Attachment 4A

AKRON METROPOLITAN AREA TRANSPORTATION STUDY

M E M O R A N D U M

TO: **Policy Committee**
Technical Advisory Committee
Citizens Involvement Committee

FROM: **AMATS Staff**

RE: **AMATS Climate Resiliency Report**

DATE: **July 22, 2022**

The purpose of the Climate Resiliency Report is to assess the vulnerability of the area's transportation infrastructure to extreme weather and climate impacts. The outline of this report follows the direction of the Federal Highway Administration's (FHWA) Vulnerability Assessment and Adaptation Framework.

This report integrates climate adaptation considerations into the transportation planning and decision-making process. The report examines historical weather patterns in the region, focusing on precipitation and average daily temperature. It includes a vulnerability assessment focusing on road and bicycle infrastructure in floodplains and identifies infrastructure of regional importance most at risk during extreme weather events. Finally, the report identifies steps AMATS should consider to integrate resiliency planning into the transportation planning process.

Recommendations of the Climate Resiliency Report include developing a goal statement regarding resiliency planning as part of AMATS Long Range Transportation Plan goals and objectives, incorporating resiliency planning into the Funding Policy Guidelines for project selection, and promoting new road and transit design approaches and standards to minimize potential disruption due to extreme weather events.

This report was presented in draft form in May 2022. Since then, staff have incorporated comments from committee members and the report is now presented as a final draft. The AMATS staff recommends approval of the AMATS Climate Resiliency Report.

AMATS CLIMATE RESILIENCY ASSESSMENT

August 2022

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This report was prepared by the Akron Metropolitan Area Transportation Study (AMATS) in cooperation with the U.S. Department of Transportation, the Ohio Department of Transportation, and the Village, City and County governments of Portage and Summit Counties and Chippewa and Milton Township in Wayne County. The contents of this report reflect the views of AMATS, which is responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official view and policies of the Ohio and/or U.S. Department of Transportation. This report does not constitute a standard, specification or regulation.

Table of Contents

Executive Summary

The Akron Metropolitan Area Transportation Study (AMATS) is responsible for regional transportation planning in the greater Akron area. The agency collaborates closely with local governments and monitors changes in the area over time. As the metropolitan planning organization (MPO) for the greater Akron area, AMATS must consider the impacts of climate on transportation infrastructure. Increases in precipitation and extreme weather events can have devastating effects on the region's roads and bridges. Critical infrastructure damage can lead to economic disruptions, delayed emergency response times and costly emergency repairs.

In terms of climate data, days over 1- and 2-inch precipitation were chosen to illustrate the rising risk of flooding. These indicators will provide vital context for the vulnerability assessment of infrastructure in the area. For example, any infrastructures in floodplains, as well as 100-year floodplains, will be ranked as the highest risk. This risk characterization will prioritize which infrastructures are most vulnerable to increases in flooding. Also, a critical assessment will identify the infrastructure that is the most critical to moving people and goods in the region. A matrix of vulnerability and criticality will produce a master list of infrastructures that will guide any decisions regarding resiliency planning.

This report will integrate climate adaptation considerations into transportation decision making process. Research and best practices from around the country illustrate that storm water management upgrades such as green infrastructure and other improvements can lower the risk of costly damages from flooding. Examples from other areas and suggestions for the AMATS area are discussed in this report.

AMATS recommends multiple strategies to incorporate resiliency planning into the transportation planning process. Recommendations include incorporating a resiliency goal into the AMATS 2050 Long Range Transportation Plan, prioritizing projects that are at high risk from extreme weather events and supporting roadway design changes to ensure transportation infrastructure is capable of withstanding extreme weather events.

The outline of this report follows the direction of the Federal Highway Administration's (FHWA) Vulnerability Assessment and Adaptation Framework (the Framework), third edition. It is a manual to help transportation agencies and their partners assess the vulnerability of transportation infrastructure and systems to extreme weather and climate effects. The analysis in this report aligns with certain elements of the Ohio Department of Transportation (ODOT) Infrastructure Resiliency Plan. While that report is more detailed and focused state-wide, this report shares a similar vulnerability assessment for the transportation infrastructure in the Greater Akron area.

Introduction

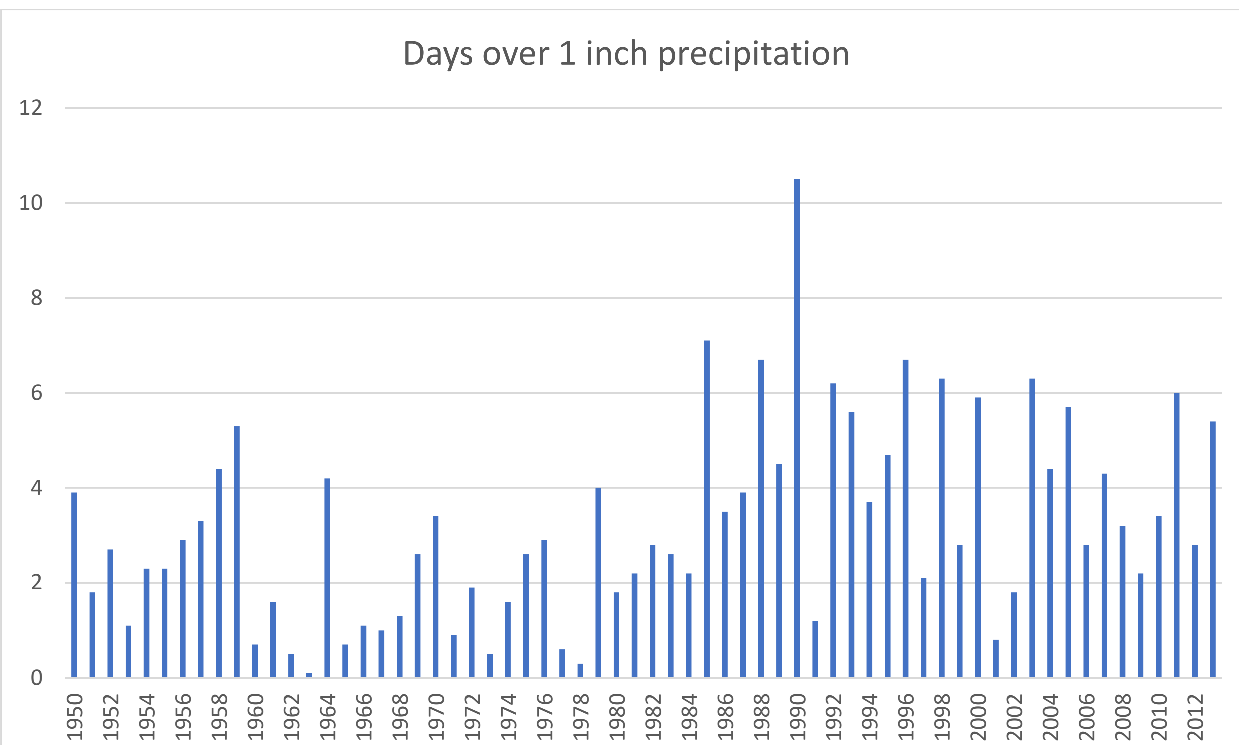
The purpose of a Climate Vulnerability Assessment is to determine what impacts can be expected on the region's transportation infrastructure due to extreme weather.

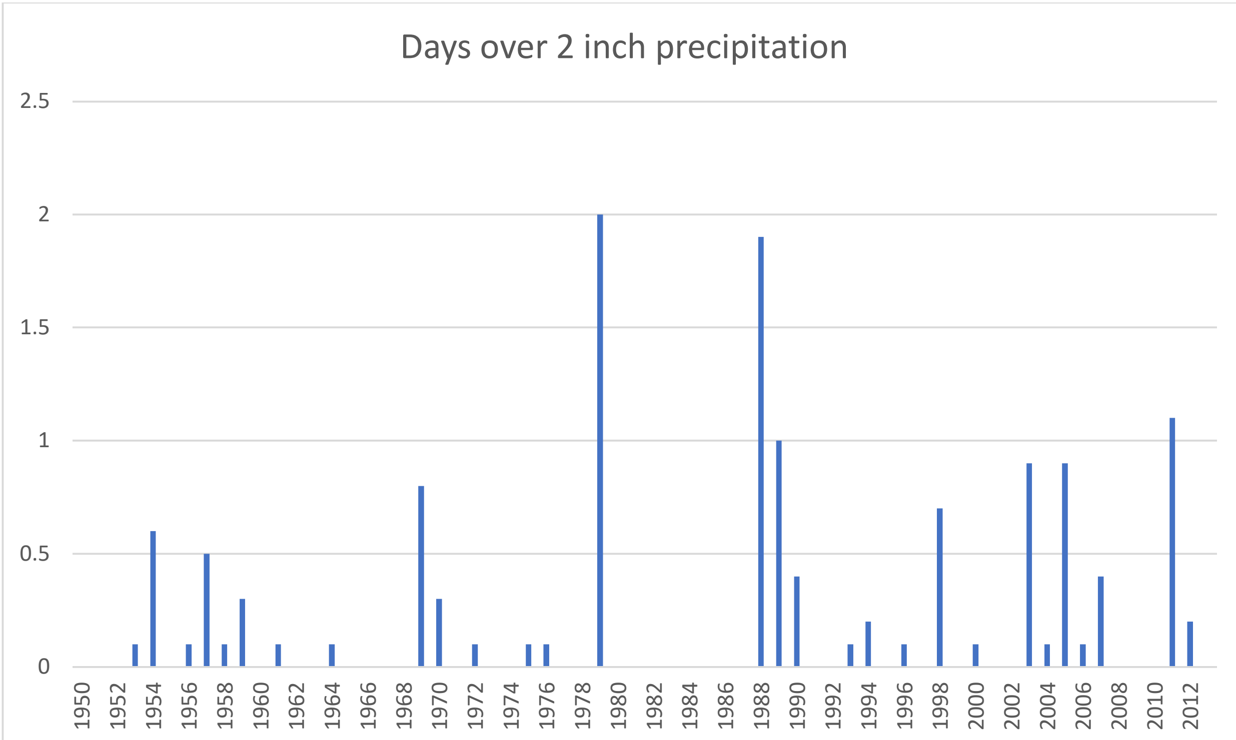
In order to determine what impacts might be expected it is important first to understand what types of extreme weather need to be accounted for. AMATS began by analyzing historic weather data related to precipitation and temperature. Because the primary extreme weather threat in the region is precipitation that results in flooding, the majority of the AMATS Climate Vulnerability Report focuses on transportation infrastructure in areas adjacent to the region's floodplains.

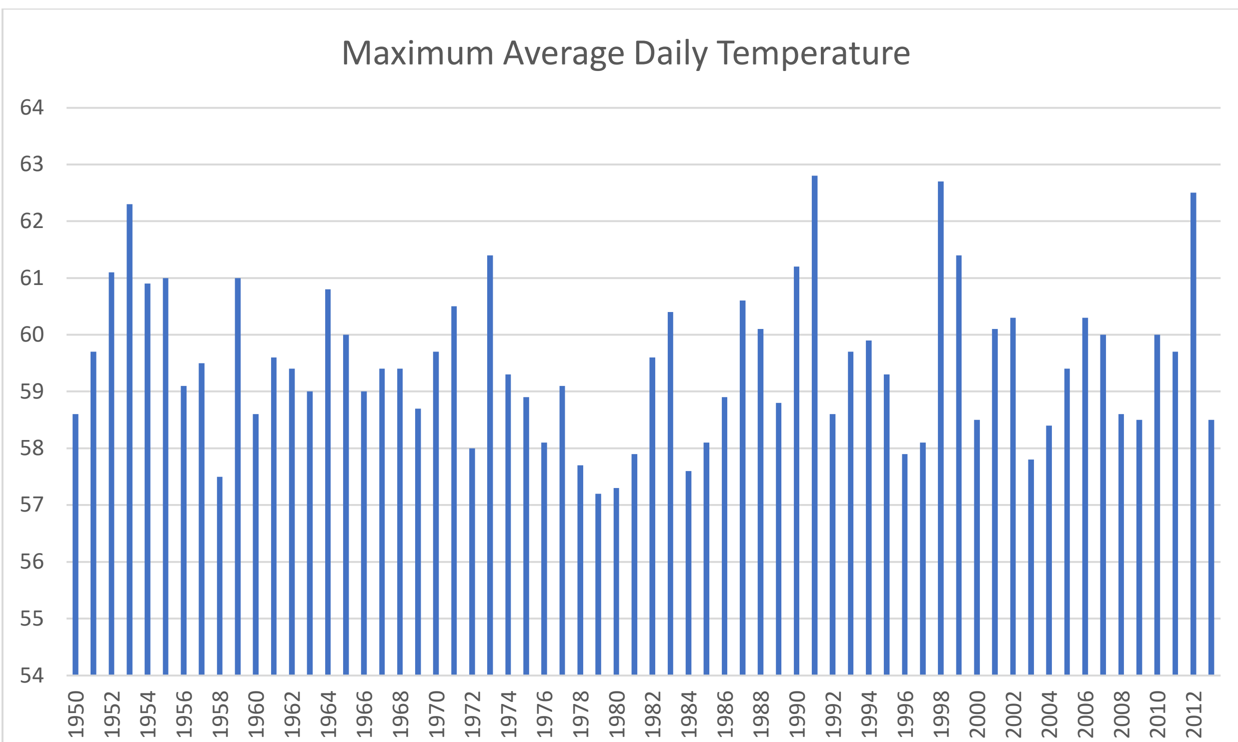
The Climate Vulnerability Assessment will identify critical roadway infrastructure that is threatened by extreme weather and conclude with recommendations for integrating climate resiliency into the transportation planning process.

Section 1: Climate Data in the Greater Akron Region

Recent data from the "The Climate Explorer", a federal-level interdepartmental toolkit, is displayed below for greater Akron. While the data is only available through 2013, it provides a historical viewpoint of how the climate has changed over time.







Based on climate data collected since 1950, the Greater Akron area's maximum daily temperature has not drastically changed. However, the area has seen a recent increase in days with 1 and 2 inches of precipitation. It is important for the region to be prepared for heavy rain events.

Non-Climate Stressors: Impervious Surfaces

Adding to these data, increased suburban sprawl would also be a cause for concern regarding increases in flooding damage. New developments that fail to implement effective storm water management practices will increase the likelihood of flash floods and costly damages to area infrastructure.

Development increases flooding when pervious, vegetated land is replaced with impervious surfaces (e.g., pavement, buildings). This reduces evapotranspiration and prevents precipitation from slowly infiltrating into the soil and recharging groundwater, rivers, and streams. Impervious surfaces increase stormwater runoff volumes, velocities, and peak discharges.

Stormwater runoff, which increases as a function of impervious surface, not only causes flooding (both peak flow and total volume of stormwater runoff) but can also affect water quality by increasing the temperature of receiving water, as well as sediment, pathogens, and nutrient loads. Urban flooding can occur due to overbank flooding or when stormwater overwhelms drainage systems and ends up in basements, backyards, and streets.

Section 2: Vulnerability Assessment

Identification of Assets

The scope of the analysis for this report is constrained to transportation infrastructure, which is defined as roads, bridges (including culverts), and multi-purpose (walking & cycling) trails. To identify infrastructure that is vulnerable to extreme weather and flooding, the following maps were made to illustrate which infrastructure is located in floodplains (regulatory, 1%, and 0.2%). As defined by the Federal Emergency Management Agency (FEMA), A "Regulatory Floodway" means **the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing** the water surface elevation more than a designated height. Additionally, the "1% floodway" is the extension of the regulatory floodway, when accounting for a flood that has a one percent change of happening, aka 100-year flood event, in any given year. Following, the ".2% floodway" is the next extension for a 500-year flood event.

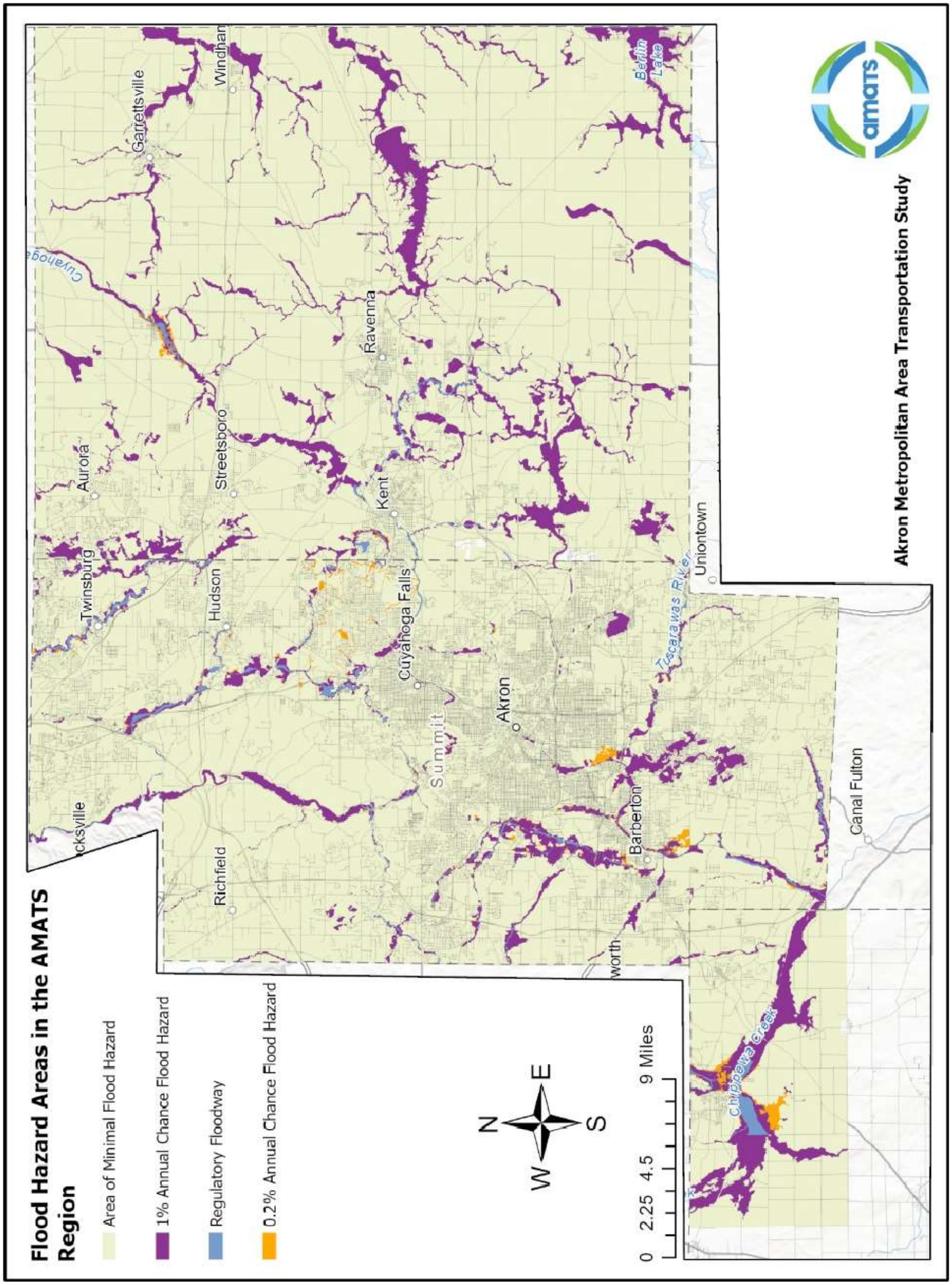


FIGURE 1: FLOOD HAZARD AREAS IN THE AMATS REGION

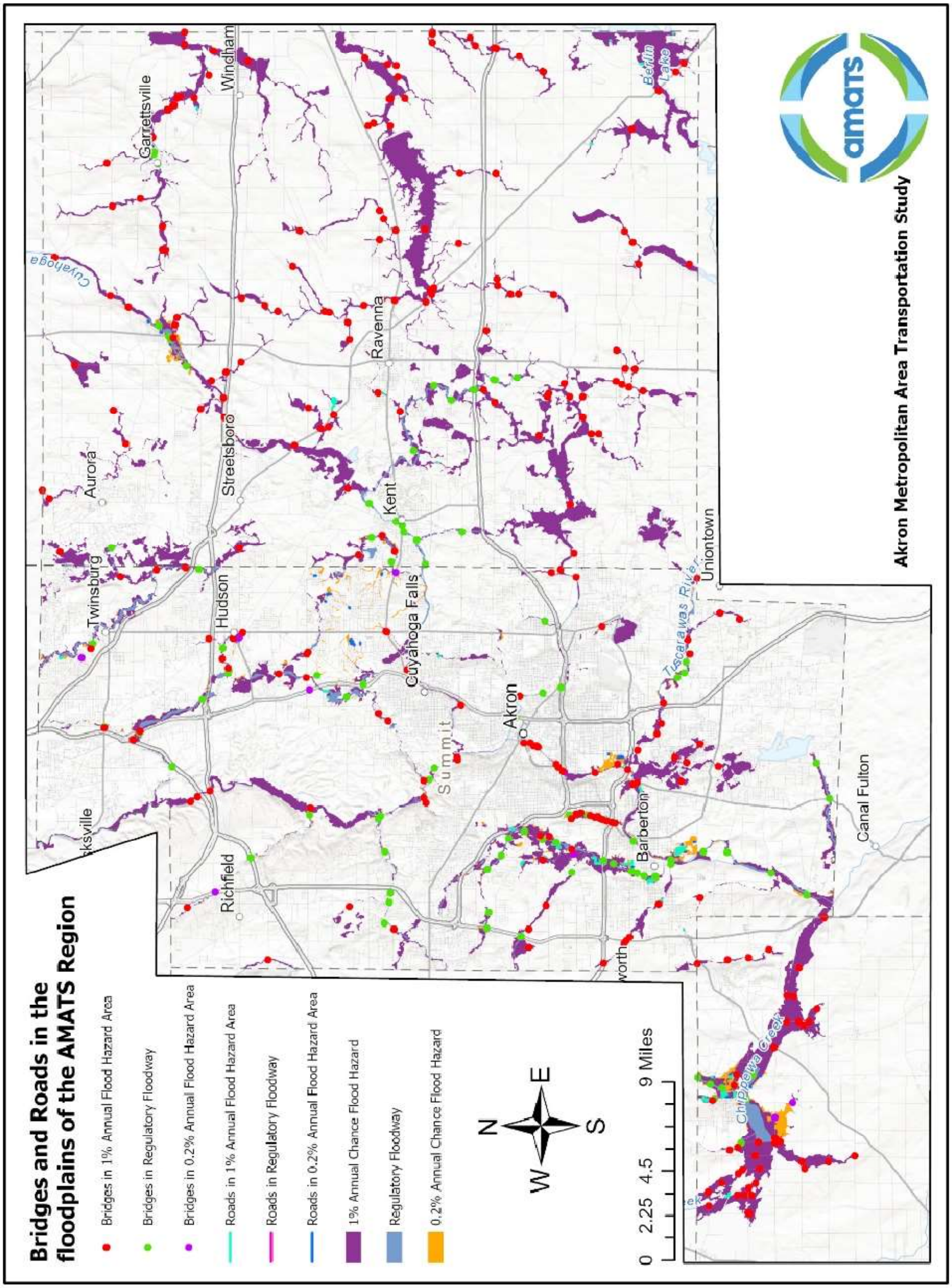


FIGURE 2: BRIDGES AND ROADS IN THE FLOODPLAINS OF THE AMATS REGION

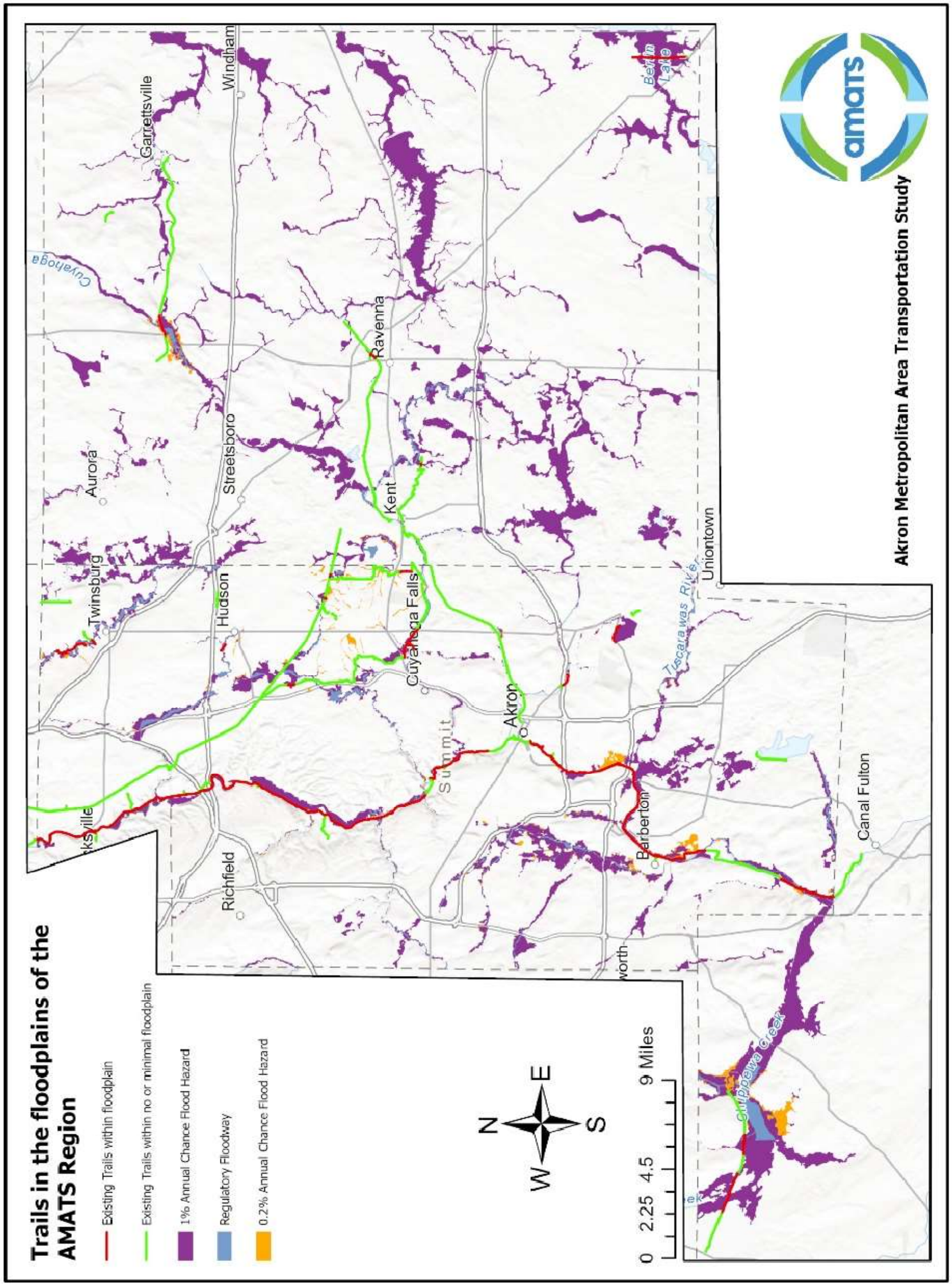


FIGURE 3: TRAILS IN THE FLOODPLAINS OF THE AMATS REGION

Vulnerability of Assets

The next step in the analysis of the areas infrastructure identified the roads and bridges (including culverts) in floodplains that are rated as "poor" or worse.

Roads are evaluated using AMATS' PCI rating. The PCI rating is a numerical rating of the pavement condition based on the type and severity of distresses observed on the pavement surface. The PCI value of the pavement condition is represented by a numerical index between 0 and 100, where 0 is the worst possible condition and 100 is the best possible condition. A poor rating is designated as less than 55. It is important to keep in mind that not every road in the AMATS area is evaluated for PCI. Only those which are eligible to receive AMATS funding are evaluated, so any listings of "poor" roadways cannot be considered exhaustive. Counties and municipalities should evaluate their own infrastructure to identify other assets potentially at risk.

Bridges are evaluated by the Ohio Department of Transportation (ODOT). AMATS reviews the ODOT Bridge Inventory dataset, which includes both bridges and culverts, and identifies those bridges which are considered "poor". Per ODOT, "poor" assets in this dataset are any asset coded 4 or less using the lowest of the "Deck Summary" or "General Appraisal" attributes.

These poor or worse assets are especially vulnerable given that they are in worse condition than other infrastructure in the area. They would be the first roads and bridges to be especially damaged by increases in flooding and other extreme weather events.

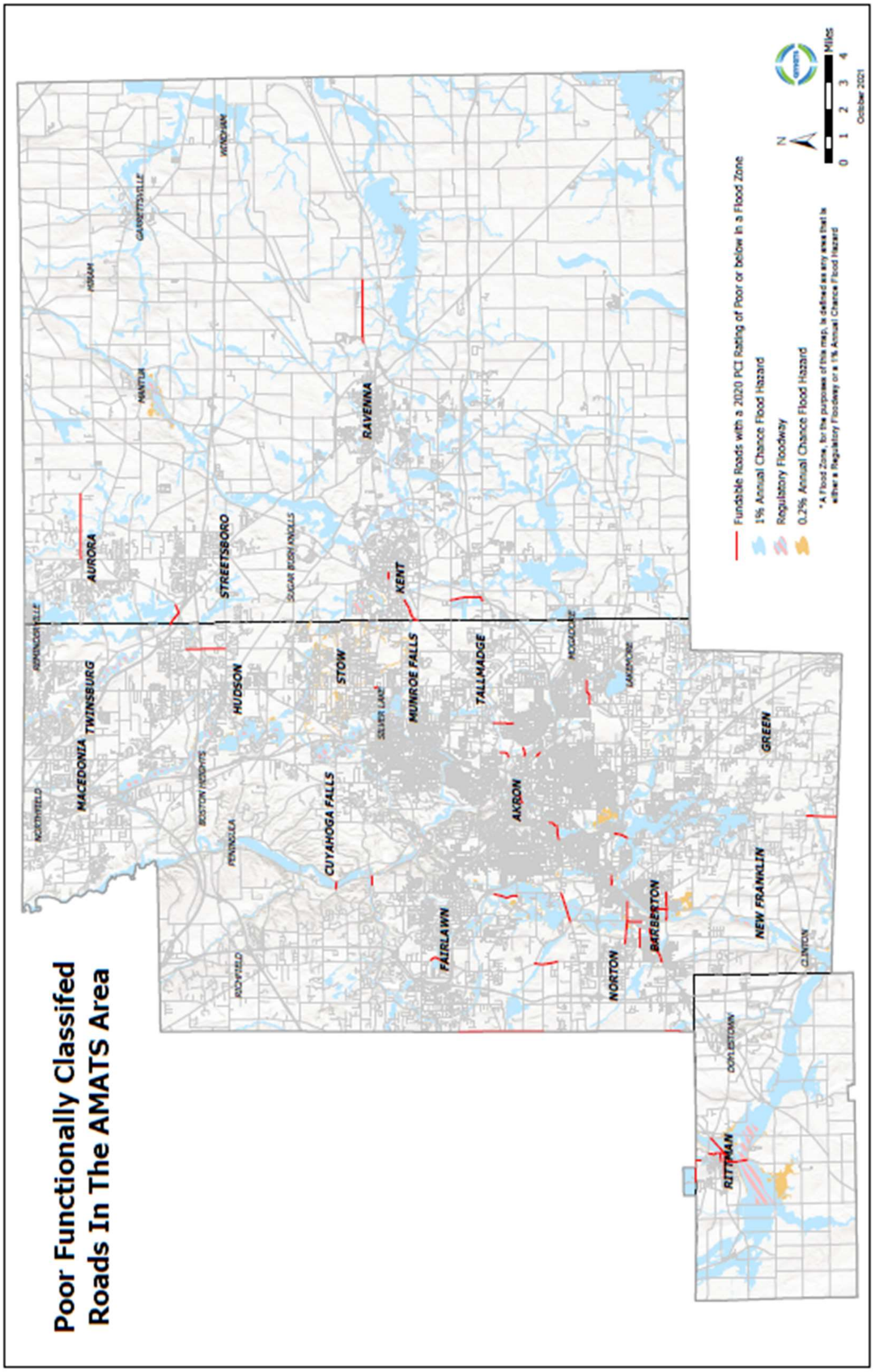


FIGURE 4: POOR FUNCTIONALLY CLASSIFIED ROADS IN THE AMATS AREA

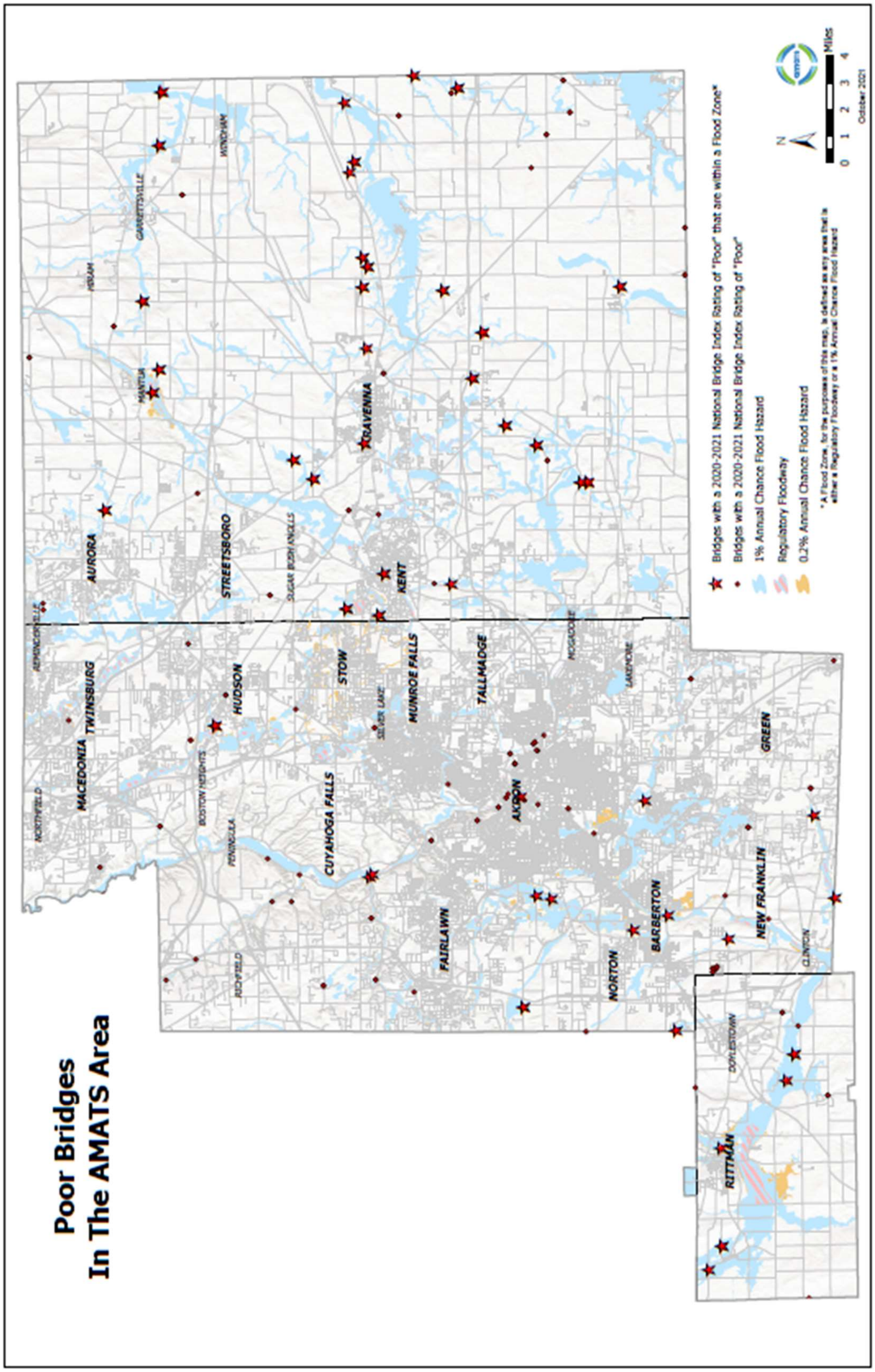


FIGURE 5: POOR BRIDGES IN THE AMATS AREA

Although there are many poor roads in floodplains within the Greater Akron area, the total miles of poor roads in floodplains is relatively low at 5.19 centerline miles. This is because in most cases the sections of poor roads that are in the floodplains are very short. Additionally, there are 46 poor bridges/culverts in floodplains. The number of poor bridges is calculated using the National Bridge Inventory's rating system.

Regional Importance Assessment

Average daily traffic (ADT) was used to identify the assets that are the most important to the transportation network in the area. Below is a list of "poor", or worse, roads and bridges, in floodplains, that are vital to the network because of relatively high ADT numbers (over 5,000).

These road segments are the final product of the analysis. They comprise the matrix of vulnerability and regional importance and should be monitored closely by local agencies for damages due to climate change and/or extreme weather events.

Roadway	***From***	***To***	***Community***	***Year(s) of Latest ADT***	***Latest ADT(s)***
Cleveland Massillon Rd	Rothrock Rd	Commercial Dr	Fairlawn	2017 2018	20,590 21,780
Van Buren Ave	Snyder Ave	Robinson Ave	Barberton	2016 2017	5,179 5,610
Stow Rd	Streetsboro St	Hudson Aurora Rd	Hudson	2017 2018	6,070 8,620
Norton Ave	Barber Rd	Wooster Rd	Barberton	2017	6,100
Triplett Blvd	Hilbish Ave	Canton Rd	Akron	2017 2019	8,060 9,400
Mogadore Rd	Tallmadge Rd	Howe Rd	Kent	2018	7,770
E Garfield Rd	Chillicothe Rd	Aurora City Limits	Aurora	2016 2017 2019	8,239 10,090 6,150
Bath Rd	Yellow Creek Rd	Riverview Rd	Cuyahoga Falls	2017	8,320
Main St	Mt Pleasant St NW	Yager Rd	Clinton	2016 2017	4,357 5,820
Haymaker Pkwy	River St	Water St	Kent	2016	18,378
Home Ave	Arlington St	Lane Change	Akron	2017	8,310
Robinson Ave	Wooster Rd	Van Buren Ave	Barberton	2019	11,830
Wadsworth Rd	Barber Rd	Collier Rd	Norton	2016	6,346

Roadway	*From*	*To*	*Community*	*Year(s) of Latest ADT*	*Latest ADT(s)*
Wooster Rd W	31st St	8th St	Barberton	2016 2017 2018 2019 2019	12,154 12,630 14,190 11,150 10,830
Brittain Rd	Eastwood Ave	Evans Ave	Akron	2017 2018	11,560 13,990
Norton Ave	Barberton Corp Limit	Barber Rd	Barberton	2018	7,890
Snyder Ave	Van Buren Ave	5th St	Barberton	2017	5,880
Manchester Rd	Carnegie Ave (Corp Limit)	Waterloo Rd	Akron	2016 2016	21,817 17,635

Local examples of vulnerable areas

There are a number of regional examples of the impacts of extreme weather events on local infrastructure.

Tinker's Creek

One example of this kind of disruption happens regularly along Tinker's Creek in Streetsboro (pictured to the right). This section of the road is in a 1% floodway designation.

Detours generated due to these types of events can lead to major travel time delays and additional congestion in otherwise low-volume roads. It can also create disruption of routes for emergency vehicles.

Yellow Creek Watershed

In Summit County, the Yellow Creek Watershed has been a source of increasingly challenging extreme weather and runoff-related issues in the past two decades. The Yellow Creek Watershed Analysis document includes a comprehensive level of detail about the challenges in the watershed.

The document highlights that "stormwater management efforts in the watershed include the formation of a Surface Water Management District (SWMD) in 2017, grant-funded stream restoration projects over several years, and most recently wetland restoration projects. However, natural erosion processes combined with extreme weather and/or inadequately managed stormwater in the watershed have contributed to evidence of channel erosion observed throughout stream network by both residents and stream experts. One particularly extreme event in 2014 caused widespread damage and stream instability that has continued to worsen."

This degradation is at least partially attributable to both extreme weather in recent years and inadequately managed stormwater runoff from impervious surfaces such as roofs, roads, and parking lots. "In Summit County and across Ohio, flooding has increased in frequency and intensity since 2003 (Delaney, 2016; Liberatore, 2013; USEPA, 2016). This increase in flood frequency, coupled with consistently increasing urbanization in the Yellow Creek Watershed, has resulted in significant hydromodification over the years (Delaney, 2016). A notable example of the increased flooding in Yellow Creek is the occurrence of a storm on May 12, 2014, which dropped approximately five inches of rain in about two hours (estimated to be around a 500-year event for those in the hardest hit areas) (National Weather Service, 2014). Per resident claims, this storm washed out culverts, eroded roadways, and caused major debris jams in addition to flooding."

The analysis of causes then goes to describe stormwater runoff problems in detail. "The Impervious area hotspot critical area addresses portions of the watershed that have dense urbanization and large amounts of impervious surface cover. Parking lots, commercial buildings, and roadways dominate the landscape. This critical area covers approximately 3600 acres, or 18%, of the watershed. The watershed's impervious cover is concentrated along the commercial corridor of Medina Road (Route 18), with much of the impervious cover within the City of Fairlawn and the Village of Richfield. These areas were developed at a time where stormwater management requirements were minimal or nonexistent. Such a large area of dense urbanization threatens the watershed by increasing the velocity, quality, temperature, and pollutant load of stormwater runoff that is being discharged."

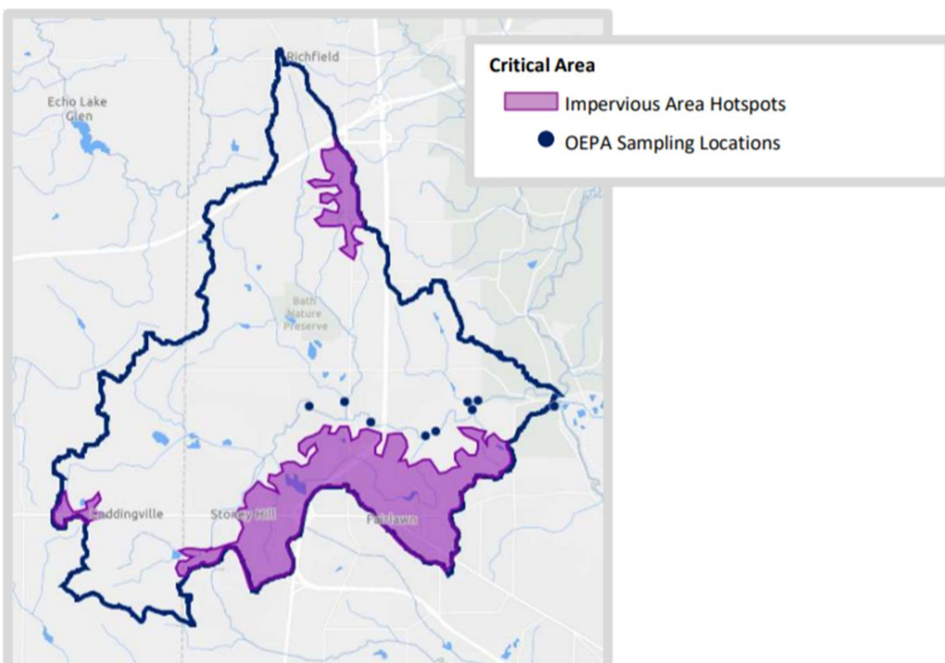


Figure 7: Critical Area 1, Yellow Creek HUC-12

Of course, the stormwater runoff not only threatens the watershed, but the infrastructure located in the watershed. This should be a cause for concern for local governments and more resources should be devoted to follow up on the recommendations set forth in the document.

Further, AMATS suggests monitoring localized flooding that is not mapped by FEMA. Flooding has occurred in the Greater Akron area along roadways in areas not designated as floodways by FEMA. Although outside the scope of this report, these locations also deserve consideration by local communities.

Section 3: Overview of Potential Solutions

While these events can have significant impacts, it is important to review potential solutions to severe weather events. Where the worst flooding happens, replacing the current infrastructure would be the first idea to consider. However, to address design flaws before any infrastructure is replaced, local governments should consider *updating design guidelines* to better manage stormwater flows. Some areas may even need stabilization projects to prevent further damage to the hardest hit areas. Further, installing green infrastructure is one of the best ways to combat problems with runoff, erosion, and flooding. Expanding funding options for green infrastructure is critical to supporting networks of regional green infrastructure. Below are several examples of effective green infrastructure.

Green Infrastructure

Green infrastructure is a set of stormwater management techniques and practices that mimic natural hydrologic functions. Commonly, green infrastructure incorporates landscape features to store or treat excess runoff. Green infrastructure can include site-specific management practices such as rain gardens, as well as watershed-scale strategies such as land preservation. The restoration of wetlands and floodplains enhances the land's ability to store water and reduce runoff. In places where urban infrastructure already exists, cities can incorporate or "retrofit" green infrastructure during infrastructure replacement and capital improvement projects. green infrastructure is gaining widespread support as a credible approach that communities can use to manage stormwater sustainably. The following are examples of different types of green infrastructure.

Bioretention

Bioretention is an adapted landscape feature that provides onsite storage and infiltration of collected stormwater runoff. Stormwater runoff is directed from surfaces to a shallow depression that allows runoff to pond prior to infiltration in an area that is planted with water-tolerant vegetation. As runoff accumulates, it will pond and slowly travel through a filter bed where it either infiltrates into the ground or is discharged via an underdrain. Small-scale bioretention areas are often referred to as rain gardens. A bioswale along a roadway is also a bioretention practice. In locations with low infiltration rates, underdrains can be used to collect runoff at the bottom of the filter bed and discharge the treated runoff to another green infrastructure practice or storm sewer system. Allowing runoff to filter through soil removes pollutants and reduces peak discharges, which mitigates flooding.

Blue Roof

A blue roof is designed to hold up to eight inches of precipitation on its surface or in engineered trays. It is comparable to a vegetated roof without soil or vegetation. After a storm event, precipitation is stored on the roof and discharged at a controlled rate. Blue roofs greatly decrease the peak discharge of runoff and allow water to evaporate into the air prior to being discharged. Precipitation discharge is controlled on a blue roof through a flow restriction device around a roof drain. The water can either be slowly released to a storm sewer system or to another green infrastructure practice such as a cistern or bioretention area.

Permeable Pavement

Permeable pavement includes both pavements and pavers with void space that allow runoff to flow through the pavement. Once runoff flows through the pavement, it is temporarily stored in an underground stone base prior to infiltrating into the ground or discharging from an under drain. Permeable pavers are highly effective at removing heavy metals, oils, and grease in runoff. Permeable pavement also removes nutrients such as phosphorous and nitrogen. Soil and engineered media filter pollutants as the runoff infiltrates through the porous surface. The void spaces in permeable pavement surfaces and reservoir layers provide storage capacity for runoff. All permeable pavement systems reduce runoff peak volume.

Underground Storage

Underground storage systems vary greatly in design. Underground storage systems detain runoff in underground receptacles that slowly release runoff. Often the underground receptacles are culverts, engineered stormwater detention vaults, or perforated pipes. One of the benefits of underground storage is that it does not take up additional surface area and can be implemented beneath roadways, parking lots, or athletic fields. Underground storage systems are typically designed to store large volumes of runoff and therefore can have a significant impact in reducing flooding and peak discharges.

Stormwater Tree Trench

A stormwater tree trench is a row of trees that is connected by an underground infiltration structure. At the ground level, trees planted in a tree trench do not look different than any other planted tree. Underneath the sidewalk, the trees sit in a trench that is engineered with layers of gravel and soil that store and filter stormwater runoff. Stormwater tree trenches provide both water quality and runoff reduction benefits.

Retention Pond

A retention pond is one of the earliest prototypes of green infrastructure and is now considered a more traditional type of stormwater infrastructure because it has been integrated into gray infrastructure design. It is an engineered stormwater basin designed to store runoff and release it at a controlled rate while maintaining a level of ponded water. Pollutants and sediment loads are reduced as the runoff is retained in the basin. Retention ponds are a very common stormwater management practice and may be designed with sustainable elements to increase water quality and decrease peak discharges. Vegetated forebays may be added to increase sediment removal as well as provide habitat. Another enhancement to traditional stormwater retention ponds is the addition of an iron-enhanced sand filter bench that removes dissolved substances such as phosphorus from runoff.

Extended Detention Wetland

Extended detention wetlands, such as the one shown in the figure on the right, may be designed as a flood mitigation strategy that also provides water quality and ecological benefits. Extended detention wetlands can require large land areas but come with significant flood storage benefits. Extended detention wetlands can be created, restored (from previously filled wetlands), or enhanced existing wetlands. Wetlands typically store flood water during a storm and release it slowly, thereby reducing peak flows. An extended detention wetland allows water to remain in the wetland area for an extended period, which provides increased flood storage as well as water quality benefits. Extended detention wetlands are distinct from preservation of existing wetlands, but the two practices often are considered together as part of a watershed-based strategy.

While green infrastructure can be a great tool, it can bring challenges, including costs, related to installation and maintenance.

Summit County Cost Examples

The following information was shared by the Summit County Engineer's Office to illustrate the substantial costs related to current runoff-related issues like scouring, erosion, and flooding.

As seen below, significant costs already exist for vulnerable infrastructure in the AMATS area. These issues currently pose challenges and are expensive to address. Local government agencies also expect these issues to grow, citing projected annual increases for certain project types.

PREVIOUS AND FUTURE PROJECTS					
Damage due to increase runoff	Scour due to increase velocity	Blockage of culverts & other large structures by debris	Blockage of storm sewers & smaller structures by debris	Increased landslide risk caused by increase runoff & saturated soils	Total Bridge Failure/wash out
Example Project	2020 Yellow Creek stream bank stabilization $185,000	2020 Riverview Rd over Slipper Run, Peninsula $260,000	Storm sewer inspection, cleaning, repairs & replacement. Akron-Cleveland Rd, 1300-ft, $250,000 (Future Project)	West Bath Rd Landslide Repairs (retaining wall and resurfacing) Design & Construction $1,675,000	Shaw Rd bridge destroyed by flooding & replaced in 2012 ($220,000) add 3%/yr inflation
Number of Similar Projects Per Year	2	1	2	1	1 every 20 years or more as flooding becomes more frequent
Annual Cost	$370,000	$260,000	$250,000	$1,675,000	$300,000
Projected Annual Increase	50%	3% inflation per year	3% inflation per year	50%	3% inflation per year

Routine Drainage Repairs attributed to Current Erosion					
Annual Amount in the 2021 SCE Budget	Landslide Mitigation	Storm Sewer Cleaning	Annual Maintenance	Culvert Replacement	Rock Channel Protection
1 years worth of efforts					
$1,225,000	$100,000	$125,000	$450,000	$450,000	$100,000
3% inflation per year					

Portage County Cost Examples

The information below was shared by the Portage County Engineer's Office to illustrate the current costs related to runoff/flooding issues.

PREVIOUS AND FUTURE PROJECTS					
Damage due to increase runoff	Scour due to increase velocity	Blockage of culverts & other large structures by debris	Blockage of storm sewers & smaller structures by debris	hydralic issues undersized culverts (Flooding)	Total Bridge Failure/wash out
Example Project	Hankee rd stabilization project $300,000	ravenna rd underpass, $100,000	Dawley Bridge #119 $50,000	Ravenna rd section B, Parkman rd sec. C, Silica sand sec. A, Porter rd C, Stroup rd C, Coit rd A	Newton Falls bridge, $700,000
Number of Similar Projects Per Year	2	2	2	1	1 every 20 years or more as flooding becomes more frequent
Annual Cost	$600,000	$200,000	$100,000	$200,000	$700,000
Projected Annual Increase	50%	3% inflation per year	3% inflation per year	3% inflation per year	3% inflation per year

Routine Drainage Repairs attributed to Current Erosion					
Annual Amount in the 2021 PCE Budget	Landslide Mitigation	Storm Sewer Cleaning	Annual Maintenance	Culvert Replacem ent	Rock Channel Protection
1 years worth of efforts					
$750,000	$50,000	$75,000	$300,000	$75,000	$75,000
3% inflation per year					

Section 5: Incorporate into Decision Making

As the metropolitan planning organization for the Greater Akron area, AMATS proposes the following strategies and recommendations to ensure the transportation planning process is considering resiliency planning and extreme weather potential.

Develop a goal statement relating to system resiliency to be included in AMATS 2050 Long Range Transportation Plan

Community planning as well as transportation planning begins with an understanding of what is important to the community and how the planning process and project evaluation criteria should reflect such key concerns. AMATS should incorporate system resiliency into its long range transportation plan goals and objectives.

Identify resiliency/extreme weather prioritization criteria that can be incorporated in the AMATS Funding Policy Guidelines

Like the concept of a goals statement, the criteria used to prioritize projects as part of the programming process should reflect the needs associated with climate change-related disruptions. Thus, to the extent that points or weights are used to assign relative importance to different goals, a desire for adaptive design concepts or of investing in projects that are in high-risk areas should be part of the prioritization criteria.

In 2021 AMATS incorporated scoring criteria for roadways endangered by land slides as part of it's safety planning component of the guidelines. AMATS could consider making additional changes to prioritize roadways threatened by extreme weather.

Consider new road and transit design approaches and standards to minimize potential disruption due to extreme weather events

AMATS acknowledges that it is customary to rely on ODOT's manuals for bridges and location and design. This recommendation is one more of an overarching nature. While there are set policies and procedures when it comes to design, the following recommendation indicates that those design standards could potentially be revised per the needs identified within this plan.

In areas that are considered highly vulnerable to current or future weather-related stresses, any project that is to be reconstructed or rehabilitated should consider new design approaches and standards that allow for greater protection against future stresses. In most cases, this would be done on a project-by-project basis given the project-specific context that determines design characteristics (e.g., drainage requirements). In some cases, government agencies have provided such a flexible design approach in context sensitive design projects; or in other cases, agencies have used design exceptions for standard approaches when circumstances have suggested an approach that is more appropriate compared to the norm. From a planning perspective, the long-range plan can be part of this overall design approach by identifying those areas that are considered highly vulnerable and AMATS can interact with implementing agencies to assure that a flexible design approach will be applied.

Conclusion

AMATS will continue to track climate stressors in the region and plan accordingly. Potential shifts in federal and state policies will also be monitored closely, and AMATS will align its goals and work programs appropriately. Specifically, AMATS will keep abreast of any updates to the FHWA's Framework and the ODOT Infrastructure Resiliency Plan. Collaboration with local government agencies will be vital as it may be necessary to adapt to more extreme weather in the future. AMATS will continue to revise its vulnerability assessment on a 4-year cycle along with other planning documents which feed into its Long-Range Transportation Plan.

Sources

Interdepartmental: U.S. Climate Resilience Toolkit- https://toolkit.climate.gov/

FHWA: Climate Change & Extreme Weather Vulnerability Assessment Framework - https://www.fhwa.dot.gov/environment/sustainability/resilience/publications/vulnerability_assessment_framework/index.cfm

EPA: Climate Resilience Evaluation and Awareness Toolkit- https://epa.maps.arcgis.com/apps/MapSeries/index.html?appid=3805293158d54846a29f750d63c6890e

Summit County Engineer's Office: Yellow Creek Watershed Technical Memorandum- https://www.summitengineer.net/files/11932/file/yellow-creek-watershed-analysis_final.pdf

Summit Soil and Water Conservation District: Nine-Element Nonpoint Source Implementation Strategic Plan- https://www.summitengineer.net/files/15937/file/yellow-creek-nps-is.pdf

NOAA Coastal Services Center: Economic Assessment of Green Infrastructure Strategies for Climate Change Adaptation: Pilot Studies in The Great Lakes Region - https://coast.noaa.gov/data/digitalcoast/pdf/climate-change-adaptation-pilot.pdf

City of Toledo: Green Infrastructure Toledo Case Study- https://toolkit.climate.gov/case-studies/all-hands-deck-creating-green-infrastructure-combat-flooding-toledo

Broward Metropolitan Planning Organization: South Florida Climate Change Vulnerability Assessment and Adaptation Pilot Project- http://www.browardmpo.org/images/WhatWeDo/SouthFloridaClimatePilotFinalRpt.pdf

Appendix

Entire list of "poor", or worse, rated roads located in floodplains in the greater Akron area.

Roadway	***From***	***To***	***Community***	***Year(s) of Latest ADT***	***Latest ADT(s)***
Cleveland Massillon Rd	Rothrock Rd	Commercial Dr	Fairlawn	2017 2018	20,590 21,780
Van Buren Ave	Snyder Ave	Robinson Ave	Barberton	2016 2017	5,179 5,610
Stow Rd	Streetsboro St	Hudson Aurora Rd	Hudson	2017 2018	6,070 8,620
4th St NW	Lake Ave	Norton Ave	Barberton	2018	3,750
Norton Ave	Barber Rd	Wooster Rd	Barberton	2017	6,100
Triplett Blvd	Hilbish Ave	Canton Rd	Akron	2017 2019	8,060 9,400
Main St S	Pavement Change	Eastern Rd	Rittman	2018	3,239
Medina Line Rd	Stimson Rd	Ridgewood Rd	Copley Wadsworth	2016 2018 2018	3,540 3,980 3,130
Market St	Arlington St	Case Ave	Akron	N/A	N/A
White Pond Dr	Copley Rd	Pavement Change	Copley Akron	2017	3,250
College St	Main St	Industrial St	Rittman	2018 2018	394 317
Mogadore Rd	Tallmadge Rd	Howe Rd	Kent	2018	7,770
Hopocan Ave	Hillsdale Ave	8th St	Barberton	2017 2019	3,800 3,417
Middlebury Rd	Corp Limit/Pavement Change	Munroe Falls Kent Rd	Kent	N/A	N/A
Hazel St	Arlington St	Pavement Change	Akron	2017	3,280
Ohio Ave	Metzger Ave	Industrial St	Rittman	2018	2,939
Eastern Rd	Rufener St	Main St	Rittman	2018	1,131
Ira Rd	Riverview Rd	Akron Peninsula Rd	Cuyahoga Falls	2017 2019	2,180 2,340
Newton Falls Rd	Ravenna Twp Limit	Rockspring Rd	Charlestown	2019 2019	560 1,120
E Garfield Rd	Chillicothe Rd	Aurora City Limits	Aurora	2016 2017 2019	8,239 10,090 6,150
Bath Rd	Yellow Creek Rd	Riverview Rd	Cuyahoga Falls	2017	8,320
Ohio Ave	Industrial St	Sunset Dr	Rittman	2018	3,962
Snyder Ave	2nd St	Van Buren Ave	Barberton	2016	4,957

Roadway	***From***	***To***	***Community***	***Year(s) of Latest ADT***	***Latest ADT(s)***
Cleveland Massillon Rd	Hemphill Rd	Summit Rd	Norton	2018	4,080
Waterloo Rd	Wooster Rd	Cordelia Ave (Corp Limit)	Akron	2019	4,383
Main St	Mt Pleasant St NW	Yager Rd	Green	2016 2017	4,357 5,820
Haymaker Pkwy	River St	Water St	Kent	2016	18,378
Home Ave	Arlington St	Lane Change	Akron	2017	8,310
Robinson Ave	Wooster Rd	Van Buren Ave	Barberton	2019	11,830
Wadsworth Rd	Barber Rd	Collier Rd	Norton	2016	6,346
Wooster Rd W	31st St	8th St	Barberton	2016 2017 2018 2019 2019	12,154 12,630 14,190 11,150 10,830
Main St N	Milton Rd	Ohio Ave W	Rittman	2018 2018 2018 2018	3,672 4,005 3,742 4,520
Wellman Rd	Middleton Rd (Corp Limit)	Aurora Hudson Rd	Streetsboro	2017	2,930
Rhodes Ave	Russell Ave	Thornton St	Akron	2019	2,040
Medina Line Rd	Weaverville Rd	Johnson Rd	Norton	2020	1,380
Brittain Rd	Eastwood Ave	Evans Ave	Akron	2017 2018	11,560 13,990
Norton Ave	Barberton Corp Limit	Barber Rd	Barberton	2018	7,890
Industrial St	Ohio Ave	Sunset Dr	Rittman	2018 2018	1,431 207
South St	Pavement Change	Lake Shore Blvd		2017	4,200
Snyder Ave	Van Buren Ave	5th St	Barberton	2017	5,880
Bowery St	State St	Main St	Akron	2017	3,280
Manchester Rd	Carnegie Ave (Corp Limit)	Waterloo Rd	Akron	2016 2016	21,817 17,635
South St	Manchester Rd	Pavement Change	Akron	2016	2,263
Grant St	S Main St	Industrial St	Rittman	2018 2018 2018	833 245 917
Darrow Rd	Lane Change	Kent Rd	Stow	N/A	N/A