The objective of this project is to identify a range of freight planning and operational best practices that reduce the natural resource impacts of freight development and movement. Impacts to freight movement from natural events are also included and represent a resiliency measure. The best practices and exemplary cases of resource protection will be identified through the literature review, via interviews with natural resource agency professionals, and with freight-based case studies.

Organization of the Report

The report is organized as follows. Chapter 2 provides an overview of environmental issues related to freight and the related regulatory climate. Chapter 3 identifies four case studies with impacts related to the defined environmental issues in IIJA. Best practices for each of the case studies are listed and discussed. Additional best practices identified in freight plans and through discussions with planning and environmental experts are also included. The intent is to provide a roadmap to identify appropriate analysis levels for these impacts and apply best practices and mitigation that satisfy state and federal guidance. Aligning the environmental work of freight plans with the state resiliency plans, in coordination with agencies environmental section could bring critical information early in the planning process.

Chapter 4 summarizes the project findings and best practices and concludes with recommendations for further action.

2. ENVIRONMENTAL IMPACTS, RESILIENCE, AND REGULATIONS

Freight Transportation and Environmental Impacts

Multimodal freight development and operations produce an array of environmental impacts based on the project, operational scope, and the existing environment. As an example of the possible impacts, the following chart provides a broad look at the range of impacts related to transportation (Figure 1). These potential impacts typically would face increasing levels of analysis as the project moves from sketch planning to the design and NEPA stages of project delivery.

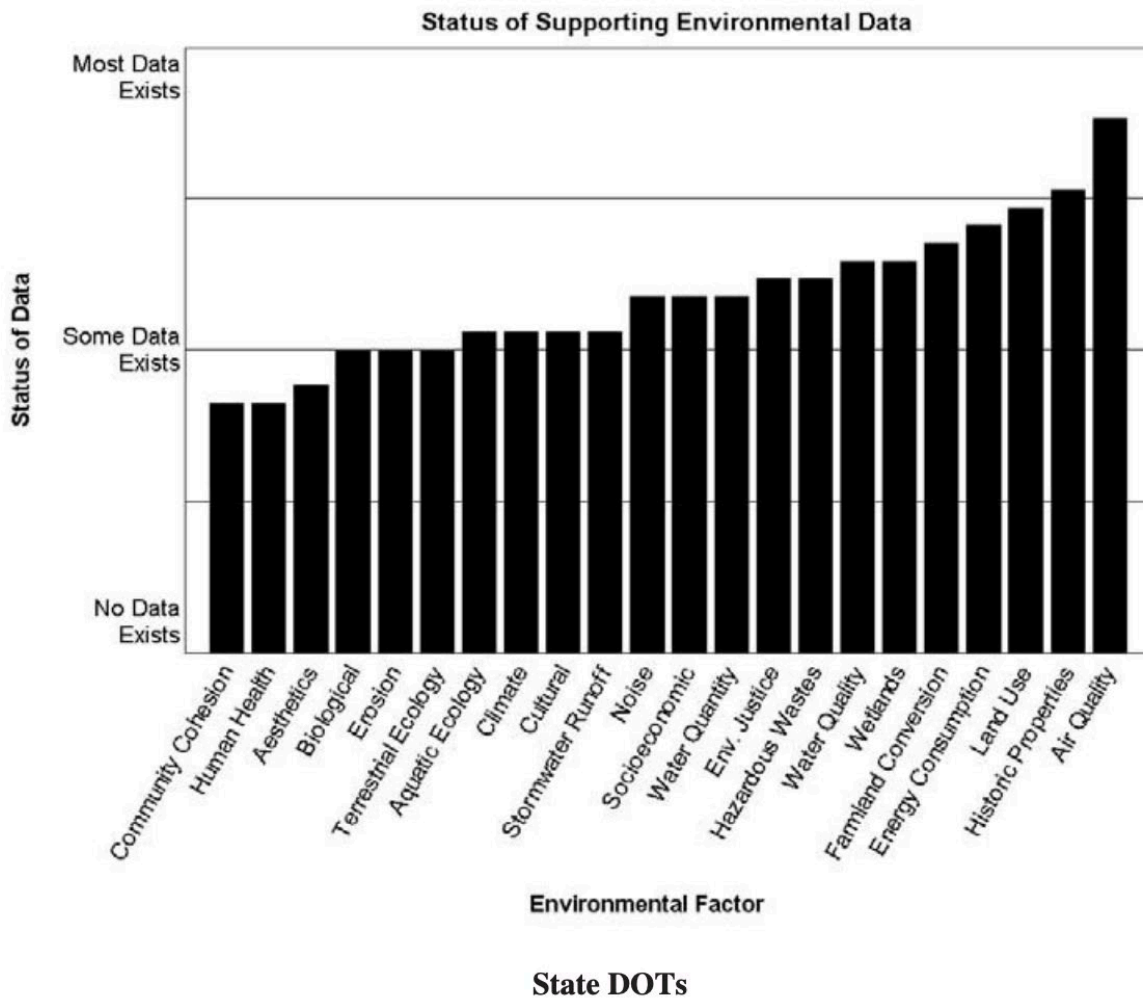


Figure 1: Consideration of Environmental Factors in Transportation System Planning (source: NCHRP Report 541 [8]).

With new freight planning regulations, the focus is directed specifically at the four specific, IJA-defined areas. Again, with expectations that if a project occurs, all these issue areas

including the four included in IJJA will need to be addressed in the NEPA process with a higher level of scrutiny than in the systems planning document. The IJJA defined areas include:

- The severity of impacts of extreme weather and natural disasters on freight mobility
- The impacts of freight movement on local air pollution
- The impacts of freight movement on flooding and stormwater runoff
- The impacts of freight movement on wildlife habitat loss

The following narrative presents each of these four reporting areas, and examines the background of the environmental issues, data, trends, and mitigation for each of the IJJA reporting areas.

The Severity of Impacts of Extreme Weather and Natural Disasters on Freight Mobility.

The frequency of weather and natural disaster events that disrupt transportation and freight movement have been increasing. The chart below shows the increase in billion-dollar disaster events rising from three, billion-dollar events in 1980, to twenty-eight events in 2024. Figure 2 identifies seven disaster types that were tracked, and the disaster costs associated with each. Freight impacts associated with these extreme weather events include, road closures, facility/infrastructure destruction, loss of connectivity, and incident, and recovery costs. The NOAA disaster events data from 1980 through 2024 are inflation adjusted.

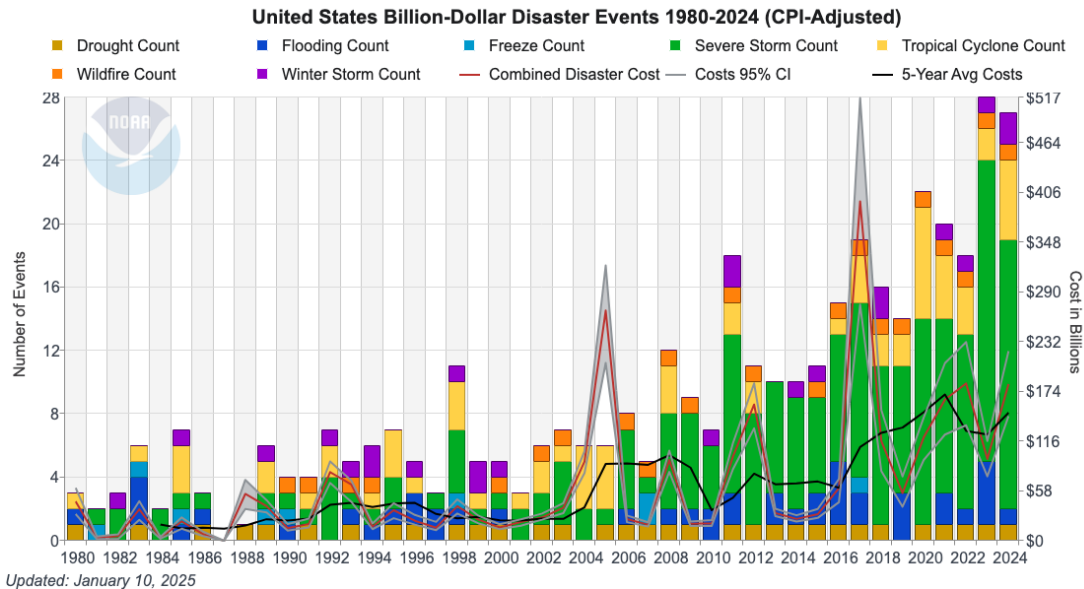


Figure 2: Billion-Dollar Disaster Events in the U.S. 1980-2024 (source: NOAA [9]).

In 1980, the total cost of billion-dollar disasters amounted to approximately \$3.6 billion. In 2024, the total disaster costs at this threshold reached \$517 billion dollars. These

incidents result in closed Interstates and impacts to logistic facilities, and additional road user costs for all vehicles.

Based on a 2024 MAFC report, *All-Hazards Assessments of Major Freight Corridors in the MASTO Region* [10] these disaster events impacted connectivity for trucking, freight rail, and any other freight facilities along the corridor.

Figure 3 below quantifies the highway closures due to disasters on five selected major freight corridors in the MASTO region. In addition to the supply chain impacts, user costs can also be a critical factor with longer shutdowns using extensive rerouting and additional miles of travel.

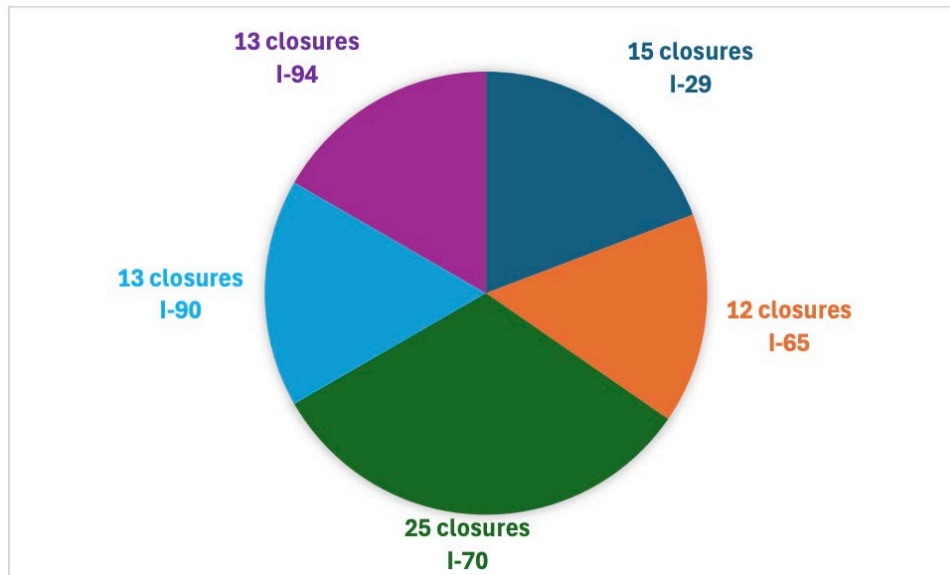


Figure 3: Number of Closures due to Disasters, by Interstate Corridor (source: MAFC [10]).

A total of 78 hazard-impacted locations were identified along five study corridors, covering the period from 2008 to 2024. Eleven percent of these closures were crash related and the remainder were weather related closures with the majority due to flooding [10].

While the NOAA's reporting of billion-dollar disasters has been suspended, a 2025 report by Climate Central shows severe storms accounted for 21 of the 23 billion-dollar incidents (Figure 4).

U.S. 2025 Billion-Dollar Weather & Climate Disasters

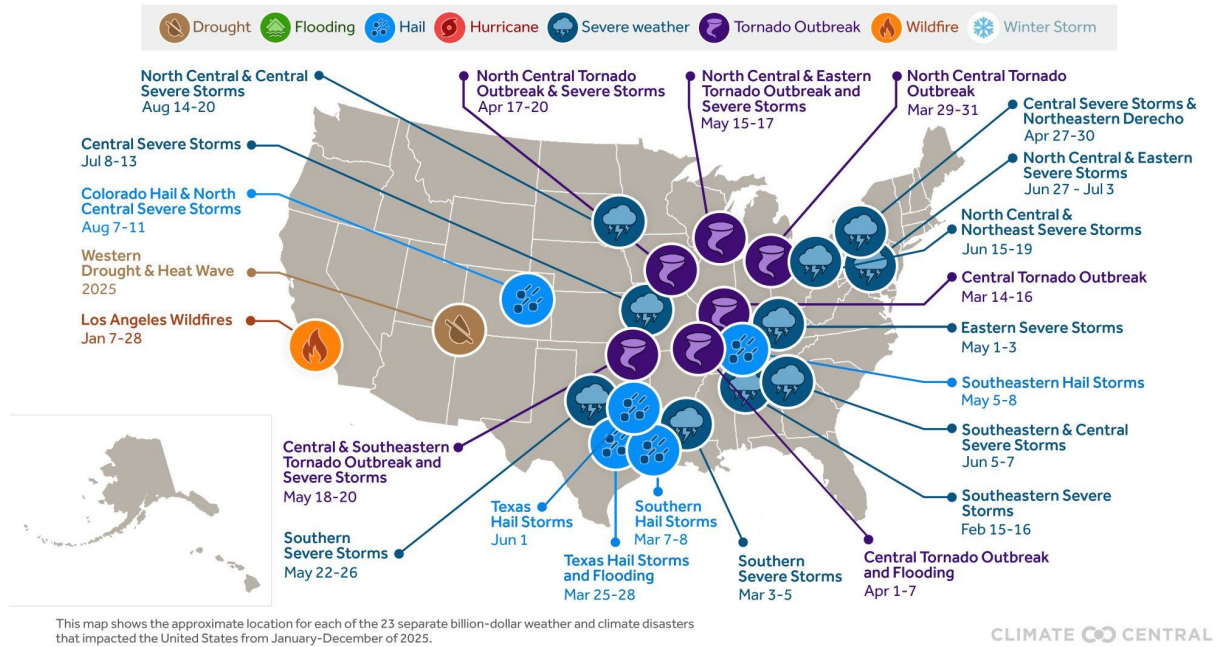


Figure 4: U.S. 2025 Billion-Dollar Weather and Climate Disasters (source: Climate Central [11]).

Continued increases in facility closures and damage due to weather and natural disasters are not sustainable. Aligning the environmental work of freight plans with the State’s resiliency plans, and in coordination with agency’s environmental section could bring critical information to bear early in the planning process.

The Impacts of Freight Movement on Local Air Pollution.

As reported in EPA’s FAST FACTS [12], Figure 5 shows that in 2022, transportation was the leading contributor to GHG emissions, followed closely by utilities and industry. The chart below (left) shows that transportation is consistently one of the largest GHG emitters, accounting for 28% of total sector emissions. The second chart (right) shows that within transportation, freight movement by medium and heavy-duty trucks accounts for 23% of the total emissions, rail contributes two percent; and boats and ships contribute another three percent.

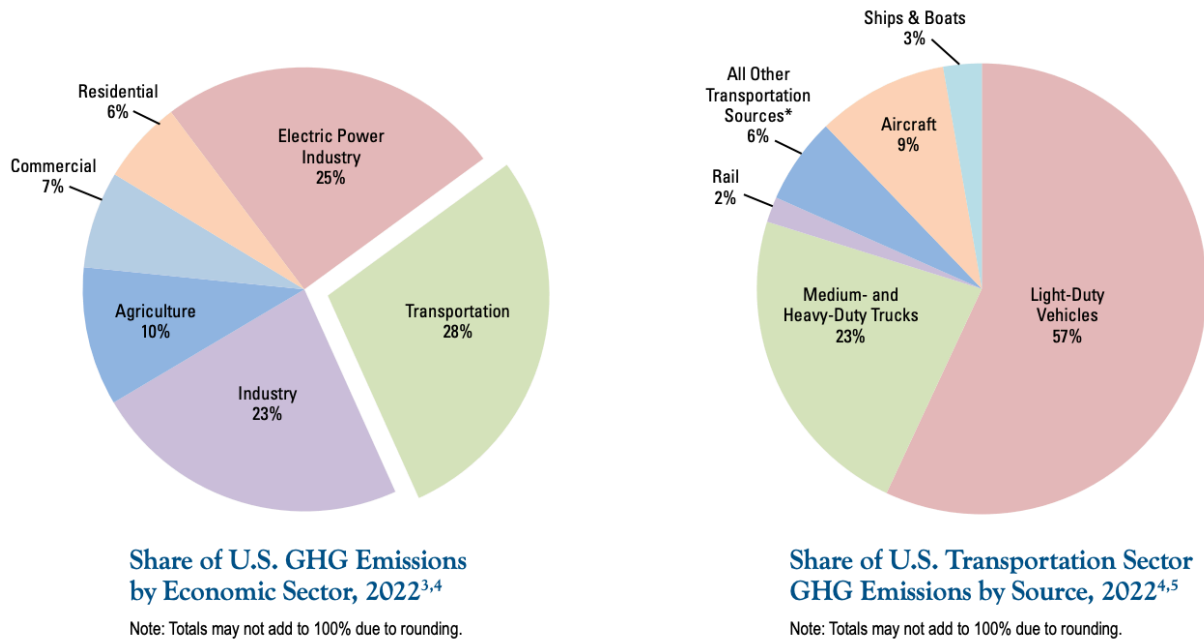


Figure 5: Share of U.S. Greenhouse Gas Emissions by Sector and by Source for Transportation Sector (source: EPA Fast Facts [12]).

Several operational situations such as congestion that concentrates emissions, idling during parking, high volume freight corridors, or terminal operations near residential areas increase the possibility of air quality impacts to the local area.

Different freight modes also demonstrate different efficiencies in fuel economy, load capacity, safety, and emissions that can affect air pollution in communities. The differences across rail, inland towing and truck emissions are tracked in the Table 2 below. Inland towing produces the fewest grams per ton-mile of emissions with the Truck mode producing the highest levels of emissions.

Summary of Emissions - Grams per Ton-Mile.

Emissions (grams/ton-mile)				
	HC	CO	NO _x	PM
Inland Towing	0.01737	0.04621	0.46907	0.01164
Eastern Railroad	0.02419	0.06434	0.65312	0.01624
Western Railroad	0.02423	0.06445	0.65423	0.01621
Truck	0.020	0.136	0.732	0.018

Table 2: Summary of Emissions from Domestic Freight Transportation Modes (source: TTI [13]).

The prominence of transportation and freight modes as part of the total emissions from economic sectors reflects the ubiquitous nature of transportation.

Solutions that can impact the level of local air pollution include the use of alternative and clean fuels, service to support alternate fuels, congestion reduction strategies, reduced idling, appropriate land use near existing emitting sources, sufficient truck parking, and use of multimodal solutions for moving freight.

The Impacts of Freight Movement on Flooding and Stormwater Runoff.

The primary impact in this case are the hard surfaced facilities and the resultant flooding and runoff, rather than freight movement. Examples include warehouses and industrial sites with large lots of impervious surfaces, rail yards, dense highway facilities, facility location in a floodplain, and insufficient drainage design. Practical solutions include increasing the use of stormwater and runoff best practices such as swales, water gardens, wetlands, and underground water retention.

Flooding and storm water issues are costly to the freight industry. According to a Freight Waves article [14]:

The cumulative impact of these weather events has been staggering. Supply chain disruptions in 2024 are estimated to have cost companies globally upwards of \$100 billion. This includes costs associated with production delays, transportation disruptions, inventory losses and increased procurement expenses.

The article stated that 2024 was a wakeup call for business worldwide. And if resiliency in freight is not addressed, the consequences of the events will continue to increase in cost and frequency.

According to FHWA, road user safety is also challenged due to flooding and extreme weather. Based on a five-year average (2019-2023), *flooding and extreme weather* are responsible for 12% of the motor vehicle crashes, 11% of estimated crash injuries, and 9% of crash fatalities. Table 3 below documents the *weather-related* crash statistics. For CMV's, 9% of fatal crashes are weather related during the period of 2019 through 2023.

Five-Year Average (2019-2023)	Five-Year Percentages
744,911 estimated crashes	12% of motor vehicle crashes
268,239 estimated persons injured	11% of estimated crash injuries
3,807 persons killed	9% of crash fatalities

Table 3: Weather Related Crash Statistics (Annual Averages) (source: FHWA Road Weather Management Program [15]).

The Impacts of Freight Movement on Wildlife Habitat Loss.

Freight movement direct and indirect impacts to wildlife habitat. Freight systems indirectly impacts wildlife habitat through development of industrial sites, and freight facilities located upon key habitat. Impacts also occur due to divided habitats, stream, or lake

contamination due to spills, runoff, noise, and collisions with wildlife. Maintenance operations such as mowing and spraying also impact wildlife.

According to the Economic Research Service Data Series, Major Uses Data Series, roads cover 13,000 square miles with over 20,000 square miles in road rights-of-way. This equates to slightly less than 1% of total land area. In rural areas, transportation such as roads, railways, and airports accounted for 26 million acres. [16].

Figure 6 below demonstrates that travel as well as facilities continue to expand escalating the potential impact to wildlife habitat.

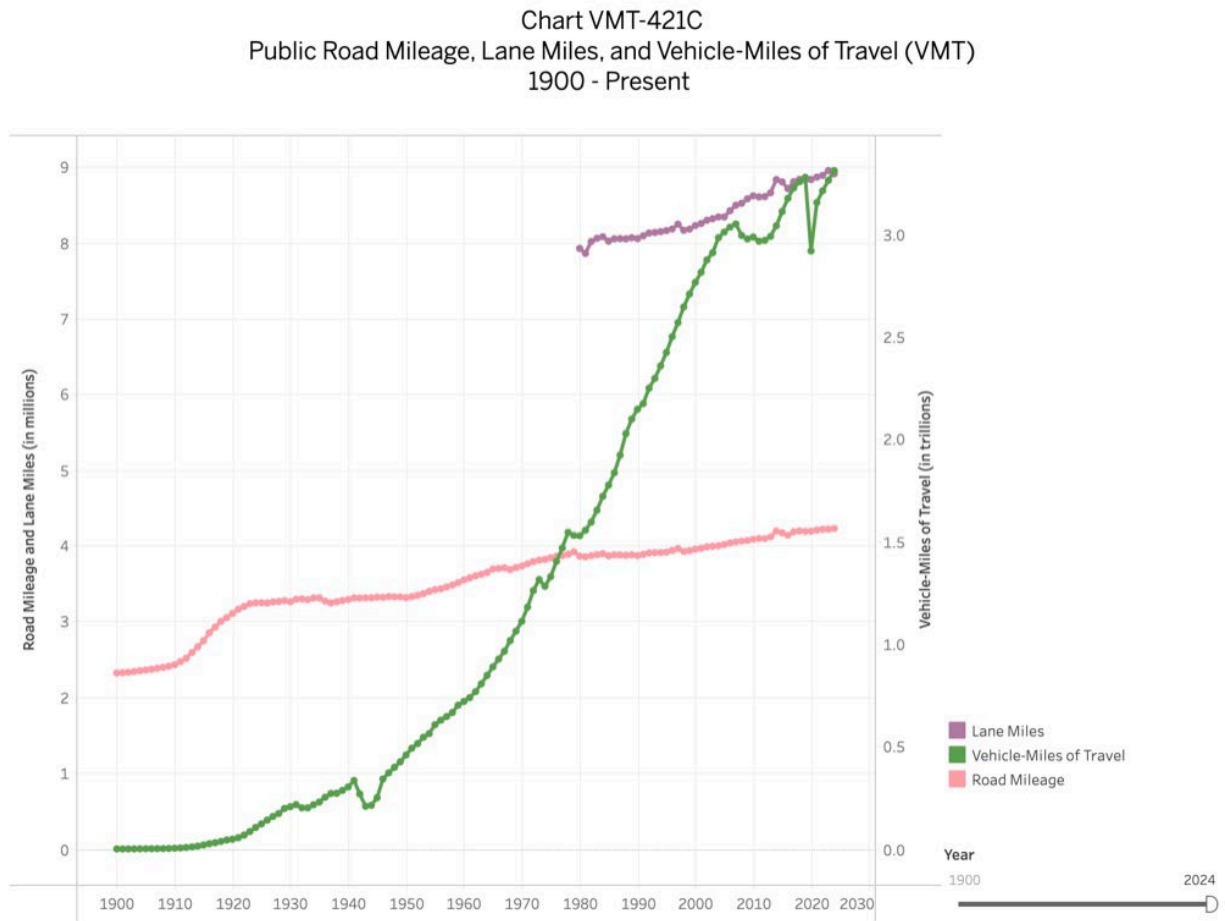


Figure 6: Public Road Mileage, Lane Miles, and Vehicle-Miles of Travel (source: FHWA [17]).

The barrier effect of a road on the environment can have far reaching impacts. Based on previous research, the 1% of total land in transportation impacts an estimated 20% of the land area due to the off-road impacts created by the road barrier [18].

In a 2008 FHWA report entitled, Wildlife-Vehicle Collision Reduction Study: Report to Congress, U.S. Department of Transportation estimates that 365 million vertebrate animals are killed on U.S. roads each year, which is roughly the amount of the entire U.S. human population [19]. According to the report, collisions with wildlife on roadways have

weakened many wildlife populations and fragmented ecosystems, making it difficult for animals to locate the resources they need to survive.

Humans are also at risk when travel and wildlife mix. While animal collisions with large trucks, rail, and waterways present relative minor risks, American drivers collide with one to two million large animals each year, “causing approximately 200 human deaths, 26,000 injuries, and at least \$8 billion in property damage and other costs.” State Farm has released new data estimating 1.7 million auto insurance claims in the U.S. from animal collisions from July 1, 2024, to June 30, 2025, a slight decline from 1.8 million the previous year. Deer-related incidents accounted for more than 1.1 million of these claims. The report also indicated that U.S. drivers faced odds of 1 in 139 of being involved in an animal collision—an improvement compared to last year’s 1 in 128 national average [20].

Based on a review of the impacts identified in IIJA, freight movement and development have the potential to negatively impact long term environmental and transportation system resiliency. Chapter 3 provides case studies for each of the four impact areas to illustrate a more encompassing approach.

3. CASE STUDIES

The four case studies presented below were identified and selected in coordination with the MAFC state technical representatives. The case studies were then developed in coordination with freight and environmental professionals from the MAASTO states. Each team is recognized in the case study. This expanded, multidisciplinary perspective on the IJJA requirements captures the full extent of freight and environmental impacts, and how to best avoid or mitigate.

Missouri River Diversion Case Study

The Severity of Impacts of Extreme Weather and Natural Disasters on Freight Mobility (due to upstream diversion of the river's water).

Case Study Team

Levi Woods, MoDOT; Chris Shulse, MoDOT; Erin Fanning, MoDNR; Caleb Whitehouse, Iowa DOT; Michael Espinoza, KSDOT; Jeremy Edgeworth, KYTC; Lucy Fletcher, Agribusiness of Brunswick, Mo; Kirsten Wallace, UMRBA.

Missouri Department of Natural Resources River Team: Erin Fanning, Chris Weiberg, Dru Buntin, Thrash Colby; Weller, Michael, Bob Bacon,

Case Study Location

The Missouri River begins in Centennial Mountains of the Bitterroot Range of the Rocky Mountains in southwestern Montana, then flows east and south for 2,341 miles before entering the Mississippi River north of St. Louis, Missouri. The river drains more than 500,000 sq mi, which includes parts of ten U.S. states and two Canadian provinces. The Missouri accounts for 45 percent of the annual flow of the Mississippi past St. Louis, and as much as 70 percent in certain droughts [21].

Management and operations on the Missouri River include 6 upstream reservoirs, and an extensive system of rock channelization on the lower Missouri to maintain the shipping channel. Rather than a lock system, the Missouri River relies on storage within the upstream dams, and flow regulation to manage flooding and navigation.

For the MAASTO states bordering the Missouri, (Iowa, Kansas, and Missouri) the river provides potable water, recreation, flood control, wildlife habitat for several critical and protected species, and a maritime freight corridor from Sioux City, IA to St. Louis, MO. This lower portion of the Missouri River provides 735 miles of navigable waterway from Sioux City to where the river joins the Mississippi River. Missouri River navigation is considered seasonal with freight operations generally occurring between April first and December first. This navigable area is the focus of this case study and any potential impacts from diversion of the river.

Impacts to Freight Movement

In 2024, the USACE Operations Report stated that approximately 200 million ton-miles of commodities, to include fertilizer, grain, and cement, are shipped on the Missouri River each year [22].

Based on BTS data, leading commodities by weight typically include grain (corn, soybeans, wheat), gravel, fertilizer, and petroleum products [23].

There are six public ports on the river in Missouri along with approximately 140 private docks between Sioux City and St. Louis [24], [25]. The public ports on the Missouri include St. Joseph Regional Port Authority, Port of Kansas City, Howard/Cooper County Port Authority, Heartland Port of Central Missouri, Greater Montgomery County Port Authority, and St. Charles County Port Authority. Ports in Iowa include Sioux City, and the northernmost port location is the New Cooperative Port of Blencoe, at Blencoe, Iowa [26].

Drinking Water

In addition to the economic importance of commerce on the Missouri River, the River provides over half of Missouri's drinking water, requiring extensive 18-to-24-hour treatment processes to remove silt, agricultural runoff (atrazine), and bacteria [27].

The MoDNR map below (Figure 7) identifies water intakes for communities that are threatened with low water during winter, droughts, or potential diversion.

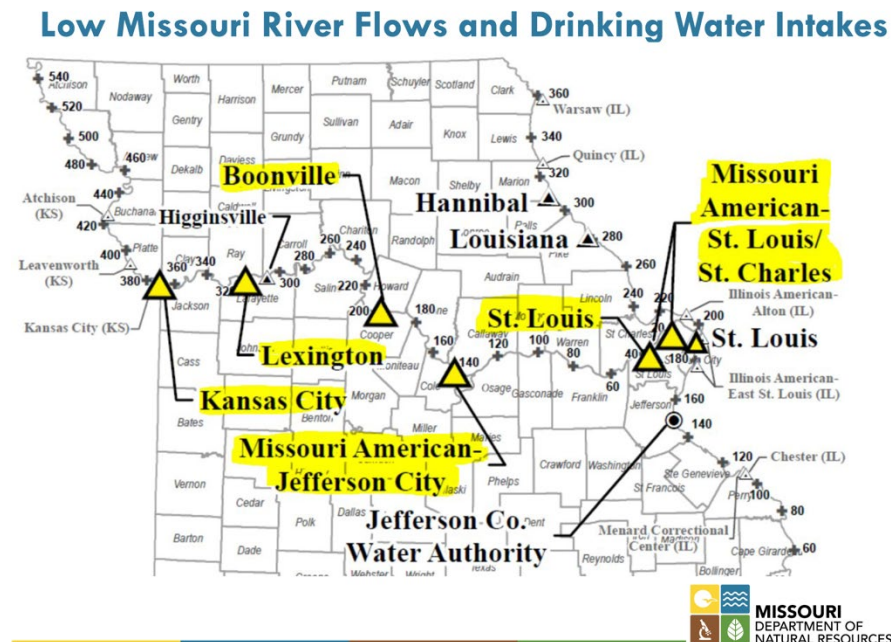


Figure 7: Low Missouri River Flows and Drinking Water Intakes (source: MoDNR [28]).

In addition, lower water levels due to diversions may also impact crop irrigation in the lower reaches which ultimately affect crop production and economic vitality of local communities.

Power Generation

While there are no hydroelectric plants in the lower portions of the Missouri, power plants do use the river for cooling and operations. When flows are reduced from the six upstream dams, power plants have had difficulty drawing water from their historic accesses. This is considered a serious threat to the reliability of Missouri's electric grid [29].

Wildlife and Habitat

Impacts of upstream water diversions on wildlife and habitat are also crucial issues. The lower Missouri provides key habitat for three federally listed animal species including the pallid sturgeon, interior least tern, and the piping plover [30].

According to the Missouri Department of Conservation Natural History site, the Missouri and Mississippi River confluence floodplain provide habitat for the federally threatened plant, the decurrent false aster [31]. Several Missouri Species of Conservation Concern such as the sturgeon chub, great plains toad, and least bittern occur in and along the river on sandbars and in marshes. Backwater channels and seasonal wetlands in the river floodplain provide habitat for many rare species of wildlife that depend on seasonal high-water flows. These critical habitats are the focus of conservation and mitigation efforts and would be potentially disrupted with decreased flows due to diversion.

Interests in Missouri River Water Diversions

According to an editorial by the Director of the Missouri DNR, Missouri and the three other downstream (Iowa, Nebraska, and Kansas) states have been in a battle with North Dakota and upstream states over water diversions for over three decades. He summarizes the current conflict as [29]:

Congress recently approved a measure that would provide \$50 million dollars to North Dakota to complete a project that will move water out of the Missouri River basin. This means federal tax dollars will divert Missouri River water away from the lower Missouri River basin to the Red River basin, which flows into Canada.

Reductions in the amount of water available downstream will harm Missouri agriculture, utilities, public water supplies, power plants, navigation, and the greater inland waterway system. Lower releases for downstream uses can also result in increased water temperature, diminished water quality and impacts to Missouri fish and wildlife.

Estimating Impacts of Diversions

Within the legislation for the diversion [32], the scope of the withdrawals is not defined. Impacts of the diversions would vary based on the extraction rates, natural and stored precipitation, evaporation rates, river conditions, as well as upstream and downstream precipitation.

Mitigation and Best Practices

- Include the potential diversion and mitigation in state resiliency plans, freight plans, and long-term transportation planning
- Increase state-to-state collaboration and activity with DOTs, natural resources, utility groups and conservation efforts
 - Create state networking to reflect the issues
- Develop a traffic and economic model to estimate impacts to interstate commerce with various levels of diversions and climate scenarios
 - This includes system impacts to flow and navigation on the Mississippi River as well
- Create diversion scenarios to model impacts to barge traffic, water availability, wildlife
- Provide greater financial support for navigation, dredging operations, and freight movement

Wildfire Case Study

The Impacts of Freight Movement on Local Air Pollution.

Case Study Team

Michael Espinoza, KSDOT; Andrew Andrusko, MnDOT; Elisha Wulf, MDOT; Jesse Gwilliams, MDOT; Jeremy Edgeworth, KYTC; Levi Woods, MoDOT.

Introduction

Freight and air quality are most often viewed as a vehicle emissions problem that is amplified due to congestion. Air quality impacts are often associated with traffic congestion, delays at facilities, warehouses and ports, and freight bottlenecks in more developed areas. Hazardous materials and gases released in rail or truck accidents and fires, or on the waterways may also negatively impact air quality in communities.

Air quality is also affected by wildfires and their impact on freight movement. When wildfires delay or position freight traffic near communities, vehicle emissions combine with the smoke from the fire increasing the potential air quality impacts. Additionally, freight movement can directly result in fires due to brake failure in rail that ignites the surrounding environment. Other fire events are driven by vehicle exhaust systems igniting grass in the right-of-way. Due to the large moving plumes of smoke, the wildfires reach, and impact is not limited to the immediate area.

This case study examines the potential air quality impacts related to freight movement and wildfires. This focus on wildfires is borne by state level experiences with an increasing number of wildfire incidents that impact freight movement.

Frequency of Wildfires

While wildfire smoke is the primary driver of decreased air quality, idling freight vehicles, slowed travel speeds, and potential concentration of vehicles near communities due to travel restrictions are likely to bring additional air quality issues. The frequency of wildfires across the MAASTO states is uneven but with profound devastation in some cases. According to historical data provided by [the National Interagency Fire Center \(NIFC\)](#), for the years 2002–2014 [33]:

.. an average of 10,949 wildland fires occur in the Midwest, and an average of 214,843 acres are burned every year. Minnesota is the state most frequented by wildland fires in terms of total fires, average total fires per year, total acres burned, and average total acres burned. It is followed by Kentucky (2nd most active) and Wisconsin (3rd most active) for the total number of fires from during those years and the average total wildland fires per year. For total fires and average total fires per year, Illinois is the least active state for wildland fires annually. However, when reviewing the total acres burned per year, Indiana has experienced the least amount of burned acres for the time frame of 2002 - 2014.

Kansas is not included in the Midwest category as defined by the NIFC, but is a member of MAFC. Based on the KSU Agronomy Updates, the fires from 2004 to 2014 are graphed below. 2014 was the most active year for Kansas in the 10-year time frame with over 8,075 fires [34].

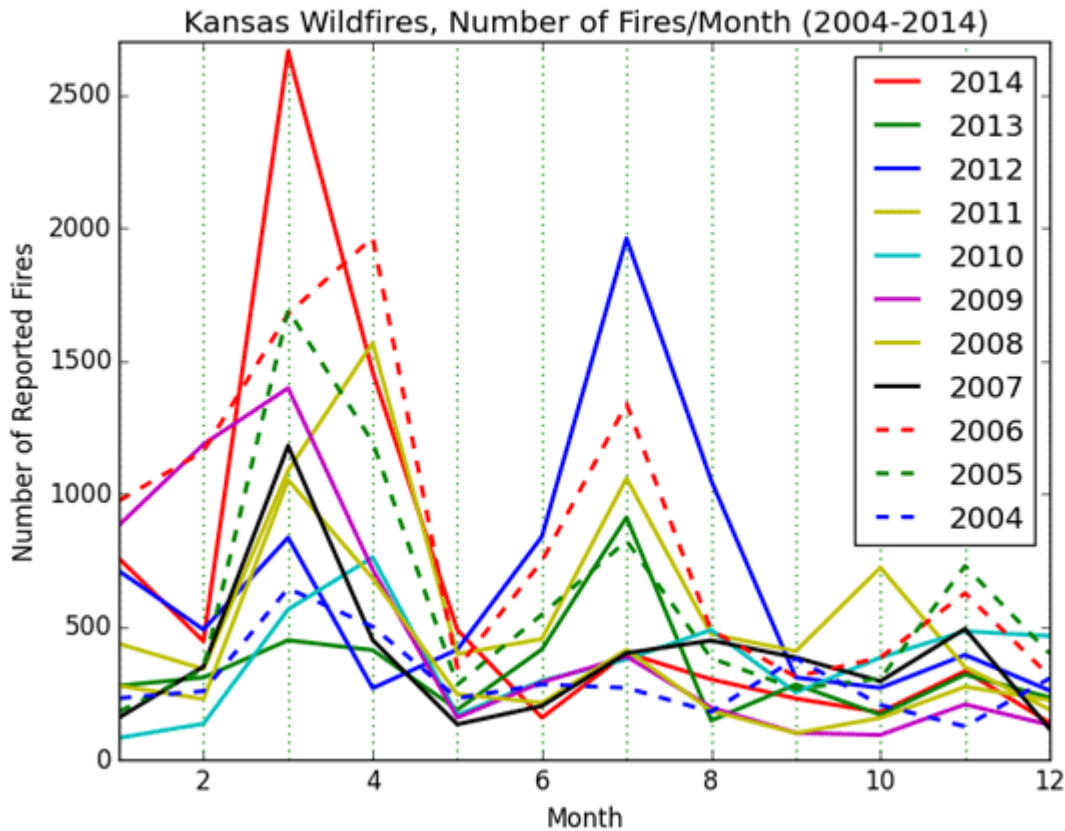


Figure 8: Kansas Wildfires by Month, 2004-2014 (source: Kansas State University [34]).

More recent data from the National Interagency Coordination Center for Wildland Fires reports in 2024, there were 64,897 wildfires that burned 8,924,884 acres across the U.S. [35].

And based on an Insurance Information Institute report, in 2024 the number wildfires and acres burned in MAASTO states for 2024 are reported as: Illinois – 47, 441 acres; Indiana – 64, 154 acres; Iowa – 362, 3,965 acres; Kansas – 41, 22,217 acres; Kentucky – 957, 24,228 acres; Michigan – 447, 2,062 acres; Minnesota – 1,123, 15,125 acres; Missouri – 2,804, 95,095 acres; Ohio – 1,107, 2,441 acres; Wisconsin - 1,162, 2,597 acres. For comparison, in California there were over 8,000 wildfires in 2024 that burned over 1 million acres [36].

The Insurance Information Institute reported that for the states included in MAASTO, the fewest acres burned in 2024 were in Indiana with 154 acres, and the most acres burned were in Missouri with over 95,000 acres.

Freight Related Wildfires

In a recent article in AGATE, Railroads and Fire, the authors cite a 2022 national study that indicates 3% of all wildfires are the results of rail operations [37].

Similarly, Minnesota DNR reports a close working relationship with railroads reporting approximately 3% of all fires related to rail operations [38].

Wildfires are also caused by truck crashes, parking over dry grass, mechanical failures, or sparks from chains dragging. Based on a 2010 – 2016 FEMA report on highway vehicle fires, 8.8% of all road vehicle fires were due to a freight road transport vehicle [39]. Eighty-three percent of the road vehicle fires were related to passenger vehicles.

Considering hazardous materials, gases and liquids, all modes are susceptible to accidental releases due to crashes, equipment failure, or operations error. Air quality impacts are due to release of a gas or chemicals may be related to a crash with a fire.

The most frequent location of releases are terminals. According to the Pipeline and Hazardous Materials Safety Administration, there are approximately 15,000 to 20,000 hazardous materials (hazmat) transportation incidents a year [40]. The document reports that highway releases are more frequent than rail. In 2017, there were 3,391 in-transit spills on trucks, compared to 431 on trains.

Wildfires tend to concentrate in large woodland and grassland areas such as national, state, local forests, and prairies. That may limit the impacts of the fire and logistics disruptions to smaller, rural communities. However, in rural area wildfires can go unnoticed and progress to unmanageable levels without immediate suppression.

Further, smoke plumes can move great distances and affect a large geography. From 2023-2025, Canadian wildfires forced over 27,000 people from their homes, air quality was declared unhealthy by health officials, and school and businesses closed in Minnesota, Iowa, Wisconsin, and Michigan. The plume gradually reached Europe [41].

Impacts related to Freight Movement

Multimodal freight movement and wildfires present two venues to impact air quality in communities. Direct impacts to air quality include equipment failure and freight operations that result in wildfires, excessive smoke, and potential hazardous materials and gas releases that impact local communities. Indirect impacts reflect the impact to air quality due to delays or rerouting multimodal freight due to a wildfire.

The impacts of large wildfires to air quality are rivaled by the economic impacts to the logistics sector. The closure I-5 in California in 2020 resulted in an estimated \$1.2 billion in supply chain damages [42].

This same report documented an industry survey on wildfires where companies reported an average increase of 15% in operational costs during wildfires. Other impacts to freight included property damage due to smoke, ash, or weather, insurance costs, and supply chain breakdowns.

Freight also plays a role in recovery from wildfires. The MAASTO states have created a regional emergency divisible load management (EDLM) plan that allows for load exemptions such as increased weights during declared national emergencies for vehicles moving supplies related to the emergency. And with the recent fires scorching across Oklahoma and Kansas, Kansas Governor Kelly issued an emergency declaration lifting some dimension restrictions and permit fees for trucks services the area [43].

In summary, the wildfires and freight case study offer a unique opportunity to see how freight and wildfires interact to impact to air quality. Four impact dimensions can be seen in this case study: wildfires caused by operation of freight vehicles; fires due to crashes of freight vehicles; vehicle emissions impact due to travel limitations of a wildfire; and the potential for release of hazardous materials during a crash and fire. A fifth dimension to the emergency nature of wildfires is the MAASTO EDLM and the ability of freight system to provide emergency services and goods during these events.

Mitigation

Addressing the impact of freight and wildfires on air quality offers a multidimensional freight planning environment. The following best practices were identified during the research process.

- Freight plans should include a multimodal census of wildfires due to freight operations and crashes
- Evaluate all multimodal plans for inclusion of wildfire due to freight
- Include the 4 IIJA freight items in the agency's resiliency plan
- Link resiliency plan with environmental and freight plan
- Consider agency - industry agreements to foster a "no wildfire" policy
- Work with industry to better manage fire potential due to vehicles
 - For example, failed rail brakes and wheels that can ignite fires, or for trucks parking near prairies and right of ways
- Implement technologies to identify and remove dangerous equipment from freight vehicles
 - Current examples include heat detection on rail systems and with truck brakes and wheels
- Consider fines for wildfires due to freight operations and crashes
 - Minnesota has a per acre fine for wildfires
- Anticipate wildfires and use weather and fire condition forecast to plan
- Support a multimodal system to diversify risk load
- Collaboration and data sharing with private sector freight movers
- Develop transportation and wildfire economic model to track the cost and disruption of wildfires

Markland Pool Case Study

Impacts of Freight Movement on Flooding and Stormwater Runoff.

Case Study Team

Jeremy Edgeworth, KYTC; Randy Lane, ODOT; Leslie Morgan, Robyn Bancroft (OKI), Bill Kinzeler (CORBA), Eric Thomas (CORBA).

Case study location

On the Ohio River, the Markland pool is 95.3 miles long, extending from Captain Anthony Meldahl Locks and Dam (ORM 436.2) to Markland Locks and Dam (ORM 531.5). Based on a 2014 Markland assessment by the Ohio River Sanitation Commission, the pool has a gradient drop of 0.4 feet per mile, averages 1,594 feet wide and 31 feet deep and is bordered by the states of Kentucky, Ohio, and Indiana. Cincinnati is the major urban and industrial hub within the pool. The Markland pool is heavily influenced by land use and industry in and around Cincinnati.

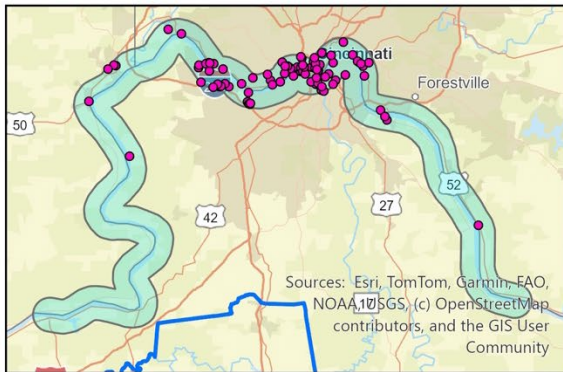
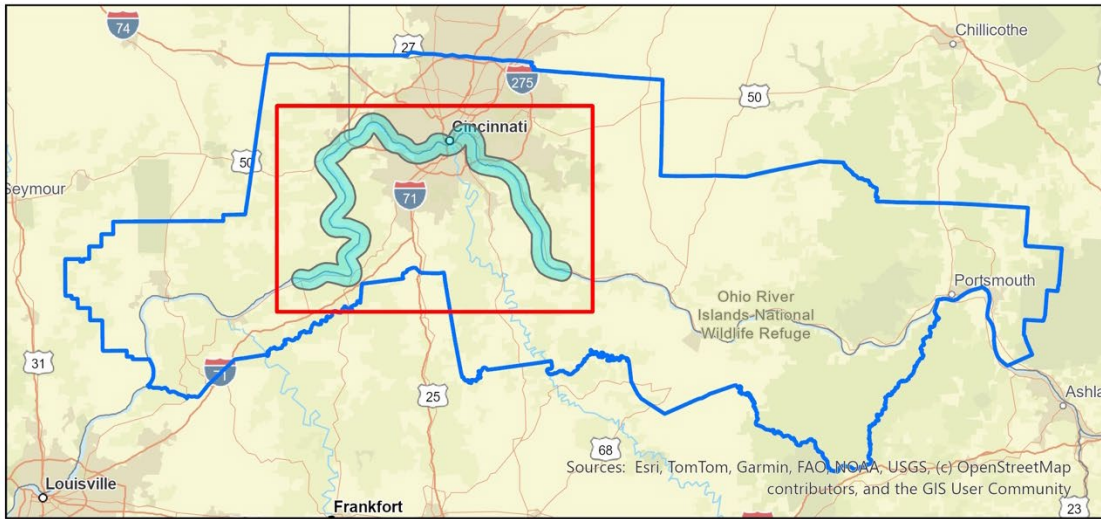
The Markland Pool falls within the Central Ohio River Business Association (CORBA) [44]. CORBA is a trade association representing local businesses conducting commerce primarily along the Ohio River in the tri-state region including Ohio, Kentucky, and Indiana with the USACE's Port Statistical Area (PSA) - Ports of Cincinnati and Northern Kentucky.

The Markland Assessment Summary reports that the Pool receives water from three major tributaries. The Little and Great Miami rivers drain 1,750 and 5,400 square miles, respectively. The Licking River drains 3,670 square miles and empties into the Ohio River downstream of the Little Miami River. Four smaller tributaries in the lower half of the pool also provide water, draining approximately 800 square miles collectively. In 2016, the Pool's watershed was primarily forested (54.7%) but also harbored a considerable amount of row crops (14.0%) and pasture lands (13.2%). Additionally, several industries are located adjacent to the pool [45].

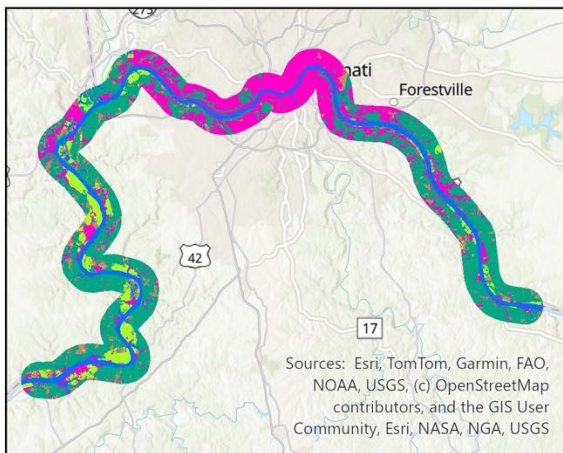
Figure 9 below details the CORBA section of the Ohio along with the Markland Pool case study area, the location of relevant businesses within the Markland Pool, and land use classifications for the area. Figure 10 expands the land use classification map to focus on the watershed and the Markland Pool.

As shown in the second map, close to 100 transportation related businesses are located adjacent to the Pool.

Markland Pool

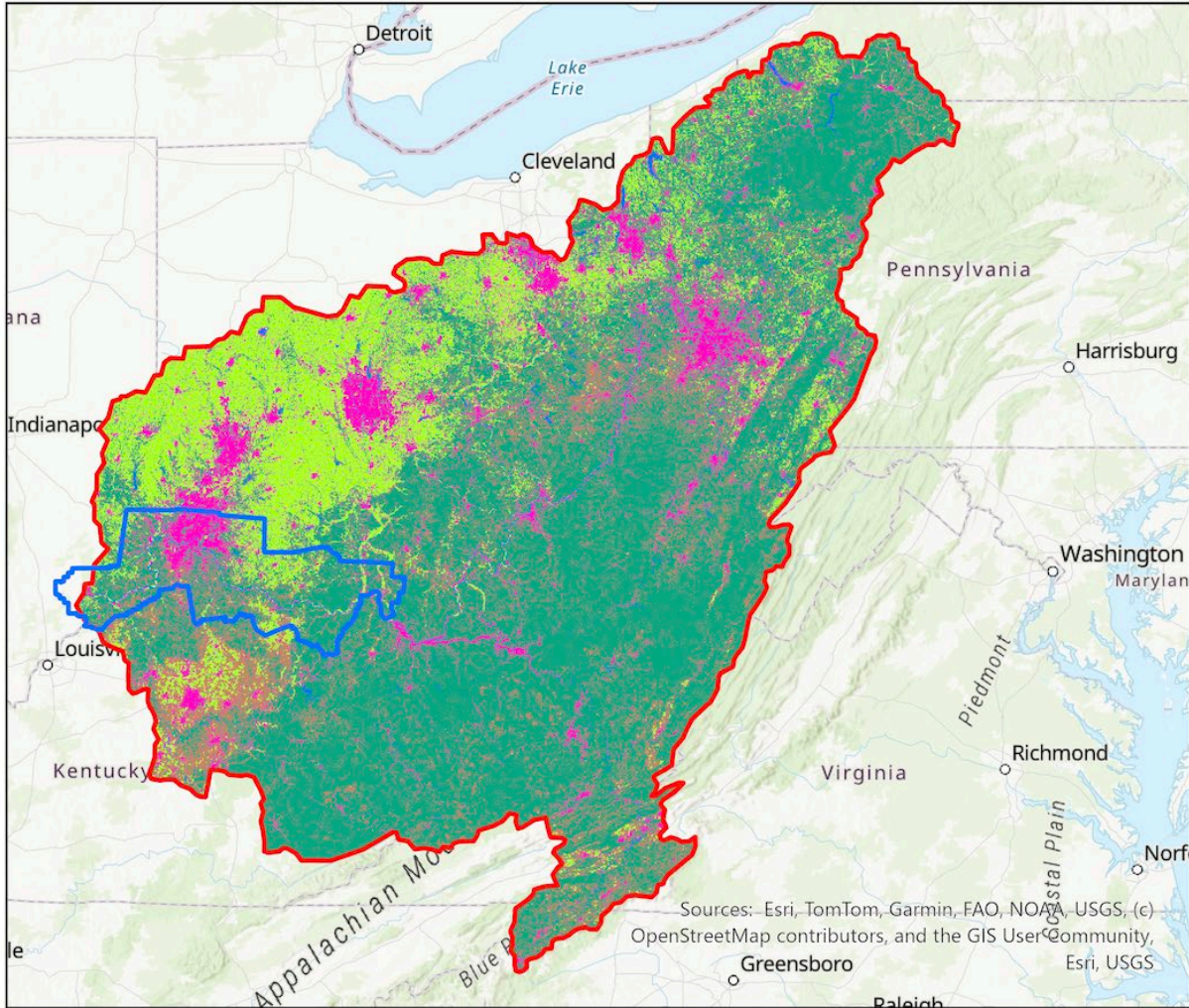


- Relevant Businesses
- ▭ Corba Extent
- ▭ Markland Pool



- Land Classification
- ▭ Water 1.06%
 - ▭ Trees 63.00%
 - ▭ Flooded Vegetation 0.01%
 - ▭ Crops 16.01%
 - ▭ Built Area 9.67%
 - ▭ Rangeland 10.22%

Figure 9: Map of Markland Pool Section of the Ohio River including CORBA Extent, Businesses, and Land Classification (source: MAFC).



Central Ohio River Business Association Watershed and Land Use

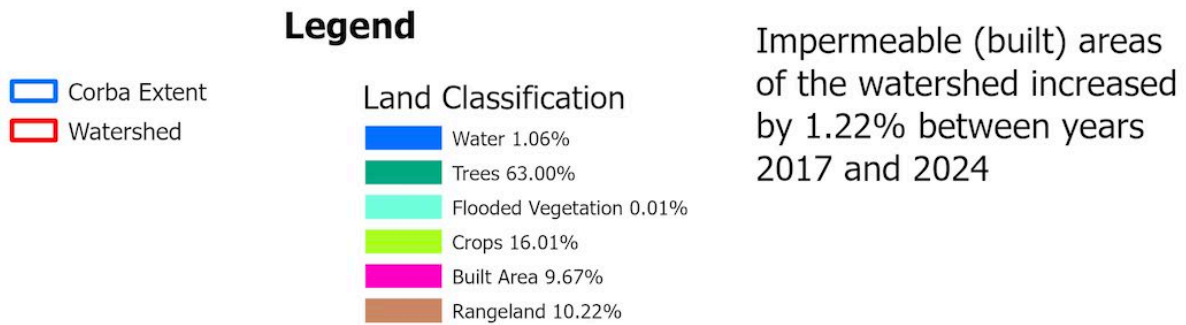


Figure 10: Central Ohio River Business Association Watershed and Land Use (source: MAFC).

When flooding occurs, the river, rail and road resources may become unavailable.

The case study team emphasized that the impacts of freight movement on flooding and stormwater runoff are particularly interesting because construction activity (roads, commercial and home building, runways, and infrastructure) creates an impermeable surface which prevents water absorption. Rail, marine, trucking and rail all require large, paved surfaces to manage loading, sorting, and reloading. This can be seen in the maps above with the large concentration of built area in pink in the Cincinnati area. While nearly 10% of the corridor is considered built, or impermeable, the majority of this is concentrated in the Cincinnati area.

Economic Case – Markland Pool

Between 2019 and 2023, over 187 million tons of goods worth about \$50 billion passed through the Markland Locks and Dam. The main shipments by percent of total tonnage were coal (26%), aggregates (23%), and petroleum (16%), along with millions of tons of chemicals, grains, steel, minerals, and machinery. Commerce on the Ohio is critical to the regions industry and businesses.

The Markland Pool is part of the larger Ports of Cincinnati and Northern Kentucky statistical area (Ports). Between its redesignation in 2016 and 2022 when the USACE reclassified the Ports as a port statistical area, the Ports has ranked as the #1 or #2 top inland port in the country based on annual tonnage [46].

Barge traffic levels and impacts due to flooding.

According to the USACE, on average, 12-15 vessels typically go through the lock on a given day and a full one-week closure of the dam translates to approximately \$5 million in lost transportation savings. "When you have to shut down the river, you're shutting down a tremendous amount of commerce moving at any one time," explained Eric Thomas, General Manager of Benchmark River & Rail Terminals, and head of the Central Ohio River Business Trade Association [47].

The U.S. Army Corps of Engineers (USACE) has not released a singular "cost" figure for flooding at the Markland Locks and Dam, but rather highlights the massive economic value of the flood risk and infrastructure. During early 2025 flooding, USACE Louisville District reservoirs and lock facilities (including Markland) were part of a system that helped prevent over \$3.9 billion in flood damages [47].

Frequency of Flooding

Flood stage in the Markland Pool is considered 52 feet. Table 4 below shows the average annual river stage extreme by date and feet. The river had an average extreme greater than 52 feet 15 times from 2010 to 2023. The highest average was over 60 feet in 2018.

Year	Month	Day	High	Year	Month	Day	Low
2010	MAR	16	50.96	2010	AUG	6	26.0
2011	MAR	13	55.90	2011	JUL	11	26.2
2011	APR	26	55.33	2011	JUL	17	26.16
2012	MAR	05	46.7	2012	OCT	30	26.0
2013	FEB	03	48.4	2013	OCT	17	26.1
2014	MAR	08	53.0	2014	OCT	09	26.18
2015	MAR	15	57.7	2015		-	
2015	MAR	08	53.0	2015	SEP	02	26.1
2016	JAN	01	44.4	2016	AUG	14	25.8
2017	MAR	04	46.9	2017	SEP	03	25.8
2018	FEB	21	55.4	2018		-	
2018	FEB	25	60.5	2018		-	
2018	APR	07	52.3	2018	AUG	10	26.1
2019	FEB	13	55.5	2019	JUN / JUL / AUG		26.3
2019	FEB	26	53.4	2019			
2020	FEB	15	54.4	2020	JUL	8	26.1
2021	MAR	4	56.9	2021	JUN	29	26.1
2022	FEB	28	51.1	2022	SEP / OCT		26.1
2023	FEB	19	45.3	2023		-	

Table 4: Average Annual River State Extremes (Highs and Lows), Cincinnati, Ohio River, 2010 – 2023 [Flood State 52 Feet] (source: NOAA [48]).

Table 5 below shows the historic number of flood crests above flood stage by month for 5 time periods. The Markland Dam was installed in June of 1964 and the increased flood control likely contributes to the decreased number of crests above flood stage after 2000. Overall, from 1858 through May 2023, there have been 112 river crests above flood stage.

Number of crests above flood stage -- 52 feet													
Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1858-1899	4	10	6	2	0	0	0	1	0	0	0	0	23
1900-1950	10	7	13	9	1	0	0	0	0	0	0	2	42
1951-2000	6	4	14	1	3	0	0	0	0	0	0	4	32
2001-2023	2	6	5	2	0	0	0	0	0	0	0	0	15
1858-2023*	22	27	38	14	4	0	0	1	0	0	0	6	112*

Table 5: Ohio River History at Cincinnati - Number of Crests Above Flood Stage (52 Feet) by Month and Period (source: NOAA [48]).

The severity and frequency of flooding is well documented. According to First Street, a company that models climate risk, Cincinnati, is an area of concern [49]. There are 23,080 properties in Cincinnati at risk of flooding over the next 30 years. This represents 19.9% of all properties in Cincinnati according to First Street.

Impact to Road and Rail Access

Downtown Cincinnati is a major crossroads for I-71 and I-75. The area also harbors other critical routes including I-275, I-471, U.S. Route 50, and the Brent Spence Bridge. Based on the First Street report, roads are considered in major risk of flooding and infrastructure is in severe risk of flooding. Figure 11. ranks the risk of flooding by land use.

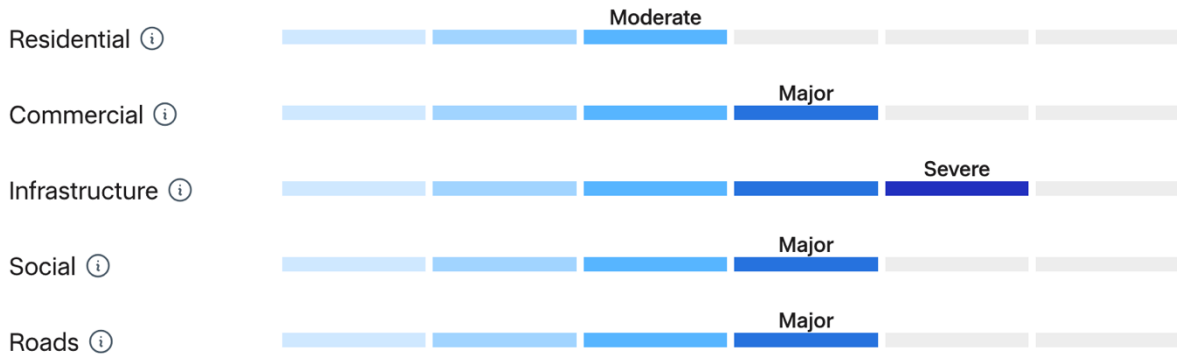


Figure 11: Cincinnati Flooding Risk (source: First Street [49]).

The OKI Freight Plan reports that in 2017, rail moved over 7.5 million tons of freight valued at almost \$6.9 billion in the OKI region [50]. CSX and Norfolk Southern (NS) are the two Class 1 Railroads that operate in Cincinnati and the surrounding area. Sixty-four percent of all the rail miles in the region are operated by these two railroads.

Rail faces similar flood threat as roadways with closures, damages, and delays.

Other freight impacts include:

- reduced speeds equal increased delivery times (river, rail, and roadway)
- additional staff, spotter vessels needed to accompany vessels
- smaller barge tows
- inability to traverse roadway and railroad bridges overpassing the river
- debris (floating, sunken) High water and hazardous navigation conditions [51]

Stakeholders

Stakeholders include industries, manufacturing, regional planning groups, city officials, levee districts, sewer districts, state DNR, USACE, Coast Guard, CORBA.

Stakeholder comments

- Freight should be a significant consideration for DOT, including ROW and environmental issues
- Developed land requires mitigation for runoff
- Management of floodplains of the river's draining to the area are critical

Summary and Findings

- The state freight plan and LRTP should include consultation with local communities to minimize impermeable surfaces, provide mitigation, and provide funding to reengineer water management in urban areas for all large-scale projects
- Create internal team of flood experts including engineering, natural resources, legal, and planning personnel
- Track and model flooding impacts and costs on all modes servicing the area.
- Conduct economic analysis of flood impacts to freight transportation, logistics, and local and regional economic viability
- Develop benefit/cost analysis of potential mitigation and damages
- Emphasize green development, water management, and mitigation in planning and funding
- Create Flood Control Procedures for key public port assets: for example, Cincinnati Municipal Lunken Airport Flood Control Procedures [52]
- DOTs should develop basic flooding safety tips/approach graphic for inclusion in their freight plans
 - See City of Cincinnati for example for property owners [53].
- Conduct business survey in flood area examining flood frequency, preparations, consequences, and mitigation
- Conduct land use review for major urban areas to assess storm and floodwater management and potential for beneficial use in the watershed. Work with local districts to develop appropriate mitigation
- Develop DOT and state resiliency plans that includes assessment of built lands
- Identify advanced measures that could reduce the impacts of stormwater and flooding through storage, management, and reuse

Freight Impact on Prairies and Endangered Species

The Impacts of Freight Movement on Wildlife Habitat Loss Case Study

Case Study Team

Janelle Veile, Illinois DOT; Adam Gabany, Illinois DOT; Brenda Anderson, Illinois DOT.

Background

This case study draws from a completed cargo expansion project that eliminated most of a high-quality prairie as well as habitat for the endangered Rusty Patch Bumble Bee. The post-project analysis of the Midfield Cargo Expansion Project provides a historic review of the \$50 million dollar freight cargo expansion at Chicago Rockford International (RFD) that threatened a 25-acre historic prairie. The Bell Bowl Prairie also provided habitat for the endangered Rusty Patch Bumblebee. This prime habitat and unique resource were reduced to just less than 5 acres of prairie after the construction. The original environmental work was cleared in 2019, however fervent opposition to the project stalled the project in 2021 to reassess the environmental consequences of the road and cargo facility development [54].

According to the project's environmental assessment, the project involved construction of a new air cargo development on the south side of the airport. New buildings, aircraft parking, aprons, taxiways, and employee parking were constructed. All work remained on airport property. The improvement did not require land acquisition, in-stream work, or tree removal. Land cover in the vicinity of the proposed improvement was primarily agricultural land with a large active commercial airfield to the north [55].

Critical Habitat and Endangered Species

In the advocacy magazine, Wild Ones, the Bell Bowl Prairie is identified as a Category I site in the Illinois Natural Areas Inventory (INAI), one of the highest-quality natural areas in the state [56]. The prairie is home to numerous plant communities and has existed mostly undisturbed for 8000 years. The federally endangered rusty patched bumblebee was observed on the property in 2021. While this seemed like potential leverage to slow or stop the projects, the U.S. Fish and Wildlife Service ruled that there was sufficient habitat elsewhere. And the project moved forward.

The article continues that:

...conservation groups, ecologists, and Illinois residents immediately pushed back, arguing that the prairie was irreplaceable and that alternative designs could spare it. Thousands signed petitions, attended public meetings, and wrote to officials. The Natural Land Institute (NLI), which had managed Bell Bowl, filed a motion to halt construction, but it was denied. By the end of 2022, Bell Bowl Prairie was converted to a construction zone.

Mitigation was provided through the removal of a planned detention basin. This allowed for less than 5 acres of rare gravel prairie to remain. Further, life cycle analysis of the

Rusty Patch bumble bee was used to avoid construction when the bees might be present and using the site.

Stakeholders

Relevant stakeholders include RFD Airport, USDOT, IDOT, FAA, FWS, public, conservation organizations, Amazon.

Best practices

- Increase public participation to reflect concern of local community and conservationists
- Increase inter-agency collaboration to understand missions of other agencies.
- Encourage conservation easements on Category 1 INAI sites to increase protection
- Create multi-attribute economic model to estimate the value of natural resources
- Assess exposure threat to species of concern based on construction activity and avoid periods when endangered species are present or dependent on the habitat

4. CONCLUDING REMARKS

IIJA's addition of environmental and resiliency impacts to the state freight plans reflects two trends. First, there have been significant efforts to better connect planning activities and awareness of the environmental context of the project area. In 2009, FHWA's Planning and Environment Linkages Program: A Guide to Measuring Progress in Linking Transportation Planning and Environmental Analysis [57], provided an extensive review and promotion of integrating environmental responsibilities earlier in the planning process. The ability to identify environmental impacts early in the development process allows for avoidance, early identification of stakeholders, and potential mitigation processes. For IIJA, the legislation directs states to develop strategies and goals to eliminate or minimize impacts in the following areas.

- The severity of impacts of extreme weather and natural disasters on freight mobility
- The impacts of freight movement on local air pollution
- The impacts of freight movement on flooding and stormwater runoff
- The impacts of freight movement on wildlife habitat loss

While the legislation does not require implementation of the strategies and goals to eliminate or minimize impacts, incorporating the directives in freight plans preloads the issues for attention as the project moves towards construction.

Second, resiliency of the transportation system and freight movement have become of increasing concern due to the frequency of major disruption events. As shown in Figure 2, the U.S. had three, billion-dollar disruption events in 1980. This escalated to twenty-eight, billion-dollar events in 2024. Many of these events destroyed rail, highway, and waterway infrastructure. Communities and cropland as well also experienced major losses.

This report provides a brief history of the IIJA environmental categories and then uses four case study to demonstrate the connectivity between multimodal freight activity and each of the environmental areas.

A range of impact scenarios and best practices for each of the case studies were identified. Best practices that were cited by team members and the literature ranged from region-wide hydrological modeling to creative and inclusive local freight and environmental planning. From the identified range of best practices, the most cited practices can be summarized as falling under one or more of these descriptive categories.

- Efforts should be multimodal and private sector freight movers should be included in the work to address impermeable surfaces, wildlife, and air quality
- Develop early planning linkages across internal divisions and conduct early interagency coordination
- Build linkages between freight plans, rail plans, long range plans, and resiliency plans

- Conduct impact modeling for different modes that includes economic, resource, hydrologic, air quality, and impact to travel, for each of the modes
- Evaluate the need for increased early detection of events such flooding or wildfires in remote areas
- Increase coordination with local entities and private sector to address impermeable surfaces, wildfire planning, and habitat

In addition, several areas were identified for additional research and collaboration.

- Tracking state freight plans and mitigation through construction would be beneficial to validate earlier planning efforts
- In coordination with private sector, review implementation of detection equipment for rail, highways, and the waterways
- In coordination with private sector, prioritize locations for implementation of early detection and warning devices
- Consider developing performance measures for each of the impact areas and strategies

The addition of environmental considerations in freight planning follows the same pattern seen in general transportation planning. As disruptions to freight movement and transportation increase, these planning approaches can be expected to provide valuable solutions to environmental and resiliency issues.

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