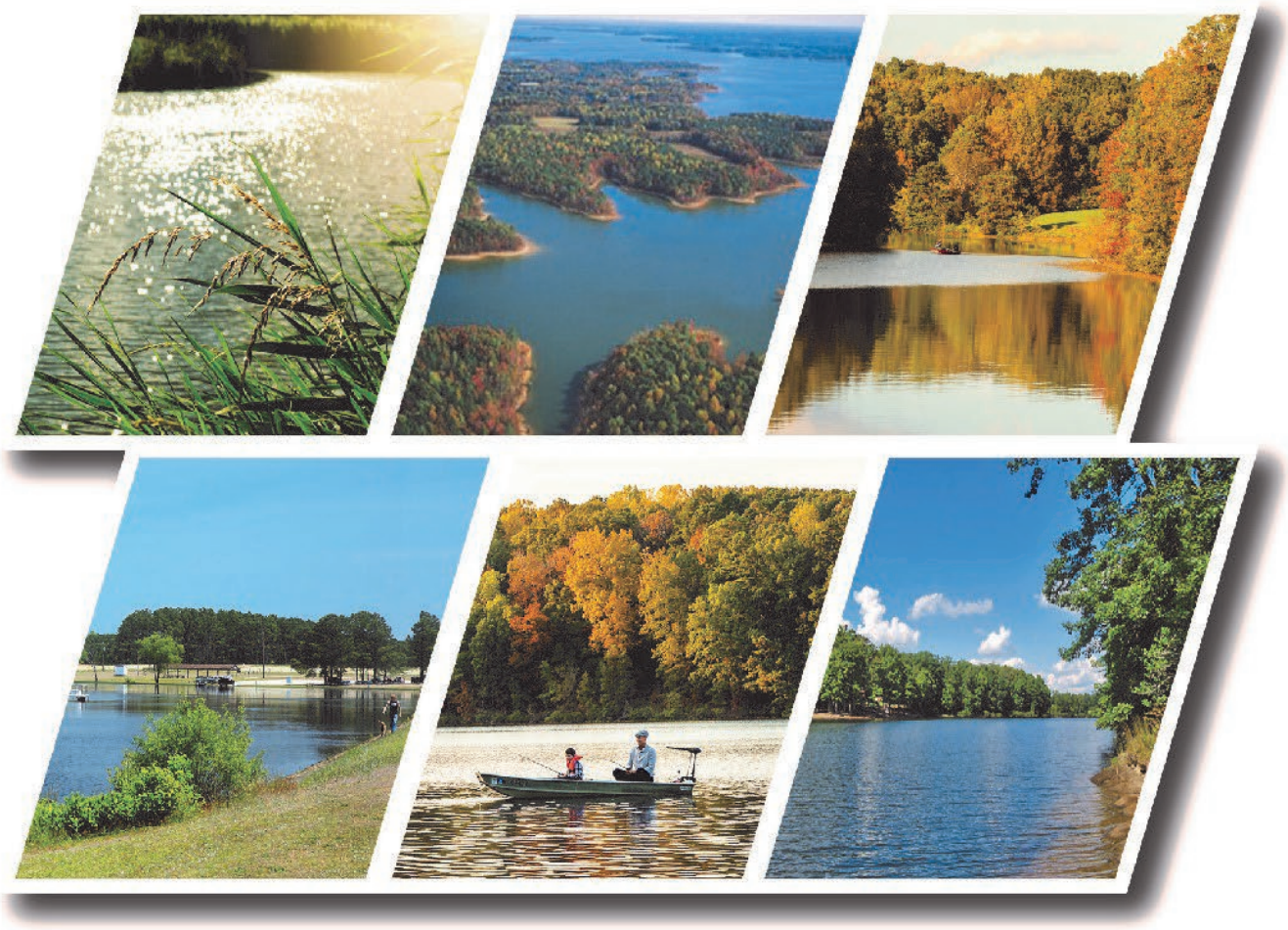
Climate Change and Natural Hazards

VULNERABILITY ASSESSMENT

for the

Kerr-Tar Region



December 2022

NC RURAL CENTER

Kerr-Tar Regional Council Of Governments

NCORR
NORTH CAROLINA OFFICE OF RECOVERY AND RESILIENCY

KLEINFELDER

RISE
Regions Innovating for Strong Economies and Environment

EQUAL HOUSING OPPORTUNITY

ACKNOWLEDGEMENTS

This document was produced by Kleinfelder in association with the North Carolina Office of Recovery and Resiliency and the RISE Kerr-Tar Region Stakeholder Partnership. Contributing authors are as follows:

Kleinfelder
Michael Hicks, Project Manager
Ariel Patterson, Resiliency Planner
Julia Maron, Climate Resiliency Planner
Katy Christie, PWS, Wetland Scientist
Kyle Johnson, Climate Resiliency Regional Lead
Kristin Caracappa, PE, CFM, Project Professional
Caitlin Spence, PhD, Climate Resilience Engineer, and Data Scientist

North Carolina Office of Recovery and Resiliency
Brian Byfield, Resilient Communities Program Manager
Andrea Webster, Resiliency Policy Advisor
Amanda Martin, PhD, Chief Resilience Officer

Kerr-Tar Region RISE Partners
Chalis Henderson, Stakeholder Partnership Facilitator
John Parker, Stakeholder Partnership Facilitator
James Cunningham, Economic Development Disaster Recovery Coordinator, Kerr-Tar Regional Council of Governments
Michael Kelly, AICP, Regional Planning & Economic Development Director, Kerr-Tar Regional Council of Governments

Stakeholder Partnership
Andrew Richardson - Emergency Management, Vance County
Brian Short - Emergency Management, Vance County
Carla Norwood – Working Landscapes
Chester Williams - A Better Chance A Better Community CEO
Chris Tucker - Emergency Management, Warren County

Doug Logan - Granville County Interim County Manager

Gabe Cumming - Working Landscapes

Henry Crews - Green Rural Development Organization Founder

Jackie Sargent – Mayor, Town of Oxford

James Stroud - Centre for Homeownership and Economic Resources

Jason Reavis - Emergency Management, Granville County

Jenni Rogan - Working Landscapes

Jennifer Teasley - Emergency Management, Person County

Jerry Edmonds - Vance County Community College

John Boyer – Engineer, City of Creedmoor

Lauren Johnson - City of Roxboro Planning Director, Person County

McKinley Perkinson - Henderson-Vance County Economic Development, Vance County

Michael Felts – Granville County Manager

Michael Frangos - City of Creedmoor, Assistant City Manager/Community Development Director

Michele Burgess – Henderson-Vance County Chamber of Commerce

Monique Wilkins - Economic Development Coordinator, Town of Louisburg, Franklin County

Paylor Spruill - Assistant City Manager, City of Henderson, Vance County

Rachel Wooster - Community and Economic Development, Warren County

Robin Edwards - Emergency Management, Granville County

Sam Boswell - Kerr-Tar Regional COG/RPO, Transportation Planner

Thom Schwalenberg - Emergency Management, Person County

Val Short - Triangle North Healthcare Foundation

LAND ACKNOWLEGEMENT

We wish to acknowledge and honor the Indigenous communities native to this region and recognize that this vulnerability assessment covers communities and structures that are built on Indigenous homelands and resources. We recognize the Haliwa-Saponi and Sappony people as past, present, and future caretakers of this land. We also recognize the unnamed tribes that once oversaw these lands and have since relocated or been displaced.

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ACRONYMS

ACS	American Community Survey
BRIC	Building Resilient Infrastructure and Communities
CDBG-DR	Community Development Block Grant – Disaster Recovery
CDBG-MIT	Community Development Block Grant – Mitigation
CDC	Centers for Disease Control
COG	Council of Governments
DWR	Division of Water Resources
EAL	Expected Annual Loss
EMS	Emergency Management Services
EOC	Emergency Operations Center
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
HMP	Hazard Mitigation Plan
HUD	Housing and Urban Development
LEAD	Low-Income Energy Affordability Data
NCDC	National Climatic Data Center
NCDEQ	North Carolina Department of Environmental Quality
NCDOT	North Carolina Department of Transportation
NCHPO	North Carolina Historical Preservation Office
NCNHP	North Carolina Natural Heritage Program
NCORR	North Carolina Office of Recovery and Resiliency
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
NRHP	National Register of Historic Places
NRI	National Risk Index
RCRA	Resource Conservation and Recovery Act
RISE	Regions Innovating for Strong Economies and Environment Program
SNAP	Supplemental Nutrition Assistance Program
SVI	Social Vulnerability Index
TMDL	Total Maximum Daily Load
WRAP	Wildfire Risk Assessment Portal
WUI	Wildland Urban Interface

Kerr-Tar Regional Council Of Governments

Diane Cox
Executive Director

Member Governments

COUNTIES
Franklin
Granville
Person
Vance
Warren

MUNICIPALITIES
Bunn
Butner
Creedmoor
Franklinton
Henderson
Kittrell
Louisburg
Macon
Middleburg
Norlina
Oxford
Roxboro
Stem
Stovall
Warrenton
Youngsville

Dear Residents:

Our region, encompassing Franklin, Granville, Person, Vance, and Warren counties, is known for its proximity to the Triangle Region, its lakes, and outdoor amenities like farms, wineries, and walking trails. Yet, flooding, wind, ice storms, heat and drought have been taking its toll on the region. These weather-related events could make the food security issue that our region faces even worse. These weather-related events can make getting food that much harder for our most at risk residents. These events can put pressure on local governments to clear the roads of ice and debris. Many of these impacts can be avoided.

In light of these challenges, our goal for the Kerr-Tar region is to take action to strengthen our resilience. This work includes reducing the immediate and long-lasting risks that natural and climate disasters pose for people, property, infrastructure, and natural resources. The Kerr-Tar Vulnerability Assessment uses rigorous technical analysis combined with local knowledge to outline the major gaps in our region's preparedness for future natural hazards, climate events and their impacts. The report is the result of numerous meetings with residents, elected officials, local leaders, the North Carolina Office of Recovery and Resiliency, North Carolina Rural Center, and Kleinfelder. These findings help us identify and prioritize efforts to become more resilient. In the coming months, we will use this Assessment to develop a suite up to 10 resilience projects for our five-county region. However, the Vulnerability Assessment is made available for any use by the public, including the development of independent resilience efforts and grant applications.

As you read through this review of our region's susceptibility to climate impacts, I hope you will think about ways you can prepare neighborhoods, communities, and the region. The purpose of this program is to make sure that our region is prepared for any of the weather-related disasters that could affect us. We want to make sure that we are prepared for the next flood, ice storm, wind event, drought, or other natural disaster that could put a strain on the regions ability to keep the residents of the region safe.

Sincerely,

Diane Cox
Executive Director

Executive Summary

Over the next 30 years, the Kerr-Tar region must adapt to changing climate conditions. In the Piedmont region, where Kerr-Tar is situated, North Carolina climate experts project that heavy rainfall will likely increase, severe weather is projected to intensify, flooding will likely increase, the number of hot days are expected to grow, and drought and wildfire may become more common occurrences. Although the scientific projections are less certain for other hazards facing the region, such as high winds and ice storms, residents should expect increases in the intensity and frequency of extreme weather events in the region due to climate change. Therefore, proactive measures to address climate change are crucial because inaction may lead to serious consequences threatening the livelihood of people, the community, buildings, and environment.

To address these concerns, the Kerr-Tar region participated in the Regions Innovating for Strong Economies and Environment (RISE) program administered by the North Carolina Office of Recovery and Resiliency (NCORR). The RISE program helps advance resilience efforts in North Carolina by supporting multi-county vulnerability assessments and regional solutions that reduce risk from climate change and natural hazards. The program is a collaboration between NCORR, the North Carolina (NC) Rural Center, the Kerr-Tar Council of Governments (COG), and Kleinfelder. These partners facilitated the development of a stakeholder partnership group made up of representatives who live and/or work in the Kerr-Tar region, comprised of Franklin, Granville, Person, Vance, and Warren counties. The stakeholder partnership group meets monthly to develop a regional approach with priority actions to reduce risk and enhance resilience in the region.

This Vulnerability Assessment provides a comprehensive analysis of the potential impacts of climate change and natural hazards in the Kerr-Tar region. It enables the region to prioritize its resiliency-building efforts based on the best available data, technical analysis, and stakeholder input. It points to shared challenges across local communities, some of which may benefit from regional-scale solutions. The main components of the vulnerability assessment include an analysis of natural hazards, risks and vulnerabilities, impacts across major sectors, and identifying opportunities for increasing regional resilience in the context of natural hazards and climate change.

The Kerr-Tar Region

The Kerr-Tar region is characterized by its plentiful natural resources and small-town charm with strong community bonds. Land uses range from rural residential, agricultural, lakeside housing, recreational areas, forestland, and urban/suburban development in and around the larger towns. Several parts of the region, especially those closer to the Raleigh-Durham area, experience population growth due to the creation of economic development initiatives, in-migration from adjacent counties, and residential development (Franklin County, North Carolina, 2020). Non-climate vulnerabilities of the region include rapid population growth (i.e., water supply resources and water quality), economic growth issues (i.e., stagnant economic activity and employment), aging or inadequate infrastructure, vulnerable populations, and the local governments' limited financial resources. Climate change is likely to aggravate these regional challenges. Through participation in the RISE program, the region will seek to create a more resilient region that can withstand the impacts of climate hazards, preserve its character, and address its challenges.

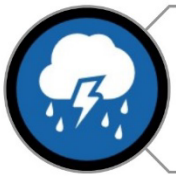
Summary of Findings

Based on research from scientific reports, regional planning documents, and local knowledge obtained from the stakeholder partnership group, the most prominent, high-impact climate hazards in the Kerr-Tar region today are severe weather (specifically heavy rainfall and winds), hurricanes, and ice/winter storms. Other high-risk hazards include wildfire and flooding. Extreme heat and drought are lower-risk hazards seen in selected areas across the region, however more communities will experience their effects over the coming years. This vulnerability assessment explores each of these climate hazards, explains present-day and future risks for the region, and depicts their impacts upon the population, resources, buildings, and environment. Summary points for each hazard of concern are shown in **Figure 1**.

Figure 1 - Hazard Impacts to the Kerr-Tar Region

- Hurricanes and tropical storms are the most damaging type of natural hazard. Hurricanes Matthew in 2016 and Florence in 2018 greatly impacted the region.
- Heavy, sustained rainfall and high winds cause property destruction, debris accumulation, and severe, widespread flooding.
- Hurricanes and tropical storms are very likely to increase over the next 30 years.

- Flooding causes damages to homes, water-filled buildings, road blockages and washouts, crop damage, and strains on stormwater infrastructure
- There are issues with inland flooding, flash flooding, and repetitive flooded areas
- Flooding is very likely to increase over the next 30 years.



- Severe weather includes heavy rainfall, thunderstorms, winds, lighting, and hail. It is a prominent natural hazard in the region.
- These events cause property damage and create dangerous conditions for residents.
- Severe weather events are very likely to increase over the next 30 years.

- Ice/winter storms cause damages to roads, ecosystems, and buildings. They lead to harsh roadway conditions, safety concerns, and power outages.
- It is very likely that ice/winter storms will produce heavier rainfall over the next 30 years, but the number of future storms is uncertain.

- Extreme heat causes health issues like heat exhausion, heat stroke, and even death.
- High temperatures and warm nights pose threats to vulnerable populations like seniors and outdoor workers. It can strain the electric grid, cause economic losess, and impact plant and animal species.
- The number of hot and very hot days are likely to increase over the next 30 years.

- Drought has significant impacts on agriculture, water supply, and wildlife.
- Extreme heat can exacerbate drought conditions and impact agriculture operations.
- Drought conditions are likely to increase over the next 30 years.

- Wildfires pose risks to farms, homes, businesses, health and water systems.
- Relatively low risk of wildfire damage for most of the region, with increased risk located around urban centers and isolated areas of high wildfire ignition occurence.
- Wildfire is likely to become a more severe threat over the next 30 years.

In addition to describing the region's climate hazards and their present-day and future risks, this vulnerability assessment explains how these hazards impact major sectors including:

- Housing
- Critical Facilities
- Regional Economy
- Historical and Cultural Resources
- Natural Environmental Systems
- Public Health
- Social Vulnerability

Summary points for sectors of concern are shown below.

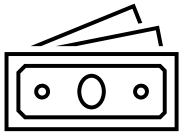
Housing

- The Kerr-Tar region's housing stock is particularly vulnerable to climate hazards due to its concentration of aging homes, mobile homes, and houses with inefficient heating and/or cooling systems. These traits can be detrimental to residents during extreme heat events or cold spells.
- Mobile and manufactured homes are less structurally capable of withstanding high wind events and hurricanes.
- 135 housing structures across the region lie in the 100-year or 500-year floodplain, mostly in Franklin County.
- Low risk of wildfire currently has little impact on homes but future increases in risk will impact densely developed neighborhoods.

Critical Facilities

- Critical facilities are susceptible to severe weather and flooding that cause business, school, and road closures, downed trees and powerlines, and even structural damage
- Extreme heat causes road surfaces to soften and overload the electric power grid
- There are critical facilities lying within the 100-year floodplain including a dialysis center and two wastewater treatment plants

Regional Economy



- Top industries in the Kerr-Tar region are manufacturing, healthcare and social assistance, and retail trade. Disruptions to the supply chain, logisitics, and transportation routes caused by hazards like flooding, hurricanes, and severe weather can affect these industries and the regional economy overall.
- Power outages and property damage to stores and farms resulting from storm events halt business operations.
- Business owners experience financial losses, and their employees may lose their jobs due to natural hazard events.

Historical and Cultural Resources

- Flooding poses the most significant climate risk to historical and cultural resources because it is difficult to physically move these resources from their existing locations.
- Three sites on the National Register of Historic Places located in the 100-year floodplain (out of 147 sites total).
- Assets are not impacted by wildfire or other lower risk hazards.

Natural Environmental Systems

- The region's vast amount of conservation areas and natural and working lands reduce diaster-related impacts to communities. They provide natural solutions for flood control, filtering pollutants, and air quality improvements.
- Protecting wetlands and other ecologically sensitive lands from development is essential.
- Numerous animal and plant species are listed as endangered, threatened, or of special concern in the region. They are vulnerable to climate impacts that can permanently change their habitat, such as higher temperatures.

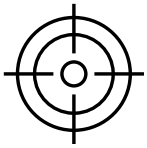
Public Health

- Natural hazards, particularly hurricanes, flooding, and extreme heat, can have direct impacts on physical and mental health.
- A high percentage of residents in the Kerr-Tar region report poor physical and mental health. People in poor health may feel the impacts of climate change more intensely than others.
- The Kerr-Tar region has a high number of elderly residents who are more susceptible to heat-related illnesses.
- Climate change may worsen water quality, water supply, and land use. There are polluted water bodies, animal feed operation sites, and contaminated waste sites within the region that, if disrupted by hazard events, may cause public health concerns.

Social Vulnerability

- Social vulnerabilities are the individual characteristics that make it harder for a person to withstand and quickly recover from natural hazards and other stresses.
- The region has moderate to high levels of social vulnerability. Vance County residents, especially those living in the central portions of the county, are the most vulnerable group in the region, consistently reporting the highest vulnerability scores for all social indicators
- Individuals living in poverty (17% of the region's population) will face increased hardships during hazardous events.
- Storm preparedness, evacuation, and recovery is more difficult for persons with disabilities (13% of the population) and elderly persons (19% of the population).
- Presence of senior facilities and mobile home parks indicate areas with vulnerable populations.
- Planners can target their resiliency efforts in areas with high vulnerability levels where residents may require additional resources and support.

Hot Spots

	• Census Tract 603.02 southwest of Louisburg in Franklin County, tract 9707.03 southwest of Butner towards Falls Lake, tract 9707.02 northeast of Butner to I-85 and tract 9706.03 from I-85 east around Creedmoor in Granville County, and tracts 9605, 9607, and 9608 around Henderson in Vance County are climate hazard hot spots. These locations are within proximity to the 100-year floodplain, have a greater number of high heat days, have more impervious surface area, and have a greater number of mobile homes and nursing homes compared to other areas in the region.

Next Steps

Now that this Vulnerability Assessment has provided an analysis of the potential impacts of climate change in the Kerr-Tar region, the region is ready to prioritize efforts to build resilience. Using this document and stakeholder input, the project team will identify five to 10 regional-scale solutions and develop an implementation pathway for each strategy. The pathways will provide clarity of purpose, identify aligned funding opportunities, and outline a direct path for implementation. The Climate Resilience Projects borne out the development of this vulnerability assessment can be found in the accompanying project portfolio for the Kerr-Tar Region.

1.0 North Carolina Office Of Recovery and Resiliency (NCORR) Overview

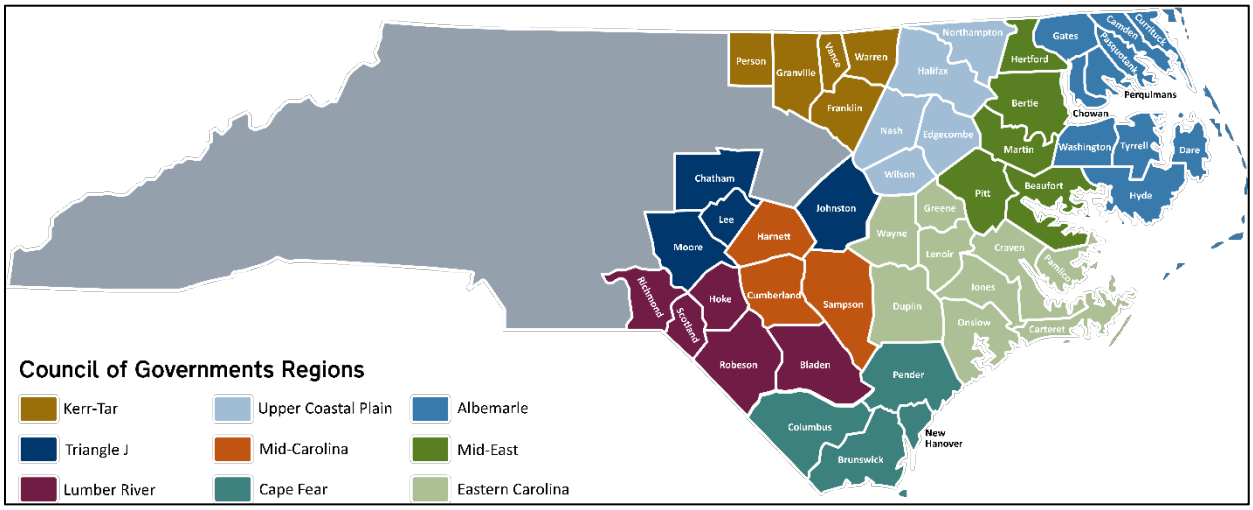
1.0 About NCORR

In the wake of Hurricane Florence in 2018, the State of North Carolina established the Office of Recovery and Resiliency (NCORR) to lead the state's efforts in rebuilding smarter and stronger. At that time, eastern North Carolina communities were still recovering from Hurricane Matthew in 2016. NCORR manages nearly a billion dollars in U.S. Department of Housing and Urban Development (HUD) funding for two grant programs: the Community Development Block Grant – Disaster Recovery (CDBG-DR) program and the Community Development Block Grant – Mitigation (CDBG-MIT) program, aimed at making North Carolina communities safer and more resilient from future storms. Additional funding is provided through the State Disaster Recovery Acts of 2017 and 2018, and the Storm Recovery Act of 2019, and the Economic Development Administration Disaster Supplemental Funds. NCORR manages programs statewide that include homeowner recovery, infrastructure, affordable housing, resilience, and strategic buyouts. To learn more about NCORR programs, visit the ReBuild.NC.Gov website. NCORR is a division of the Department of Public Safety.

1.1 About RISE

Using funding from the Economic Development Administration (EDA), NCORR in partnership with the North Carolina Rural Center conceived of and executed the Regions Innovating for Strong Economies and Environment (RISE) program. **Figure 2** depicts the nine regions participating in the RISE program, all are grouped by their designated Council of Government's (COG) coverage area.

Figure 2 - North Carolina Council of Governments (COG) Regions



The RISE program aims to support resilience primarily in the storm-impacted regions of North Carolina by:

- Facilitating the Regional Resilience Portfolio Program, which provides coaching and technical assistance to regional partners in the eastern half of the state to build multi-county vulnerability assessments,
- Identifying priority actions to reduce risk and enhance resilience in their region,
- Developing paths to project implementation,
- Developing the North Carolina Resilient Communities Guide, a statewide resource that will provide tools, guidance, and opportunities for building community resilience, and
- Hosting the Homegrown Leaders program, a North Carolina (NC) Rural Center leadership training workshop, which operates in the eastern half of the state, which emphasizes resilience as a tool for community economic development.

RISE is funded by the U.S. Economic Development Administration and the U.S. Department of Housing and Urban Development's Community Development Block Grant – Mitigation funds, with in-kind support from NCORR and the NC Rural Center. In addition, the Duke Energy Foundation committed $600,000 in grant funding to support the Regional Resilience Portfolio Program.

1.2 Regional Resilience Portfolio Program

The Regional Resilience Portfolio Program provides technical assistance to help communities collectively reduce risk from climate hazards (also referred to as natural hazards) and increase resilience across the region. There are two main deliverables for each region participating in the RISE Regional Resilience Portfolio program:

- A vulnerability assessment that can be a standalone document but is also appropriate for integration into regional and local plans, grant applications, public presentations, educational opportunities, and other planning tools; and,
- A project portfolio of five to ten projects identified through community input and expert consultation. It is a separate document that outlines funding opportunities and paths to project implementation.

In the Kerr-Tar region, which covers Franklin, Granville, Person, Vance, and Warren counties, the program was developed through collaboration between NCORR, the NC Rural Center, the COG, Kleinfelder, and the five participating counties. The partners formed a stakeholder group made up of representatives who live and/or work in the Kerr-Tar region. Most of the stakeholders are municipal or county government employees. Others come from military, community based organizations, community development, and education fields. There is a balanced number of representatives from each county in the region. The stakeholder partnership held monthly stakeholder meetings beginning in January 2022 that continued through November 2022. Initial meetings focused on understanding regional climate resiliency, climate hazards, and how climate change impacts are affecting the region. There was an Open House held in April 2022 for all stakeholders: the morning session was virtual, and the evening session was an in-person event.

The following vulnerability assessment for the Kerr-Tar Region is the first of the two main deliverables with it informing the Project Portfolio.

2.0 Introduction

Climate hazards are a natural occurrence and unavoidable. Due to climate change, hazards such as storms, heat, floods, and drought, are projected to intensify and become more frequent. The unfortunate reality is that hazard events do not impact all communities and persons equally. Some communities are located in more vulnerable areas. Some communities lack resources to address the hazards and support impacted persons.

The primary intention of the vulnerability assessment is to identify how climate hazards impact specific sectors and which areas in the Kerr-Tar region are most vulnerable to their potential devastating effects. This assessment focusses on people, infrastructure, and assets. Although the assessment leans more heavily on climate hazards, there is discussion of non-climate hazards and how they contribute to community vulnerability.

The contents of the vulnerability assessment incorporate stakeholder feedback, public input, research findings, and information gathered from regional hazard mitigation plans, planning documents, the *North Carolina Climate Risk Assessment and Resilience Plan*, the *North Carolina Climate Science* report, and numerous other sources.

2.0 Vulnerability Assessment Organization

The main components of the vulnerability assessment include:

The **Climate Hazards** section begins with a discussion of the region's top hazards and then proceeds to provide a general description of climate hazards (sometimes referred to as natural hazards) and associated impacts for the Kerr-Tar region. It incorporates current and projected risk levels for hazards. The climate hazards to be discussed in greater detail include:

- Hurricanes and tropical storms;
- Flooding;
- Severe weather (includes thunderstorms, wind, lighting, hail, and heavy rainfall);
- Ice and Winter storms;
- Extreme heat;

- Drought; and
- Wildfire

The **Sector Impacts** section evaluates how climate hazards affect various sectors. It describes the present-day and future risk of each climate hazard, as well as how individual vulnerabilities make it more difficult to withstand hurricanes, floods, heat waves, severe weather, and other natural disasters. Climate hazards have different effects on different sectors so there are slight variations in how information is presented. The most up-to-date information and data are used to supplement the discussion. Of all climate hazards, flood data is the most widely available for in-depth analysis and second to that is wildfire data.

- Housing;
- Critical Facilities;
- Regional Economy;
- Historical and Cultural Resources;
- Natural Environmental Systems;
- Public Health; and
- Social Vulnerability

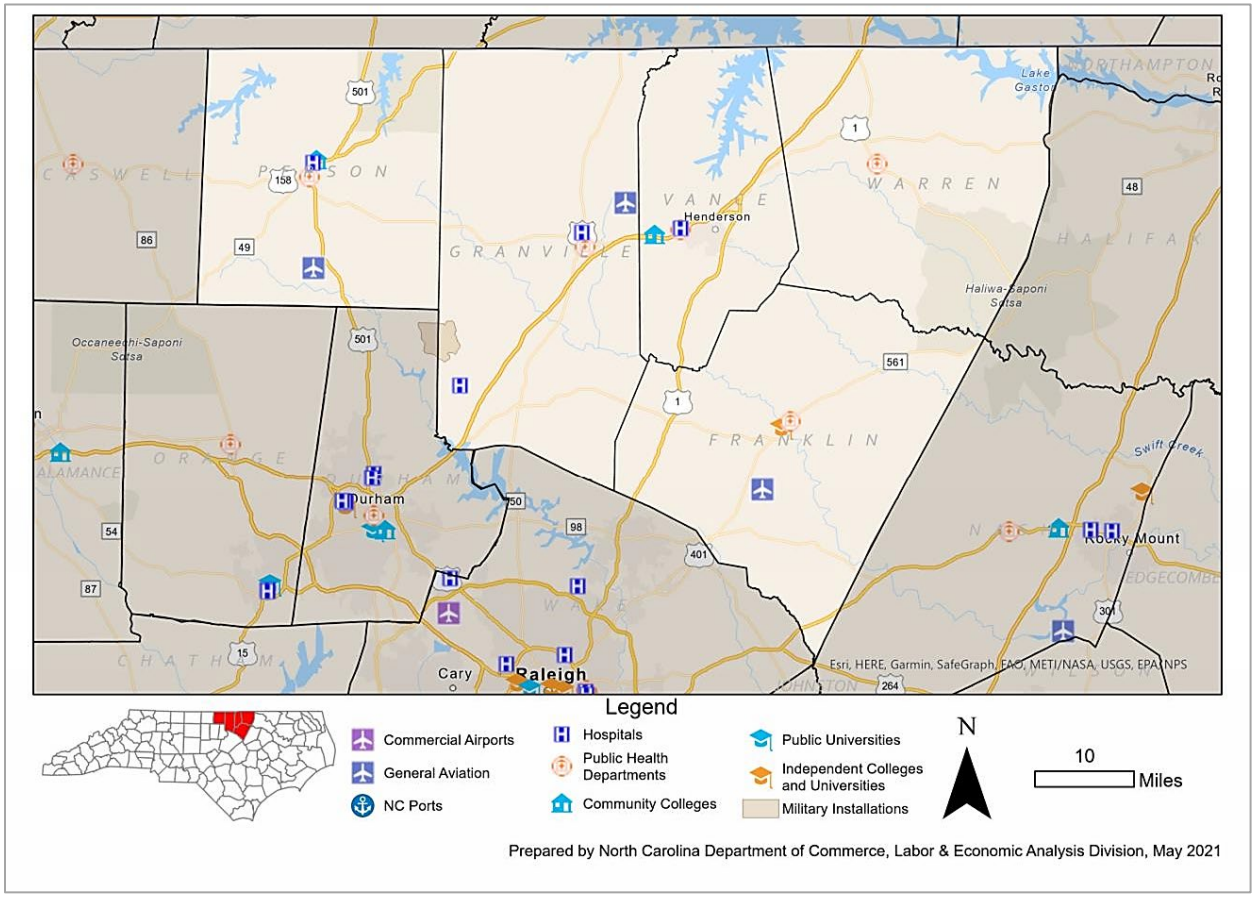
The **Areas of Concern – "Hot Spots"** portion of the documentation includes an analysis of communities that will be hardest hit by climate hazards. The conclusion provides an overview of the major findings and discussion of next steps in the RISE program. The appendix contains supplemental materials applicable to the vulnerability assessment. The references section provides a listing of all sources.

2.1 Overview of the Kerr-Tar Region

The Kerr-Tar region is comprised of five counties: Franklin, Granville, Person, Vance, and Warren counties. It is in the northern Piedmont area of North Carolina which between the western mountains and the coastal plain to the east. The Piedmont area spans from the Virginia border to the South Carolina border; four of the five counties that make up the Kerr-Tar region lie at the Virginia border. The Kerr-Tar region is north of the Raleigh-Durham metropolitan area. Franklin

and Granville counties share a border with Wake County (where Raleigh is located). See **Figure 3**.

Figure 3 – Regional Map



Source: NC Department of Commerce

The Kerr-Tar region is known for its mostly mild climate, unique natural resources, and plentiful water resources. The region contains the headwaters for the Tar River, a major river that traverses through the State, and Flat River, a smaller river that flows into the Neuse River. Historically, the region's water resources, and network of tributaries served as an important transportation route. They helped sustain the region's major industries (namely agricultural, lumber, and textiles) for more than two centuries (Franklin County, North Carolina, 2020).

The region contains several significant lakes including Kerr Lake, Lake Gaston, Mayo Lake, Hyco Lake, and Falls Lake. All water body types provide statewide and regional benefits including unique ecosystems, a sanctuary for wildlife, recreational opportunities, and economy drivers.

Several of these lakes and rivers also serve as regional sources of drinking water. The Tar River and the Neuse River, for instance, are surface water sources for Franklin (Neuse and Tar) and Granville (Neuse only) counties.

The region is a mix of rural and suburban communities, with populations ranging from 68,573 persons in Franklin County, to Warren County with 18,642 people. There are 229,882 people in total living in the region. Major cities include Louisburg, Oxford, Roxboro, Henderson, and Warrenton. See **Table 1** for county profiles.

Table 1 - County Profiles

County Name	County Seat	Land Area (sq. mi)	Population	Population per sq. mi
Franklin	Louisburg	492	68,573	139
Granville	Oxford	532	60,992	115
Person	Roxboro	392	39,097	100
Vance	Henderson	252	42,578	169
Warren	Warrenton	429	18,642	43
Regionwide	**n/a**	**2,098**	**229,882**	**110**

Source: (United States Census Bureau, 2020)

Table 2 shows key demographic information for the Kerr-Tar Region's counties. Highlighted information shows the major findings and other important facts. Of note is Warren County's highest percentage of American Indian and Alaska Native persons at 5.7%. The Haliwa-Saponi Tribe resides primarily in the area traditionally known by the elders as "The Meadows" which includes the southeastern portion of Warren County. The State-recognized tribe is the third-largest tribe in North Carolina with over 4,000 members (Warren County, NC, 2022). Additional State-recognized tribes in the region include the Sappony, whose traditional homelands since the early 1700's are in the High Plains Settlement along the North Carolina-Virginia border, in the rolling hills of Person County, NC and Halifax County, VA (Sappony History Timeline, n.d.).

Table 2 – Demographic Information for the Kerr-Tar Region

Fact	Franklin	Granville	Person	Vance	Warren
Race and Hispanic Origin					
White alone	70.1%	64.5%	70.0%	45.1%	40.5%
Black or African American alone	25.9%	31.9%	26.8%	51.5%	51.4%
American Indian and Alaska Native alone	0.9%	0.9%	0.9%	1.0%	5.7%
Asian alone	0.7%	0.7%	0.4%	0.8%	0.4%
Native Hawaiian and Other Pacific Islander alone	0.1%	0.1%	Z	0.1%	Z
Two or More Races	2.2%	1.9%	1.9%	1.6%	2.0%
Hispanic or Latino	9.0%	8.5%	4.5%	8.3%	3.9%
White alone, not Hispanic or Latino	63.0%	57.8%	66.3%	39.0%	38.2%
Population					
Population 2010	60,619	59,916	39,464	45,422	20,972
Population 2020	68,573	60,992	39,097	42,578	18,642
% Change	13%	2%	-1%	-6%	-11%
Age and Sex					
Persons under 5 years, %	5.6%	5.1%	5.3%	6.2%	4.5%
Persons under 18 years, %	21.8%	20.5%	20.6%	23.4%	17.9%
Persons 65 years and over, %	17.1%	17.7%	20.1%	19.1%	26.2%
Female persons, %	50.5%	49.2%	51.7%	53.3%	50.5%

Fact	Franklin	Granville	Person	Vance	Warren
Veterans, 2016-2020	4,008	3,634	2,555	2,197	1,261
Foreign born persons, %, 2016-2020	5.6%	4.5%	3.2%	5.1%	2.4%

Source: (United States Census Bureau, 2020). *Note, 'Z' represents a value greater than zero but less than half unit of measure shown*

For detailed Census information about the Kerr-Tar region, see **Table 31** in the **Appendix.**

2.1.1.1 Regional Strengths

The region's history of agriculture and manufacturing has evolved into an appealing region for its strong sense of community, natural resources, rural lifestyle (although some areas are becoming more suburbanized due to population growth) and increasing economic opportunities. Based on County planning documents, here are the major strengths of the Kerr-Tar region:

- **Quality of life** where quality neighborhoods are within and close to quaint historic towns that enhance the appeal
- **Part of the Research Triangle region** [Raleigh-Durham-Chapel Hill area], home to some of the fastest growing companies and communities in the world, where innovation is thriving, and the economy is strong
- **Proximity to regional opportunities** including employment centers, world-renowned colleges and universities, sports venues, art and museums, fine dining and shopping, and a variety of outdoor recreation experiences
- **Home to valuable natural assets** especially within the Tar River corridor and its many lakes
- **A stable agricultural community**
- **A sense of community, relatively rural pace and character** that contributes to the identity and attractiveness of the area. In Franklin County for instance, residents enjoy the slower pace of a small-town or rural setting that is **within a convenient distance of thriving employment centers**, world-renowned colleges and universities, major and minor league sports venues, art and museums, fine dining and shopping, and a variety of outdoor recreation experiences.

During stakeholder meetings and an open house held between January and April, stakeholders provided their local knowledge about the region's strengths. Below is a summary of the main takeaways heard during these forums:

- **Increased tax bases**: Stakeholders stated that tax revenues have increased in certain portions of the region, primarily the unincorporated southern areas of Franklin and Granville Counties and within the towns of Creedmoor, Butner, Louisburg, Franklinton, and Youngsville.

- **Shared approaches to resiliency:** There are shared approaches towards collaboration and co-learning opportunities related to resiliency across the region. For example, the Emergency Management Services (EMS) professionals in each county have monthly meetings to exchange ideas leading to unity, partnership opportunities, and actionable items for the region. The region's collaborative spirit encourages building a more resilient region. Other resiliency-related strengths shared by stakeholders include faster emergency response times due to small land areas of towns, greater teamwork with key partners, active citizen participation and a shared willingness to help one another.

- **Opportunities to enhance resiliency efforts**: The region's educational institutions can provide residents technical support, grant writing opportunities, research, and data collection to support its climate resiliency efforts. There are seven educational institutions in the region including Franklin County Community College, Louisburg College, Vance-Granville Community College (with campuses in Henderson, Warrenton, Creedmoor, and Oxford), and Piedmont Community College. Adjacent to the region are several other major educational institutions including Duke University, University of North Carolina (UNC) Chapel Hill, and NC State University.

2.1.1.2 Regional Challenges

Non-climate related issues impede the region's ability to create, enhance and sustain its resiliency-building efforts. The following information was obtained through stakeholder feedback and provides a more personalized, local viewpoint of the region's present-day challenges. To

corroborate the stakeholder input, the project team reviewed planning documents, regional data, and maps.

- **Lack of Resources**: The most significant non-climate stressors impacting the region are lack of resources, both financial resources and employees. Stakeholders shared that current government employees serve multiple roles and tend to focus on the immediate issues and day-to-day tasks. Some of them have little expertise in grant writing, developing funding strategies, and comprehensive planning, making it difficult to obtain additional resources.

- **Employment:** In February 2022, stakeholders reported that there was extremely high unemployment in the towns of Warrenton, Henderson, Roxboro, and Louisburg. The feedback is substantiated by the State Department of Commerce's unemployment figures for February 2022 with Vance County at 6.5% and Warren County at 6.8%. These figures were some of the highest rates in the state, ranked at 93 and 94 respectively, out of the 100 counties in the state (North Carolina Department of Commerce, 2022). Also reported by stakeholders were gaps in entry level and service work jobs, along with lingering supply chain issues.

- **Financial Constraints**: Available funding is less than expenditures in many towns given that the number of repair projects exceeds the annual budget. Stakeholders reported that Person County experiences this issue. And, that towns are unable to raise taxes because it would become a hardship for many residents.

- **Pressures of Population Growth**: Franklin County experienced the greatest population growth between 2010 and 2020 at 13%. The region's overall population increased 2% over the same time span. See **Table 3** for additional information. Challenges associated with Franklin County's current and projected population growth are listed below (Franklin County, North Carolina, 2020).

    - Preserving viable agriculture
    - Conserving valuable natural resources
    - Providing adequate infrastructure

- Improving access to healthcare,
- Increasing the tax base
- Seeking a balanced approach to growth management while maintaining a high quality of life for residents now and in the future

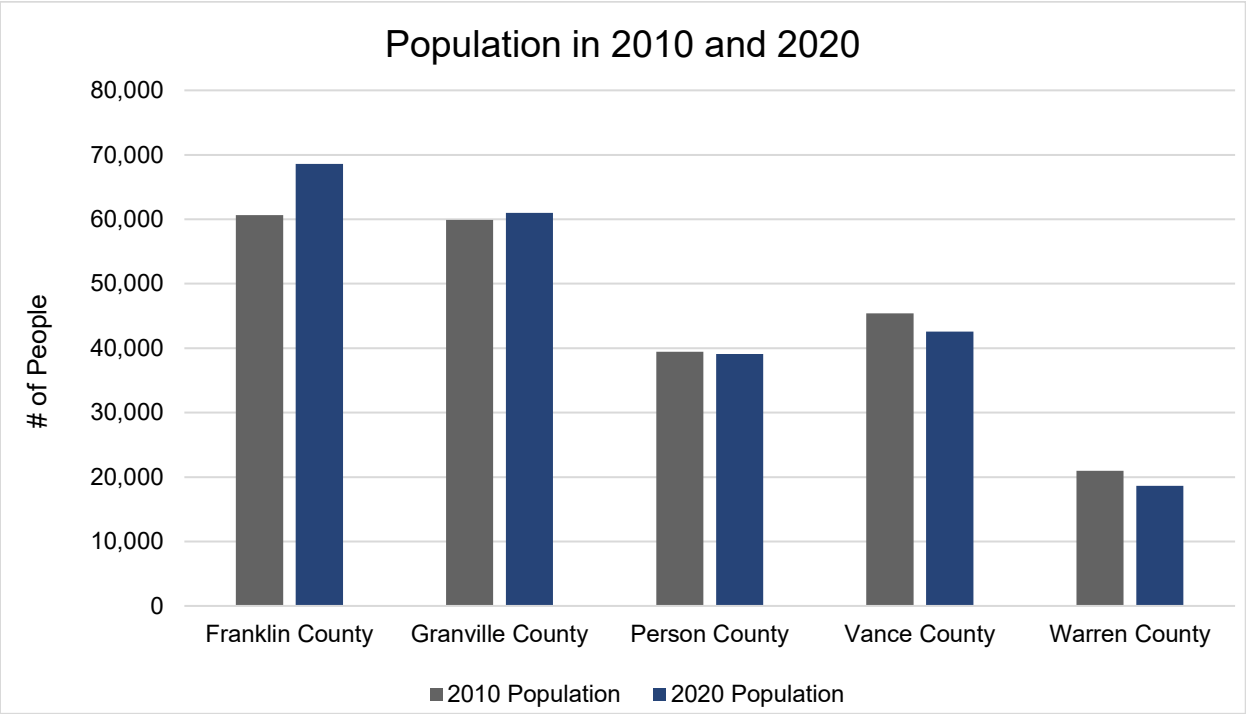
Table 3 - Population Growth in the Kerr-Tar Region, by Percentage

	Franklin	Granville	Person	Vance	Warren	Regionwide
2010 Population	60,619	59,916	39,464	45,422	20,972	**226,393**
2020 Population	68,573	60,992	39,097	42,578	18,642	**229,882**
% Change	13%	2%	-1%	-6%	-11%	**2%**

Source: (United States Census Bureau, 2020)

Stakeholders corroborated with this information stating that population growth, primarily in southern Franklin and Granville Counites, leads to a strain on public services. For example, new subdivisions are not clustered so there are longer response times in emergency situations. **Figure 4** depicts population growth for each county.

Figure 4 - Population Growth in Kerr-Tar Region



Source: (United States Census Bureau, 2020)

- **Water Supply**: While population growth can be a positive attribute, it can be a challenge and lead to a strain on public services including water supply. This is especially true for the rapidly growing Franklin County where water supply issues are a major challenge because demand will exceed supply in the coming years. *Franklin Next,* the county's Comprehensive Land Use Plan, states that Franklin County Public Utilities (FCPU) experienced high annual customer connection growth rate of approximately 7.5% for several years and expects this trend to continue through the 20-year planning horizon (Franklin County, North Carolina, 2020). As population projections show continued growth, there will be increased stress on the current capacity of the system.

  Detailed information about supply and demand projections through 2070 for the Franklin County Public Utilities company is shown in **Table 4**. North Carolina's Division of Water Resources (DWR) provides the data in the table as shown in the most recent, Complete 2020 Local Water Supply Plan (LWSP) for the utility company (NC DEQ Division of Water

Resources, 2020).[1] It shows that demand will exceed supply sometime between 2040 and 2050. To help alleviate supply issues, the county implements demand management practices to reduce the per capita water demand including more restrictive outdoor water use regulations, replacement of older water mains and meters, development of plans to finalize a long-term water supply and coordination with neighboring systems to purchase additional supply (NC DEQ Division of Water Resources, 2020).

Table 4 - Demand vs. Percent of Supply in Franklin County Public Utilities

	2020	2030	2040	2050	2060	2070
Surface Water Supply	2.00	2.00	2.00	2.00	2.00	2.00
Ground Water Supply	0.00	0.00	0.00	0.00	0.00	0.00
Purchases	3.67	3.67	3.67	3.67	3.67	3.67
Future Supplies	n/a	0.00	0.00	0.00	0.00	0.00
Total Available Supply (MGD)	**5.67**	**5.67**	**5.67**	**5.67**	**5.67**	**5.67**
Service Area Demand	2.55	3.632	4.90	5.68	6.26	6.92
Sales	0.32	0.42	0.42	0.42	0.42	0.42
Future Sales	n/a	0.00	0.00	0.00	0.00	0.00
Total Demand (MGD)	**2.87**	**4.05**	**5.32**	**6.11**	**6.69**	**7.34**
Demand as Percent of Supply	**51%**	**71%**	**94%**	**108%**	**118%**	**130%**

Source: (NC DEQ Division of Water Resources, 2020)

According to DEQ Division of Water Resources' 2020 and 2021 reports on water suppliers serving the four other counties in the region, demand does not exceed supply through 2070, measured by 'demand as percent of supply' for any year for the following systems: South Granville Water and Sewer Authority (SGWSA), Kerr Lake Regional Water, Roxboro Water system, Vance County

[1] A Local Water Supply Plan is an assessment of a water system's current and future water needs and its ability to meet those needs (NC DEQ Division of Water Resources, 2020). As of July 2022, the 2021 LWSP is labeled 'Provisional.' Division of Water Resources (DWR) states that "data users are cautioned that LWSPs labeled PROVISIONAL have yet to be reviewed by DWR staff." Therefore, the 2020 completed report data is shown here.

Water District, Stovall, Louisburg, Bunn, Norlina, Warrenton and Warren county water district (NC DEQ Division of Water Resources, 2022). However, for the Oxford municipal water system in Granville County, demand will exceed supply sometime between 2050 and 2060, as shown in the completed 2021 LWSP (NC DEQ Division of Water Resources).

Regionwide, there are water quality issues as several stakeholders reported the presence of "forever chemicals."

- **Emergency Shelters**: Stakeholders shared that emergency shelters are not well-dispersed across the region and the existing ones have capacity and utility constraints. For example, Warren County has one shelter, and its generator can only support lights. This shelter cannot provide air conditioning during a power outage, which is an intended use of the shelter. In times of need, local religious institutions provide shelter.

- **Aging structures**: Most of the housing across the region is aging. Older homes often lack adequate insulation, plumbing, and/or roofing, which makes the occupants more vulnerable to climate hazards. Basic needs like electric power supply may be at risk due to home's age and maintenance costs. American Community Data (ACS) 2019 data show the percentages of homes in each county that are at least 30 years old. Vance County has the highest percentage of homes at least 30 years old at 67%.

    - Franklin County: 44%
    - Granville County: 52%
    - Person County: 58%
    - Vance County: 67%
    - Warren County: 55%

    In addition, there are infrastructure assets including dams, water systems, and bridges that require upgrades due to their age. *Franklin Next* reports that continued investment in water infrastructure is essential to support development in key areas and maintain adequate pressures and delivery rates throughout the system (Franklin County, North Carolina, 2020).

- **Broadband Connectivity:** Stakeholders shared that broadband and cellular communication services are unreliable throughout the region. This statement is verified in Granville County's comprehensive plan stating that "high speed internet access in rural areas is an issue throughout the State of North Carolina…the divide between north and south Granville, as it pertains to broadband access, is especially distinct" (Granville County, North Carolina, 2018).

- **Aging Population**: The region's population is aging, especially in the northern portions of the region. With aging comes challenges such as reduced mobility and physical ailments, which can make it hard to evacuate from severe weather events. *Table 5* shows age information for the region using ACS data. Warren County has the highest percentage of persons aged 65 and over at 25%, as well as the highest median age in the region of 48 years old. Franklin County has the most persons aged 65 or older at 11,502 persons, who make up 17% of the total population. The Kerr-Tar region's median age (43.3) is higher than the statewide value of 38.9 years old.

Table 5 - Age Characteristics in the Kerr-Tar Region

County	Total population	65 years and over	65 years and over, %	Median age
Franklin	68,027	11,502	17%	41
Granville	59,823	10,187	17%	43
Person	39,561	7,771	20%	44
Vance	44,614	8,140	18%	41
Warren	19,746	5,017	25%	48
Regionwide	**231,771**	**42,617**	**19%**	**43.3**
North Carolina	**10,386,227**	**1,688,354**	**16%**	**38.9**

Source: (United States Census Bureau, 2019)

2.1.1.3 Resiliency-Related Work

Efforts to build a more resilient region are currently underway, although there is more work to be done to protect communities from both climate and non-climate hazards. Identifying the region's resiliency-focused strengths, challenges and projects is an essential first step in developing a path forward. Stakeholders provided insight into current and future resiliency-related efforts during meetings and the open house. The list below is a culmination of information heard directly from stakeholders. Below is a summary of stakeholder's feedback.

Current Efforts

- The City of Creedmoor did not receive funding in the latest round of FEMA Building Resilient Infrastructure and Communities (BRIC) grant program to upgrade the 80-year-old Lake Rogers dam.
- Recent updates to the region's HMPs:
    - Tar River Regional Hazard Mitigation Plan (HMP) was updated in 2021. This HMP covers Franklin, Granville, Vance, and Warren counties.
    - The Eno-Haw Region HMP was updated in 2020. This HMP includes Person County and other counties outside the Kerr-Tar region including Alamance County, Durham County, and Orange County.
- The Town Manager of Roxboro indicated that the town applied for BRIC funding to address flooding issues within its limits. Roxboro lies between two ridges, which leads to nuisance flooding.
- The Kerr-Tar COG organized a regional Food Policy Council to address food access issues in the region. Stakeholders cite food access as a critical element of regional resiliency because climate hazards impact food supply and food delivery.
- Warren County is developing a Comprehensive Plan and Land Use Plan that contains resiliency components including improving resiliency of critical infrastructure. County staff released the Draft Plan in July 2022 for public review.
- There is a renovation project at the Kerr Lake Regional Water System (KLRWS), the public water system serving portions of Vance, Granville, Warren, and Franklin counties. The KLRWS consists of a conventional surface water treatment plant, distribution mains, storage tanks and water meters. Stakeholders cite water supply and water quality as a regional resilience issue. Extreme heat and drought may impact water supply and water quality in the future.

- Regionwide, EMS divisions collaborate with local industries to produce up-to-date and reliable emergency preparedness tools.
- Warren County recently implemented new zoning policies to stimulate economic development activities along I-85 primarily in the area surrounding the towns of Butner and Creedmoor. Stakeholders cite economic development as a regional resilience topic given its connection to natural resources, which will be impacted by climate change. The region's natural resources bring in new businesses, increased tourism, and new employment opportunities.
- Vance County prioritizes land use controls and planning tools to enforce its flood ordinances. The ordinances direct development away from the 100-year floodplain, require structures elevated above base flood elevation and incentivize development to encourage cluster development and avoiding wetland and flood prone areas.

Stated Needs from Stakeholders

- Implementing backup power for critical facilities is a priority in Granville County.
- All counties recognize that more public outreach is needed to inform residents of the risk of climate hazards. Tools such as a regional website, and literature on flood protection, sheltering, and emergency preparedness could become available at public facilities if this idea is pursued.
- The City of Roxboro and Person County may consider stormwater fees to help drive financing of other resiliency efforts.
- Provide an educational tool when Vance County updates its land use policies and implements improved mapping system upgrades.
- Construction of a new Emergency Operations Center (EOC) in Warren County is needed to help nearby residents withstand severe weather events.
- Continuous need to provide emergency communication tools to non-governmental entities about hazard risks. Examples include educating real estate professionals about housing in floodplains, and working with local media outlets, independent and corporate retail locations about hazard risks.

3.0 Climate Hazards

The Kerr-Tar region is located in the Piedmont region of North Carolina which lies in between the Coastal Plain region to the east and the Western Mountains region to the west. The Piedmont region, and its Kerr-Tar communities, is far enough inland that its weather is not heavily influenced by the ocean. And it is far enough from the western mountains that it does not receive mountain-influenced rainfall.

Based on regional HMP data and stakeholder feedback, the most prominent, high-impact climate hazards in the Kerr-Tar region are severe weather (specifically heavy rainfall and winds), hurricanes, and ice/winter storms. Other high-risk hazards include wildfire, flooding, and extreme heat in select areas (Wood., 2020). Drought is considered a lower risk hazard in the region, but communities will experience its effects over the coming years. Additional analysis using publicly available Geographic Information System (GIS) data confirms these as the top hazards. The region is uniformly exposed to all hazards, and the hazards' spatial extent ranges from minimal (i.e., an icy road intersection) to large (i.e., a far-reaching hurricane). All high-risk hazards have widespread potential impacts and damage and can threaten the general population and built environment.

The following section describes how major climate hazards, influenced by climate change, are likely to affect the Kerr-Tar region over the next 30-50 years. The discussion is based on a detailed analysis of the science in the 2020 *North Carolina Climate Science Report* and other climate science research reports.

3.0 Hurricanes and Tropical Storms

Hurricanes and tropical storms are some of the most damaging natural hazards influenced by climate change in the Kerr-Tar region. They are among residents' top concerns. Heavy, sustained rainfall and high winds combine to cause property destruction, debris accumulation, and severe widespread flooding. Although coastal areas are directly exposed to hurricanes and tropical storms, their impact can be felt hundreds of miles inland. For the inland Kerr-Tar region, the primary hurricane hazard is flooding from heavy rainfall, followed by strong winds. In some hurricane events, tornadoes may develop.

In recent history, hurricanes Matthew (October 2016) and Florence (September 2018) caused widespread damage across the region due to heavy rain, flooding, and winds. Major issues included flooded neighborhoods, challenging water rescues, multi-day power outages, and contamination after hazardous waste sites and water treatment infrastructure flooded (Wright, 2016). In the Kerr-Tar region, the 48-hour observed rainfall depth (October 8-9, 2016) ranged from 3 to 10 inches. The hardest hit counties were Warren and Franklin counties, both of which were declared disaster areas by FEMA. The heaviest rainfall total occurred in southern Franklin County receiving 9-10 inches (North Carolina Emergency Management, 2017). Flooding from Hurricane Matthew was particularly devasting because many areas received above average rainfall in the month of September leading to wet antecedent conditions prior to the hurricane event. Therefore, Matthew's heavy rain fell on already-soaked ground, causing flooding in areas that had never flooded before. Hurricane Florence devastated the area two years later, in September 2018, and in many cases undid recovery efforts in areas hit hard by Hurricane Matthew (Armstrong, 2018).

Climate scientists project the intensity of the strongest hurricanes is likely to increase with global warming (Kunkel, et al., 2020). Heavy rainfall associated with hurricanes and tropical storms will very likely increase for North Carolina, which increases the risk of flooding (Kunkel, et al., 2020). However, it is unknown whether the number of hurricanes making landfall in North Carolina will change (Kunkel, et al., 2020).

3.1 Flooding

Flooding is a concern among Kerr-Tar Region residents, some of whom are still rebuilding and recovering after Hurricanes Florence and Matthew caused widespread and damaging flooding. Crops were lost, residents required water rescues, floodwaters damaged wastewater treatment plants and carried sewage into floodplains areas used for water supply, swimming, and recreation (Armstrong, 2018).

Damaging floods in the region are caused by rainfall resulting from hurricanes and tropical storms, and/or short-duration heavy rainfall from intense storms (i.e., thunderstorms, and winter coastal storms). Flooding may occur near rivers as they rise due to high volumes of sustained rainfall that

exceeds the capacity of streams. Waters rise to cover urban areas even away from streams or water bodies where blockages, impervious surface (i.e., hard pavements), or insufficient drainage capacity prevents water from running off and infiltrating into the ground efficiently. In steep hilly and mountainous areas, sudden heavy rainfall may cause floods to rise rapidly in dangerous flash flooding with high erosive potential. Changes in climate conditions such as rainfall amount, water management practices, or in land use and land cover can determine how flooding will impact communities.

Over the coming years, the number of inland flooding events are likely to increase because of projected increases in heavy rainfall. Future heavier rainfall will lead to more frequent and/or severe flooding (Kunkel, et al., 2020). Since flooding is already a concern in the Kerr-Tar region and increased frequency and severity of flooding across all scales is a very plausible future outcome, regional adaptation efforts should focus on protecting buildings to a higher standard of flooding levels and developing programs for safe evacuations and economic recovery. Evacuation of older adults, nursing homes and other long-term care facilities, and those without access to personal vehicles is a special concern in the Kerr-Tar region.

3.2 Severe Weather

Severe weather in the Kerr-Tar region encompasses thunderstorms, winds, lightning, hail, and heavy rainfall. Although typical severe weather systems geographically affect small areas, they can cause substantial property damage and be extremely dangerous.

3.2.1.1 Thunderstorms

Thunderstorms are a major source of heavy rain in the Kerr-Tar region, and are associated with flooding, high winds, hail, lightning, and sometimes tornadoes and waterspouts. While individual thunderstorms are unlikely to cause flooding on the scale of a hurricane or tropical storm, thunderstorms can cause short-duration heavy rainfall which leads to flash flooding and power outages in some parts of the Kerr-Tar region. Stakeholders confirmed these findings, stating that thunderstorms are very hard to prepare for and caused power outages and structural damage in Granville County. Lightning associated with thunderstorms may ignite wildfires; both lightning and high winds result in property damage, disruption to transportation networks, and potentially loss of life.

Severe thunderstorms are likely to occur more frequently in the Kerr-Tar region by mid-century. Thunderstorms are typically isolated, intense events which cannot be simulated in large-scale climate models. However, these climate models can simulate changes over time in the frequency and intensity of conditions conducive to thunderstorm formation (i.e., the measures of temperature, humidity, and wind speeds). It is also possible to study fine-scale events like thunderstorms using more detailed, localized models. While no consensus on future thunderstorm characteristics in North Carolina has been reached through such methods, studies across the United States have found that conditions conducive to thunderstorm formation are likely to become more common by mid-century (Del Genio, Yao, & Jonas, 2007).

3.2.1.2 Wind

High winds in the Kerr-Tar region are associated with a range of weather patterns including frontal movement and storms, hurricanes, tropical cyclones, thunderstorms, and tornadoes. When high winds occur, they damage property, interrupt travel by blocking roads, create dangerous driving conditions, and increase the potential spread of wildfire during dry weather. This was the case in October 2018, when Hurricane Michael brought high winds that wreaked havoc in Granville and Person counties, causing downed trees, road closures, and power outages. Residents reported that they expected flooding from the storm but instead were hit by strong winds; in one case a giant tree blew down, destroying a home in Stem (Mitchell, 2018).

Currently, climate science studies do not contain enough evidence or consensus to make a confident conclusion on future changes in high winds or in storms caused by cyclones, which are associated with strong wind in the region. However, it is likely that convective storms will occur more frequently, and that hurricanes and other tropical cyclones will affect the region with greater intensity in the next 30-50 years (Kunkel, et al., 2020).

Studies of tornado formation across the United States reveal that while the number of days per year on which tornadoes occur has decreased since the 1970s, tornadoes are more likely to occur in clusters (multiple tornadoes in one region and day) and that the length of the season over which tornados occur will increase (Elsner, Elsner, & Jagger, 2015) (Kunkel, et al., 2020). While these conclusions are not specific to the Kerr-Tar region, regional emergency managers should consider the implication that tornado destructiveness may plausibly increase in the region over

the next 30-50 years and that tornadoes may become a plausible threat earlier in the year and continue to occur later into the year. Kerr-Tar region residents noted that tornadoes and tornado warnings have increased in frequency.

3.2.1.3 Lightning

Lightning is one of the more dangerous severe weather hazards in the United States and is responsible for numerous deaths, injuries, and property damage including buildings, power lines, electrical systems each year. Lightning can also cause forest and brush fires. While evidence of how lightning activity in the Kerr-Tar region will change over the next 30-50 years is inconclusive, scientific evidence suggests it is likely that severe thunderstorms will become more frequent in the same period (Kunkel, et al., 2020).

3.2.1.4 Hail

Hail is an important hazard in the Kerr-Tar region because hailstorms can be damaging to crops. Hail can fall during thunderstorms. Hailstorms can occur in spring, summer, or fall but are more common in late spring and early summer, when many crops are at or near harvest. Hail can also cause damage to property including buildings and vehicles.

Scientific evidence of future changes in hail specifically is inconclusive in the Kerr-Tar region. However, scientific evidence suggests it is likely that thunderstorms, a leading cause of hail, will become more frequent in the Kerr-Tar region in the next 30-50 years (Kunkel, et al., 2020).

3.2.1.5 Heavy Rainfall

Heavy rainfall in the Kerr-Tar region can have severe consequences to residents, agriculture, and businesses. This hazard is typically the result of short-duration intense convective storms such as thunderstorms, extratropical storms (most common in the winter months), and hurricanes and tropical storms. Heavy rainfall is expected to become more frequent and severe in the future. There has been an upward trend in the number of heavy rainfall events (3 inches or more in a day), with the last four years (2015-2018) experiencing the greatest number of events since 1990.

It is not straightforward to characterize current trends in heavy rainfall based on observed data, nor is it straightforward to make statements on likely future trends in heavy rainfall based on climate modeling studies. The heaviest rainfall events tend to be spatially isolated unless caused by a very large storm system, so weather station records of heavy rainfall amounts can be very different from station to station during the same storm. Because of this, spatial smoothing techniques used to estimate of the frequency of such extreme events between stations tend to underrepresent the frequency of heavy rainfall in areas far from stations. Due to these weaknesses in means of characterizing past heavy rainfall and making future projections of heavy rainfall, current trends in station data and climate science studies on the types of storms which tend to produce heavy rainfall in the Kerr-Tar region provide important evidence on future changes in heavy rainfall.

While climate science studies have not quantified the increases in precipitation likely to result from changes in each storm type, it is likely that heavy rainfall will occur more often and with greater intensity in the Kerr-Tar region over the next 30-50 years (Kunkel, et al., 2020).

3.3 Ice and Winter Storms

The future prevalence and impacts of winter storms, snow, and ice in the Kerr-Tar region are presently uncertain, but when cold-weather storms occur the impacts can be severe. During stakeholder meetings and the open house, Kerr-Tar residents reported that the region experiences ice storms which cause dangerous roadway conditions, days-long power outages, wage losses, and food insecurity. Residents report disruption to utilities, transportation systems, and agriculture, leading to costly crop loss, accidents, hazards to those reliant on electric-powered medical equipment, and food spoilage. Ice and winter storms can also result in injury or loss of life due to hypothermia and road accidents.

Winter storms in the region are typically caused by cyclones and bring precipitation which falls primarily as rain. When winter storms coincide with very low temperatures in the Kerr-Tar region, the precipitation may fall as snow, sleet, freezing rain, or a wintry mix. These storm events can create dangerous conditions over a large area. Winter storms can have a substantial impact on communities, utilities, transportation systems, agriculture, and can result in the loss of life due to hypothermia and accidents.

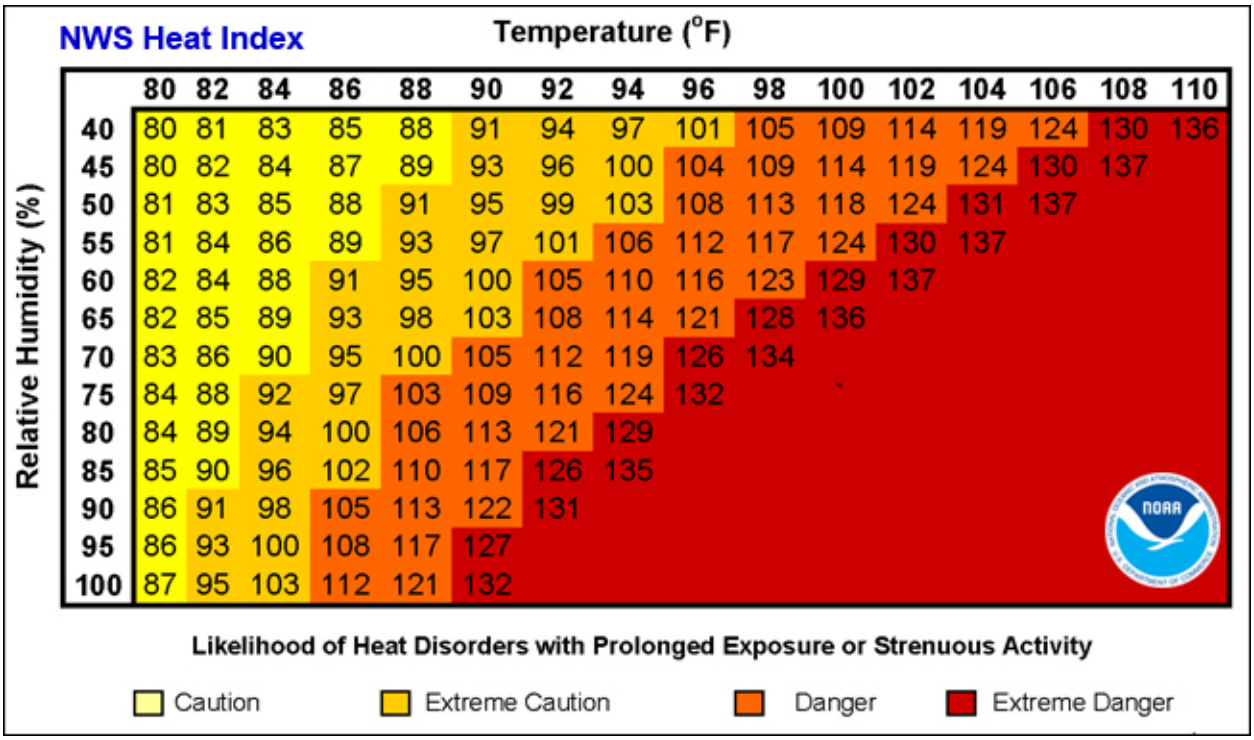
In the Piedmont region, climate scientists cannot provide definitive results regarding future changes in the frequency or intensity of storms, but they say that it is very likely that winter storms of similar intensity will produce heavier precipitation (Kunkel, et al., 2020). However, the Kerr-Tar region's average winter temperatures have been consistently higher than the long-term average since the 1990s and projections show that winter temperatures are very likely to continue increasing through the remainder of the century. Therefore, winter season snowfall is projected to become even more rare in the Kerr-Tar region than it is today (Kunkel, et al., 2020).

Research has not yet reached consensus confirming or disproving the relationship between arctic warming and the frequency of extreme cold spells at lower latitudes such as the Kerr-Tar region (Cohen, et al., 2020) (Kunkel, et al., 2020). However, given the impacts of extreme cold, winter weather, and icing in the Kerr-Tar region, it is important not to discount preparation for these events as part of climate resilience planning.

3.4 Extreme Heat

Extreme heat can have significant impacts on health, property, and infrastructure. Residents of mobile homes and low-income households, young children and infants, elderly persons, people with chronic medical conditions, and outdoor workers are especially vulnerable to extreme heat. "Heat waves" are defined as any event lasting at least three days where temperatures reach ninety degrees Fahrenheit or higher. Humidity can accompany heat waves, or it may be very dry. The National Oceanic and Atmospheric Administration (NOAA) identifies heat as the number one weather related cause of death from a natural hazard, followed by frigid winter temperatures. The National Weather Service (NWS) developed the Heat Index to better inform the public of heat dangers based on combined heat and humidity as shown in **Figure 5**. Heat Index, also known as the apparent temperature, is what the temperature feels like to the human body when relative humidity is combined with the air temperature (National Oceanic and Atmospheric Administration, n.d.)

Figure 5 - Heat Index Chart



Source: (National Oceanic and Atmospheric Administration (NOAA))

shows the health risks of heat exposure using the Heat Index chart. It will impact persons with prolonged exposure and/or physical activity in the following ways:

- Highlighted in yellow indicate caution should be taken as fatigue is possible;
- Highlighted in dark yellow indicate extreme caution should be taken as heat stroke, heat cramps, or heat exhaustion are possible;
- Highlighted in orange indicate dangerous conditions where heat exhaustion or heat cramps are likely, and heat stroke is possible;
- Highlighted in red indicate extremely dangerous conditions where heat stroke is highly likely

Table 6 - Health Risks by Heat Index Values

Classification	Heat Index	Effect on the body
Caution	80° - 90°F	Fatigue possible with prolonged exposure and/or physical activity
Extreme Caution	90° - 103°F	Heat stroke, heat cramps, or heat exhaustion possible with prolonged exposure and/or physical activity
Danger	103° - 124°F	Heat cramps or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity
Extreme Danger	125°F or higher	Heat stroke highly likely

Source: (National Oceanic and Atmospheric Administration (NOAA))

While most Kerr-Tar region residents consider extreme heat to be a lower-priority concern relative to other natural hazards in the region at present, climate science studies indicate extreme heat may become a dangerous threat in the region's future (Kunkel, et al., 2020). The Eno-Haw HMP, which includes Person County, ranked extreme heat as a high-priority concern while the Tar River Regional HMP, which includes the four other counties, ranked it as a lower-priority concern. Extreme heat has the potential to become particularly dangerous in the region due to the high number of outdoor workers in agriculture, the aging population, reported limited access to employer-sponsored healthcare, and certain types of housing that has lowered cooling capacity. This information was expressed by stakeholders in stakeholder meetings, see Appendix for a summary.

The average annual temperature in North Carolina has increased by about 1.0°F since 1895 (Kunkel, et al., 2020). The most recent data indicates that 2019 was the warmest year on record for North Carolina. Summers have become warmer in the Kerr-Tar region and current trends suggest continual increase in average temperatures. Trends in annual average temperatures in the Piedmont region are similar to statewide trends that show the current warming trend will continue. By the 2050s, climate models project that the State's annual average temperature will

increase by 2°– 5°F under a higher scenario (RCP8.5), and by 2°–4°F under a lower scenario (RCP4.5), as compared to the average temperature for 1996–2015 (Kunkel, et al., 2020).[2]

In addition, the observed and projected increases in the number of very hot days (maximum temperature of 95°F or higher), and very warm nights (minimum temperature of 75°F or higher) suggest increased frequencies of dangerous heat index values and cooling demand which are a serious concern in the region. By the 2050s, climate projections show the number of very hot days may increase from 13 days per year to 20-70 days, and that very warm nights may increase from an average of 1.6 per year to 5-50 days (Kunkel, et al., 2020). While the region is primarily rural and suburban, the number of warm nights may be even higher in urbanized centers that have more impervious surfaces such as Henderson or Oxford. Dark impervious surfaces like roads trap heat during the day and release it at night. These areas have less vegetative cover like trees and green spaces that have a cooling effect.

3.5 Drought

The Kerr-Tar region is particularly vulnerable to drought given the regional importance of agriculture and the prevalence of homes which rely on private wells for drinking water. Drought is also an important concern in the Kerr-Tar region's southern counties, where population growth has increased water demand over the last decade. Droughts are a normal occurrence in nearly all climatic regions including areas with high and low average rainfall. Drought is the consequence of a natural reduction in the amount of rainfall anticipated over an extended period, usually a season or more in length. High temperatures, winds, and low humidity can exacerbate drought conditions. Droughts can also be exacerbated by water management regimes which extract water more rapidly than it can be replenished.

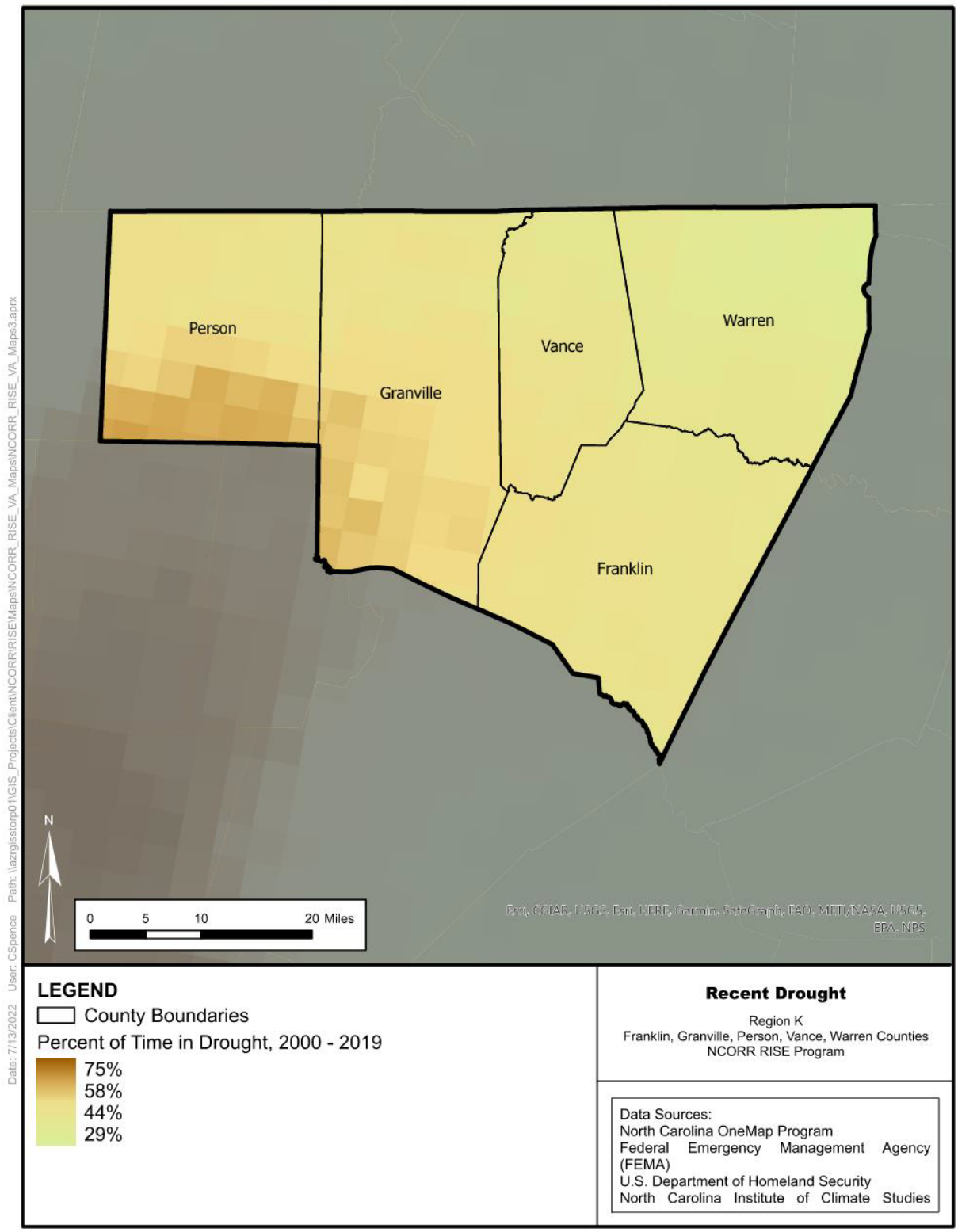
The Kerr-Tar region faced drought in 2007–2009, along with much of the southeast United States (Kunkel, et al., 2020), and was deemed in "Extreme Drought" or "Exceptional Drought," the most severe category, by October 2007. Private domestic wells are often the first to undergo the

[2] A higher scenario (RCP8.5) is where greenhouse gas emissions continue to increase, and a lower scenario (RCP4.5) is where which emissions increase at a slower rate. RCP stands for Representative Concentration Pathway.

impacts of falling groundwater levels during drought. The drought of 2007–2009 affected not only domestic wells, but also centralized surface water and groundwater supply systems. Under the dry conditions, wildfire activity in the region heightened. North Carolina's agriculture industry suffered an estimated $573 million loss due to the combined effects of the drought and an extreme cold spell in April 2007 (Kunkel, et al., 2020). The state and region responded to the drought's severe impacts with a range of interventions: bottled water distribution to residents whose wells had dried up, water drawdown conservation restrictions on public water supplies, North Carolina's governor requested federal disaster aid and waved road weight restrictions for trucks carrying hay to conserve soil moisture on drought-stricken farms (2007 Drought Timeline, 2007).

The onset of droughts is typically slow, but over time droughts can have damaging effects to agriculture, municipal and recreational water supply and use, natural vegetation, and wildlife. Over the coming years, rising temperatures and the resulting increase in evaporation will accelerate the rate at which soils dry out. Thus, naturally occurring droughts in North Carolina will be more severe (Kunkel, et al., 2020). As severe droughts intensify and become more frequent, this will increase the risk of wildfires (Kunkel, et al., 2020). *Figure 6* depicts the percent of time the region was in drought from the years 2000-2019. Person County spent the most time in drought during this time period. Since drought conditions are likely to increase in the future, the Kerr-Tar region should consider revisiting lessons learned from past droughts to prepare.

Figure 6 - Regional Drought in the Kerr-Tar Region



3.6 Wildfire

In the Kerr-Tar region, wildfires pose risks to farmers and to homes, industries, and businesses located in sparsely settled rural areas where evacuation routes may not be clear and water supplies used to fight fires are more likely to come from small wells which may not reliably supply water during drought conditions. Although there is a lower risk of wildfire damage for much of the region, it is likely to become a more severe threat in the next 30-50 years.

Wildfire is any outdoor fire that is not under control, supervised, or prescribed, meaning planned and executed under controlled circumstances for a specific purpose. Wildfires naturally occur in forest and grassland ecosystems but may also be caused by human factors. Nationally, negligent human behaviors such as smoking in wooded areas and improperly extinguishing campfires have eclipsed natural causes such as lightning as the most common start of wildfires. In North Carolina, debris burning is the leading cause of wildfires (North Carolina Forest Service, n.d.). Fires are particularly dangerous in dry conditions such as droughts, in conditions where fuel has built up to higher than usual levels, and when fires occur near human settlement.

Drought conditions increase the probability of wildfires by producing fuel in both urban and rural settings. During a drought, dead and dying vegetation provides a ready fuel source which can sustain and propagate burning when a fire ignites. More accumulated fuel after a long period without burning can increase the duration and destructive potential of wildfire. Wildfires are more likely to spread widely during high wind conditions, which can blow burning debris to ignite fire in new areas. Since severe droughts are likely to occur more frequently in the Kerr-Tar region's future, it is likely that climate conditions conducive to wildfires will increase in the next 30-50 years (Kunkel, et al., 2020).

Local weather conditions influence the risk of wildfires, but human behavior and natural resource management strategies can mitigate the risk. Public cooperation with fire prevention measures lowers the risk of wildfire even during high-risk weather conditions. Fire ignition is more likely in areas where people camp, burn debris, and where construction is taking place. Fires are more destructive when fuel has accumulated over long periods without burns. The region can prepare for more conditions conducive to burning in the future through public education on responsible

camping and smoking practices, fire-smart land management in agricultural areas, and developing a prescribed burning program to reduce fuel accumulation.

4.0 Kerr-Tar Region Sector Impacts

The following sections are a discussion of how climate hazards impact the following sectors:

- Housing
- Critical Facilities
- Regional Economy
- Public Health
- Historical and Cultural Resources
- Natural Environmental Systems
- Social Vulnerability

4.0 Housing

- The Kerr-Tar region's housing stock is particularly vulnerable to climate hazards due to its concentration of aging homes, mobile homes, and houses with inefficient heating and/or cooling systems. These traits can be detrimental to residents during extreme heat events or cold spells.
- Mobile and manufactured homes are less structurally capable of withstanding high wind events and hurricanes.
- 135 housing structures across the region lie in the 100-year or 500-year floodplain, mostly in Franklin County.
- Low risk of wildfire currently has minor impact on homes but future increases in risk will impact densely developed neighborhoods.

Housing is a fundamental source of shelter and protection for individuals and families. Stable, safe housing provides comfort to its inhabitants, especially important during weather-related events. A lack of housing, poor-quality housing, or housing instability can negatively affect an individual's physical and mental health status. For example, residents that experience dampness, mold, inadequate heating, and cooling, or overcrowding in their homes can suffer mental and physical health impacts.

Using a variety of data sources, this section describes housing characteristics that affect vulnerability. It also includes maps that identify which homes are most vulnerable to each hazard. To explore the impacts of climate hazards on the housing sector more deeply, we look at present day conditions and 30-year projections of climate hazards using best available methods.

4.0.1.1 Housing Characteristics that Affect Vulnerability

Individual homes may be more vulnerable to the impacts of natural hazard events if they have certain characteristics including the structure's age, housing type, home ownership (owner- vs. renter-occupied), and occupancy status. These factors may make a home more susceptible to hazard impacts. For example, mobile (or manufactured) homes may be more prone to structural damage related to high wind events and hurricanes. Also, homes 30 years and older may have inefficient heating or cooling systems that will be detrimental to residents during periods of cold spells and extreme heat.

Structural Condition

The age of residential buildings can directly impact its ability to withstand natural hazards. Approximately 55% of homes in the region were built more than 30 years ago and just 2% were built after 2014 (United States Census Bureau, 2019).

Table *7* provides the percentages of homes in each county that are at least 30 years old, which can put them at higher risk of costly maintenance and repair. Older homes may also be more prone to dampness, mold issues and inadequate heating and cooling systems. Stakeholders expressed that some older homes in the region lack air conditioning which could endanger people living in them, especially during high heat events.

Table 7 - Homes Greater Than 30-Years Old

County	Homes Greater than 30-Years Old (percent)
Franklin	44%
Granville	52%
Person	58%
Vance	67%
Warren	55%
Regionwide Average	**55%**

Source: (United States Census Bureau, 2019)

Table *8* further illustrates the construction dates of homes for each county in the Kerr-Tar region. Regionwide, the highest percentage of homes were built between 1990 and 1999 at 21%. Following close behind is 2000 and 2009 at 19%. There is significantly less housing built between 2009 and 2019 than any other period. This coincides with the financial crash in 2009.

Table 8 - Home Construction Dates

Structure Build Date						
	Franklin	**Granville**	**Person**	**Vance**	**Warren**	**Regionwide Average**
Built 2014 or later	4%	2%	2%	1%	2%	**2%**
Built 2010 to 2013	4%	3%	2%	1%	4%	**3%**
Built 2000 to 2009	25%	22%	17%	12%	17%	**19%**
Built 1990 to 1999	23%	20%	22%	20%	22%	**21%**
Built 1980 to 1989	14%	15%	15%	17%	16%	**15%**
Built 1970 to 1979	11%	12%	13%	18%	13%	**13%**
Built 1960 to 1969	7%	9%	9%	10%	5%	**8%**
Built 1950 to 1959	5%	5%	8%	10%	8%	**7%**
Built 1940 to 1949	2%	4%	4%	5%	3%	**4%**
Built 1939 or earlier	6%	7%	9%	7%	9%	**8%**

Source: (United States Census Bureau, 2019)

Housing Type

The type of structure influences its vulnerability to withstand climate hazards. Scientists expect detached single unit buildings with foundations to safely withstand strong storms, including tornadoes. Mobile (or manufactured) homes, on the other hand, are at a higher risk of severe damage during storms and high wind events. Extreme temperatures can endanger the lives of its occupants if evacuation is not feasible.

Table *9* shows housing type for each county within the region. Mobile (or manufactured) homes represent approximately 24% of housing in the region. Warren County has the highest percentage of mobile homes at 34%. Counties with larger proportions of mobile homes should consider ways to ensure safety and structural integrity during storms.

Table 9 - Housing Types

Housing Type						
	Franklin	**Granville**	**Person**	**Vance**	**Warren**	**Regionwide Average**
Single Unit	72%	72%	72%	63%	62%	**68%**
Multiple Units	5%	8%	6%	14%	4%	**7%**
Mobile Home	23%	20%	22%	23%	34%	**24%**

Source: (United States Census Bureau, 2019)

Home Ownership and Occupancy

Housing tenure status (renting versus homeownership) and occupancy can impact a home's vulnerability to climate hazard events. Renting tenants are more transient than homeowners and are less likely to do regular maintenance on the home. Likewise, occupied housing is more likely to receive regular maintenance and improvements than vacant housing. Over time, deferred maintenance can impact a building's ability to withstand climate hazards. **Table 10** depicts the composition of housing within each county. In the Kerr-Tar region, approximately 30% of homes are rented and 18% are vacant. Vance County has the highest percentage of renter-occupied homes at 43% and Warren County has the highest percentage of vacant housing units at 35%.

Table 10 - Housing Tenure and Occupancy in the Kerr-Tar Region

Housing Tenure and Occupancy						
	Franklin	**Granville**	**Person**	**Vance**	**Warren**	**Regionwide**
Owner-occupied	74%	72%	76%	57%	73%	**70%**
Renter-occupied	26%	28%	24%	43%	27%	**30%**
Vacant housing units	11%	12%	14%	16%	35%	**18%**
Occupied Housing Units	89%	88%	86%	84%	65%	**82%**
Total Housing Units	28,507	24,318	18,503	20,139	12,002	**103,469**

Source: (United States Census Bureau, 2019)

4.0.1.2 Flooding Impacts on Housing

Flooding can have a major impact on the housing sector. It may require expensive cleanup and repairs, and long-term effects such as mildew and molding. Extreme cases of flooding can result in a complete loss of the structure, abandoned homes, and/or displacement. This is especially true for individuals who cannot afford the repair costs. Riverine floodwaters are particularly problematic as they carry large loads of sediments that are deposited and left behind in the interior of homes when floodwaters recede. This results not only in damage to the housing structure itself but also to the personal items inside.

Currently, in Franklin, Granville, Vance, and Warren Counties, 148 residential buildings are at risk from 100-year flood events, with estimated damages of $756,118 (AECOM, 2021). This represents 0.2% of the total 98,050 buildings in those counties. In Person County, there has been approximately $300,000 in property damage due to floods between 1999-2018 (Wood., 2020).

The project team utilized available data to compare residential building first floor elevations to 100-year and 500-year water surface elevations to analyze how many residential buildings are at risk of flooding. Approximately 45 residential buildings (valued at approximately $1.64 million) have a first-floor elevation below the current 100-year water surface elevation. Approximately 90

residential buildings (valued at $2.94 million) have a first-floor elevation below the current 500-year water surface elevation.

Table *11* shows the number of homes in the 100-year and 500-year floodplain. Franklin County has the highest values for both floodplain types, at 22 and 68 homes, respectively. Regionwide, 45 homes are in the 100-year floodplain and 90 homes are in the 500-year floodplain.

Researchers estimate that 130 additional residential buildings (a total value of $7.59 million) outside of the current floodplain are likely to flood in the next 30 years (North Carolina Floodplain Mapping Program).

Table 11 – Number of Homes in Floodplain

County	Homes in 100-Year Floodplain	Homes in 500-Year Floodplain
Franklin	22	68
Granville	14	10
Person	2	6
Vance	3	5
Warren	4	1
Regionwide	**45**	**90**

Source: NC OneMap and FEMA

Figure 7 and **Figure 8** identify homes exposed to the 100- and 500-year flood event, respectively. As a proxy for the 30-year projections, the 500-year flood event map was applied by the project team. For both maps, note that one pinpoint represents one residential building. It is possible that the residential building has multiple units.

Regionwide, the greatest number of residential buildings in the floodplain are located in southern Franklin County, close to the Tar River. Residential buildings located in the floodplain are at greater risk from flooding during a hazard event. The State of North Carolina regulates the floodplain to protect property, people, and reduce future flood losses. It is important to note which residential buildings are located in the floodplain to ensure residents are aware of their increased risk and take proper precautions to mitigate damages from flooding. Residential buildings that are

not in the floodplain may still experience flooding as any location that receives rainfall has the potential to flood. However, homes located closer to a body of water are inherently at greater risk than ones more distant from a body of water.

Figure 7 - Homes Exposed to the 100-Year Flood Event

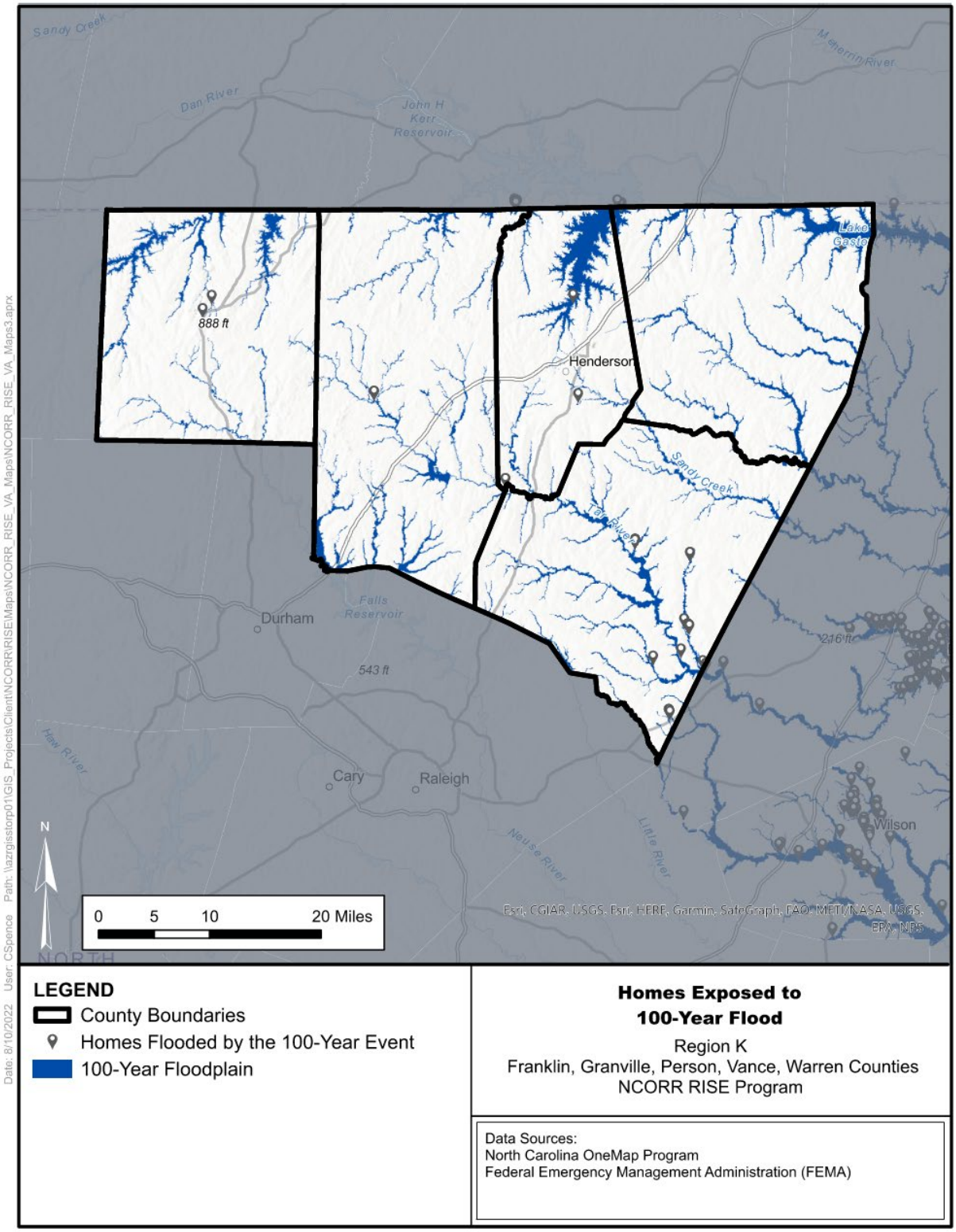
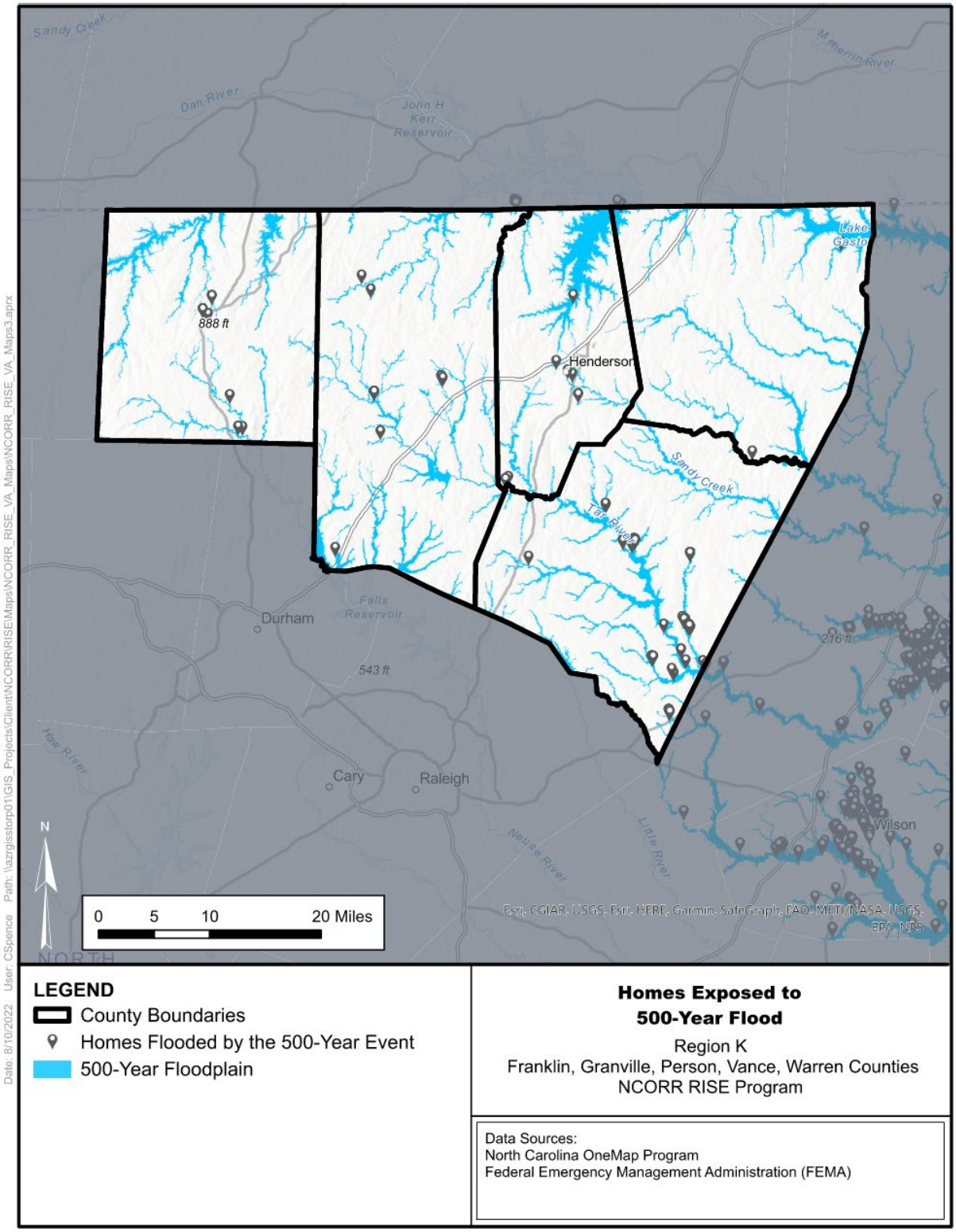


Figure 8 - Homes Exposed to the 500-Year Flood Event



4.0.1.3 Hurricanes and Tropical Storm Impacts on Housing

Hurricanes and tropical storms can have devastating impacts on homes and entire communities. Heavy rainfall from these storms can cause localized flooding and high winds can damage the exterior of homes, tear off shingles and damage roofs, cause trees to fall onto homes, break windows, and damage personal property. Hurricane and tropical storm induced winds are more likely occurrences in the Kerr-Tar region. In Franklin, Granville, Vance, and Warren counties, 82,178 residential buildings are currently at risk from 100-year hurricane winds, with estimated damages of $49.9 million (AECOM, 2021). This represents 83.8% of the total 98,050 buildings in the area. In Person County, approximately 20,647 residential buildings are at risk of impact from a 100-year hurricane wind event, representing 84.9% of all residential buildings and estimated damages of $6.5 million (Wood., 2020). Overall, about 84% of residential buildings in the Kerr-Tar region are at-risk from hurricane wind event with estimated damages would be $56 million.

4.0.1.4 Severe Weather and Ice Storm Impacts on Housing

Severe weather impacts to housing are similar to the impacts from flooding and hurricanes. Severe weather encompasses thunderstorms, wind, lightning, hail, and heavy rainfall, all of which cause damage to housing and property. Stakeholders confirmed these findings sharing that wind damages housing structures and can render them uninhabitable. In the future scenarios, the 2020 *North Carolina Climate Science Report* notes that “global climate models consistently project an increase in the frequency of severe thunderstorm environments in the United States in the mid- to late 21st century” (Kunkel, et al., 2020). Therefore, it is likely that the impact on housing due to severe weather may increase in the next 30-50 years in the Kerr-Tar region.

Ice and winter storms can damage houses by causing pipes to freeze and burst. Accumulation of ice on trees can cause them to fall into houses and damage roofs. Prolonged periods of low temperatures can strain old residential heating systems and cause electrical problems. Ice is a major threat to residents in the Kerr-Tar region.

4.0.1.5 Extreme Heat and Housing

Excessively hot temperatures can strain aging building materials in homes and residential structures. Some homes may lack central cooling units, leaving residents to rely on fans and open

windows. Where cooling units are installed, higher energy use can overburden power lines and be very cost prohibitive to homeowner or occupier. Mobile (or manufactured) homes are more susceptible to loss of cooling/heating due to a lack of proper installation and an elevated crawl space.

As temperatures fluctuate, the cost to keep housing at comfortable temperatures increases. Across the United States, low-income households tend to spend a larger portion of their income on home energy costs (i.e., electricity, natural gas, and other home heating fuels) than other households spend (United States Department of Energy, Office of Energy Efficiency & Renewable Energy, 2018). This is measured by the "energy cost burden." Energy burden is defined as the percentage of income spent on energy costs (United States Department of Energy, National Renewable Energy Laboratory, 2018). Increased energy burden can contribute to higher levels of social vulnerability, as more income is diverted towards energy consumption than usual. Energy burden is sometimes used as an indicator of social vulnerability.

Table 12 depicts the low-income energy affordability in the region and state. In North Carolina, the average energy burden is 3% in comparison to 5% in the Kerr-Tar region. Of the five counties in the region, Warren County has the highest energy burden with 6% of income spent on energy and the lowest energy burden is tied between Franklin, Granville, and Vance counties at 4%.

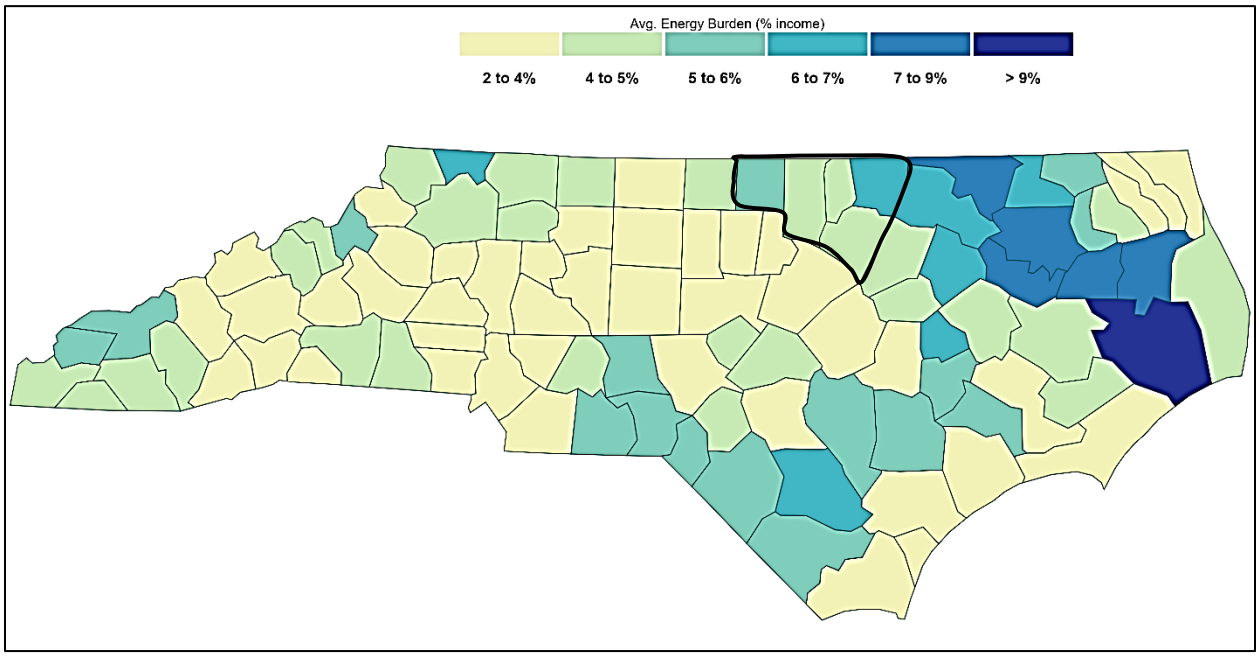
Table 12 - Low-Income Energy Affordability in the Kerr-Tar Region

County	Avg. Energy Burden (% income)
Franklin	4%
Granville	4%
Person	5%
Vance	4%
Warren	6%
Regionwide	**5%**
North Carolina	**3%**

Source: (United States Department of Energy, National Renewable Energy Laboratory, 2018)

Figure 9 shows the average energy burden of counties within the Kerr-Tar region (outlined) and across the state. The county with the highest energy burden in the state is on the coast, in Hyde County at 9%. This is 4% higher than the Kerr-Tar region's average of 5%. Given the climate projections for increased temperatures, it is likely that energy burden levels will increase to keep houses cooler. However, factors such as changes in employment, health conditions, economic status, and others will impact energy burden levels as well.

Figure 9 - Energy Burden by County in North Carolina



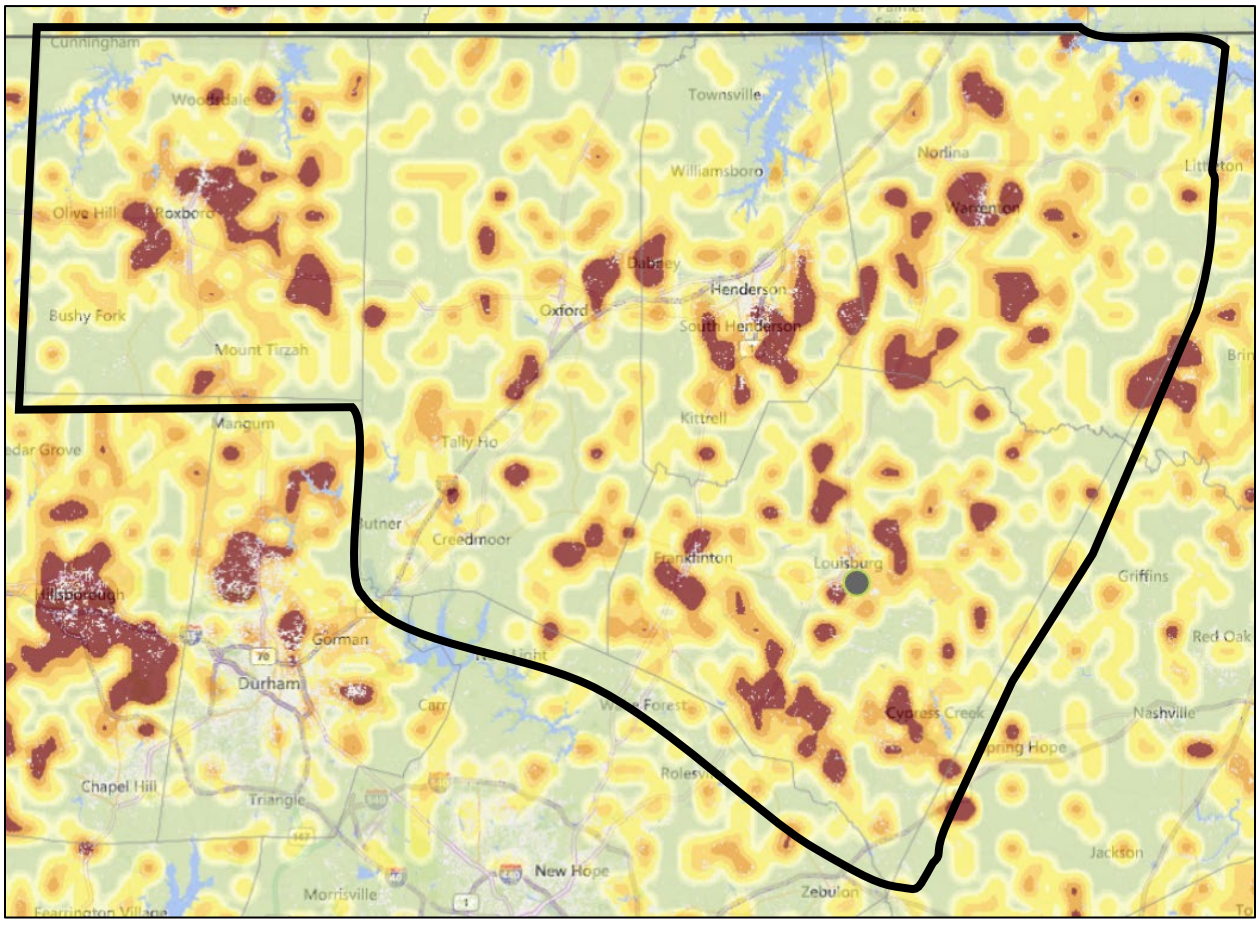
Source: (United States Department of Energy, National Renewable Energy Laboratory, 2018)

4.0.1.6 Wildfire and Housing

The most severe fires typically occur between February and May when dry and windy days provide the best conditions for ignition. When uncontrolled, wildfires threaten housing units as embers and small flames land on roofs and grasses and ignite the house quickly. In Franklin, Granville, Vance, and Warren counties, 8,476 residential buildings are currently at risk from wildfires, with estimated damages of $974.7 million (AECOM, 2021). This value represents 8.6% of the total 98,050 buildings in the four counties. Since it is not possible to accurately model 30-year projections of wildfires in the region, the best measurement to substitute is wildfire ignition density levels. The Southern Group of State Foresters Wildfire Risk Assessment Portal (WRAP)

analyzes, among other parameters, the density of wildfire ignition. Wildfire ignition density is a record of wildfire occurrence as modeled by historic wildfire ignition locations. Wildfire ignition density is 'low' for much of the Kerr-Tar region, with isolated areas of high wildfire ignition occurrence (Southern Group of State Foresters, 2022). In **Figure 10**, the output values are categorized into seven (7) classes reflecting average ignition rates, from Very Low (lightest yellow) to Very High (darkest brown). The areas of concern in the maps below include the central part of Person County, southern parts of Vance County, central and southwestern Warren County, and scattered portions in Franklin County.

Figure 10 - Wildfire Ignition Density in the Kerr-Tar Region

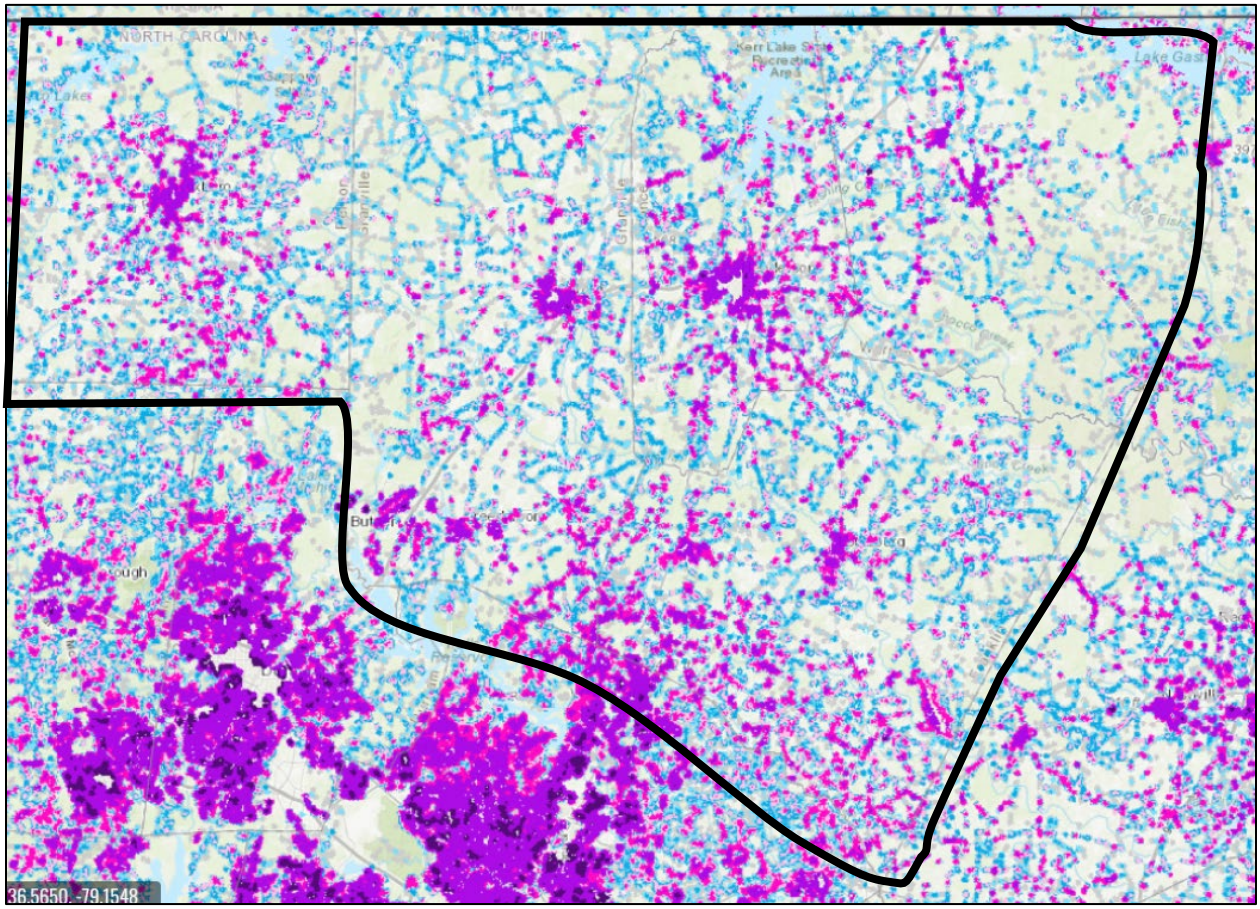


Source: (Southern Group of State Foresters, 2022)

Another parameter that may be used in lieu of future wildfire conditions is the Wildland Urban Interface (WUI). The WRAP estimates the impact from wildfire on people and homes through the WUI Risk Index. The WUI Risk Index layer is a rating of the potential impact of a wildfire on people

and their homes. It has a scale of one (light gray) to seven (dark purple); seven represents the highest risk of wildfire. Risk increases in locations of high housing density. **Figure 11** shows there is relatively low risk of wildfire damage for most of the Kerr-Tar region, with increased risk located around urban centers (Southern Group of State Foresters, 2022). Specifically, the western part of Franklin County and central Vance County have higher risk of wildfire than other parts of the region.

Figure 11 - Wildland Urban Interface in Kerr-Tar Region



Source: (Southern Group of State Foresters, 2022)

Given the low WUI Index score and the low wildfire ignition density levels in the Kerr-Tar region, it can be assumed that wildfire does not present as a highly dangerous hazard to the housing sector. However, if the region becomes more populated and housing becomes more densely developed, the wildfire risks to homes is likely to increase.

4.1 Critical Facilities

- Critical facilities are susceptible to severe weather and flooding that cause business, school, and road closures, downed trees and powerlines, and even structural damage
- Extreme heat causes road surfaces to soften and overload the electric power grid
- There are critical facilities lying within the 100-year floodplain including a dialysis center and two wastewater treatment plants

Critical facilities consist of assets, systems, and networks, both physical and virtual, that impact security, economic security, and public health and safety. Kleinfelder conducted an analysis on critical facilities within the Kerr-Tar region and includes critical health resources such as emergency medical services, dialysis centers, pharmacies, urgent care centers, and hospitals; critical social hubs and resources such as SNAP-authorized retailers (Supplemental Nutrition Assistance Program), schools, and places of worship; emergency response facilities such as emergency operations centers, police and fire stations, emergency shelters, and cellular towers; group quarters and vulnerable housing such as colleges and universities, correctional institutions, nursing homes, and mobile home parks; and facilities with hazardous contamination potential such as hazardous waste sites, landfills, and power plants. **Table 32** in the **Appendix**, shows the counts of critical facilities, organized by Sector, for the region.

Below is an inventory of the region's major critical facilities. Should any of them be impacted by natural hazards, the effects could be very costly and widespread, and crossing state lines.

- Airports: Person-Roxboro Executive Airport (Person County), Triangle North Executive Airport (Franklin County), Henderson-Oxford Airport (Granville County), Deer Run Airport (Vance County), Warren County Airport
- Major Highways in the region:
    - Interstate I-85,
    - US Routes 1, 15, 64, 158, 401, and 501
    - North Carolina 49

- Freight rail: CSX Transportation. Norfolk Southern and Western.
- Electric power: Duke Energy (all counties), Wake Electric (Franklin, Granville, and Vance), PSNC Energy (Granville County), Progress Energy (Vance and Warren counties), Piedmont Electric Membership Corporation (in unincorporated Person County and Granville County), Halifax Electric Membership Corporation (Warren County)
- Natural gas: Dominion Energy

4.1.1.1 Impacts of Hazards on Critical Facilities

Climate hazard occurrences in the region can damage critical facilities leading to many direct impacts; the most severe is injury and loss of life. Buildings, utilities, and roadways are especially at risk of extensive damage. Property damage may be widespread. Power outages from downed trees and powerlines are probable occurrences during hurricanes, high wind, and ice/winter storm events. Loss of power can range from a mild inconvenience to a life-threatening event for those reliant on powered medical equipment and cooling air conditioning units. Under severe weather events, transformers can explode, and a buildings' exterior features like windows can shatter. Blocked roadways and bridges can prevent access to life-saving care and delay first responders. Hurricanes and severe weather can have a significant impact on this sector. Although coastal areas are most vulnerable to hurricanes, their wind and rain effects can be felt hundreds of miles inland.

Damage to infrastructure within the Kerr-Tar region has secondary impacts that can be just as detrimental as the direct ones. These include mental trauma, displacement, financial losses for businesses and individuals, job losses, prolonged cleanup, and food and water supply disruptions. Socially vulnerable populations such as youth, the elderly, disabled persons, low-income persons, and mobile home occupants, among others, are at greater risk of harm from hazardous events. As such, critical facilities like senior centers, assisted care communities, healthcare facilities, mobile home parks, schools, and other facilities serving socially vulnerable populations should be prioritized in resiliency efforts.

Throughout the region, there are several critical facility-related projects underway, or newly created, to address hazards described below. All are found in the regional hazard mitigation plans. See **Table 33** in the **Appendix** for the full list of critical facility-related projects.

4.1.1.2 Flooding & Critical Facilities

Flooding is a concern in the Kerr-Tar region, particularly flash flooding. At the April 2022 open house, an attendee noted that the same geographic areas tend to flood during heavy rain events. All types of structures in or near a floodplain are at-risk of damage to varying degrees. Factors that affect the degree of damage include physical location, building methods, structure age, elevation levels, among others.

Kleinfelder used available Geographic Information Systems (GIS) data to compare the locations of critical facilities to the 100-year floodplain to analyze how many critical facilities are at risk of flooding. **Table 13** shows all critical facilities exposed to a 100-year (1%) flood event. The 'Exposed' threshold is defined as whether the critical facility is in the floodplain or not. Of all 1,035 critical facilities in the region, 11 are exposed to the 1% flood, highlighted in light yellow. These 11 facilities include one dialysis center, one landfill (closed), one pharmacy, six SNAP-Authorized retailers and two wastewater treatment plants. The highest percentage of facilities in the 1% flood event is wastewater treatment plant: two of the seven facilities in the region, or 28.6%, are exposed.

Table 13 - Critical Facilities Exposed to a 100-year (1%) Flood Event

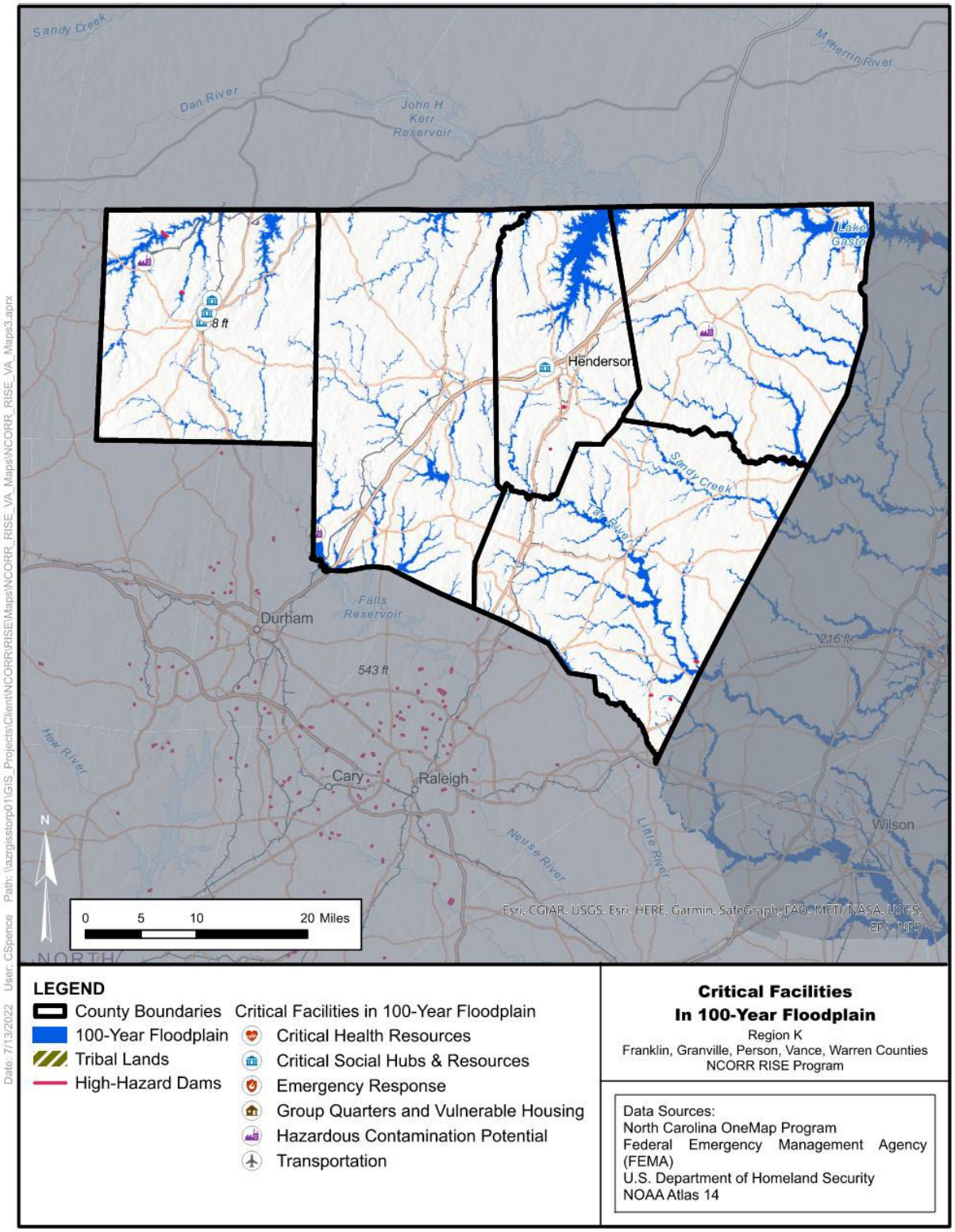
Critical Facility (CF) Type	# of CF	# of CF Exposed	% of CF Exposed
Airports	3	0	0%
Cellular Towers	26	0	0%
Colleges & Universities	3	0	0%
Correctional Institutions	17	0	0%
Dialysis Centers	47	1	2.1%
Emergency Medical Services	64	0	0%
Emergency Operations Centers	5	0	0%
Emergency Shelters	70	0	0%
Fire Stations	70	0	0%

Critical Facility (CF) Type	# of CF	# of CF Exposed	% of CF Exposed
Hazardous Waste Sites	39	0	0%
Hospitals	4	0	0%
Landfills (Active)	5	0	0%
Landfills (Closed)	21	1	4.8%
Mobile Home Parks	67	0	0%
Non-Public Schools	16	0	0%
Nursing Homes	23	0	0%
Pharmacies	52	1	1.9%
Places of Worship	151	0	0%
Police & Law Enforcement	24	0	0%
Power Plants	65	0	0%
Public Health Departments	5	0	0%
Public Schools	0	0	0%
SNAP-Authorized Retailers	248	6	2.4%
Urgent Care Centers	3	0	0%
Wastewater Treatment Plants	7	2	28.6%
All types	**1,035**	**11**	**0.01%**

Source: Kleinfelder

If any of these facilities is flooded, persons with medical conditions and social service recipients would feel the impacts of building closures and potentially destroyed interiors. Flooded wastewater treatment plants may also lead to job losses and service interruptions. **Figure 12** shows a map of all critical facilities in the 100-year floodplain, grouped into five categories: Critical Health Resources, Social Hubs & Resources, Emergency Response, Group Quarters & Vulnerable Housing, and Hazardous Contamination Potential.

Figure 12 - Critical Facilities Exposed to a 100-Year Flood Event



In addition to an analysis of the 100-year floodplain, Kleinfelder used available GIS data to assess critical facilities in the 500-year floodplain. For future risk levels, a 500-year floodplain is used as proxy for the 30-year projection. **Table 14** shows all critical facilities exposed to a 500-year (0.2%) flood event. The 'Exposed' threshold is defined as whether the critical facility is in the floodplain or not. Of all 1,035 critical facilities in the region, 11 are exposed to the 0.2% flood. These 11 facilities include one dialysis center, one pharmacy, six SNAP-Authorized retailers and three wastewater treatment plants. The highest percentage of facilities in the 0.2% flood event is wastewater treatment plant: three of the seven facilities in the region, or 42.9% are exposed.

Table 14 - Critical Facilities Exposed to a 500-year (0.2%) Flood Event

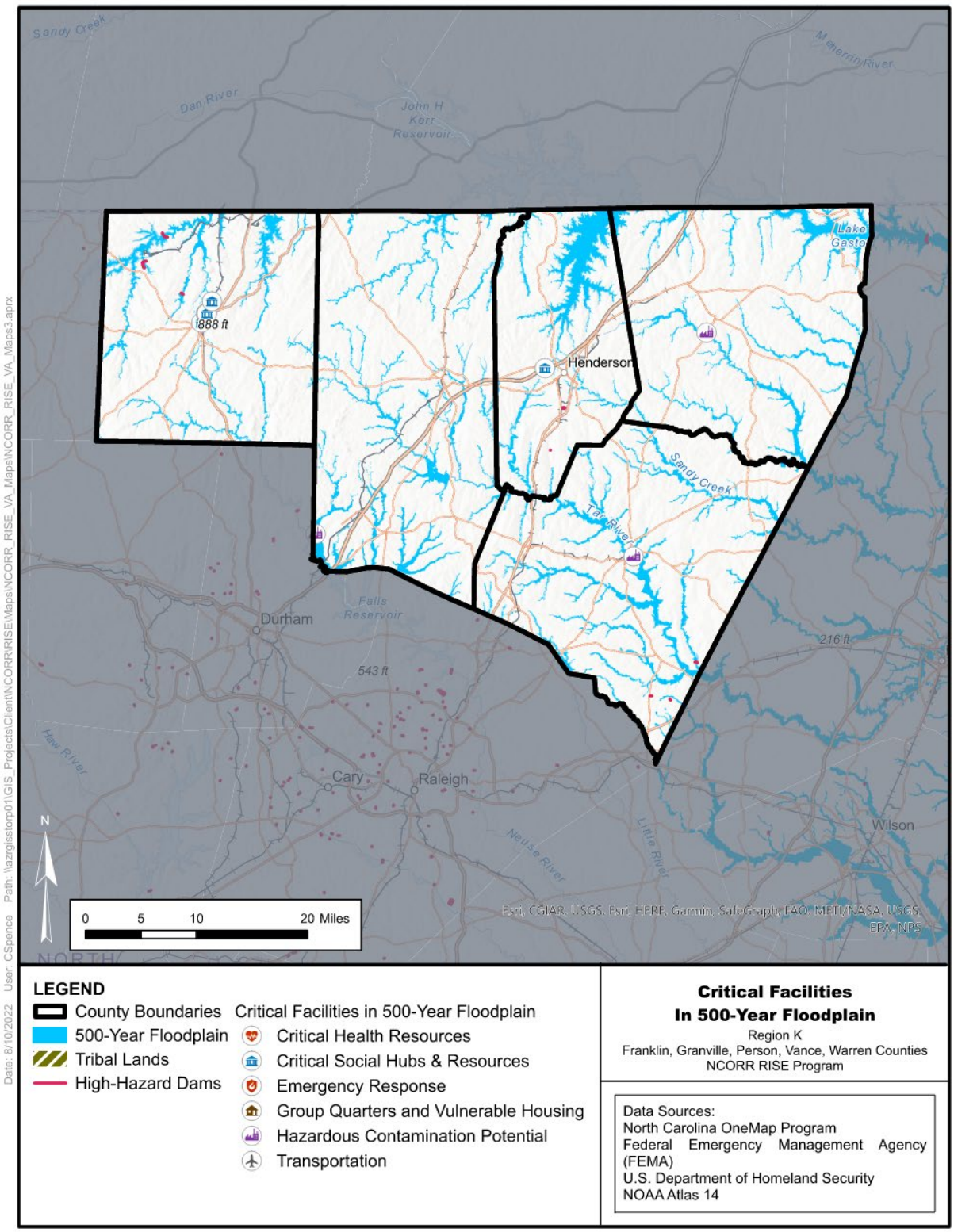
Critical Facility (CF) Type	# of CF	# of CF Exposed	% of CF Exposed
Airports	3	0	0%
Cellular Towers	26	0	0%
Colleges & Universities	3	0	0%
Correctional Institutions	17	0	0%
Dialysis Centers	47	1	2.1%
Emergency Medical Services	64	0	0%
Emergency Operations Centers	5	0	0%
Emergency Shelters	70	0	0%
Fire Stations	70	0	0%
Hazardous Waste Sites	39	0	0%
Hospitals	4	0	0%
Landfills (Active)	5	0	0%
Landfills (Closed)	21	0	0%
Mobile Home Parks	67	0	0%

Critical Facility (CF) Type	# of CF	# of CF Exposed	% of CF Exposed
Non-Public Schools	16	0	0%
Nursing Homes	23	0	0%
Pharmacies	52	1	1.9%
Places of Worship	151	0	0%
Police & Law Enforcement	24	0	0%
Power Plants	65	0	0%
Public Health Departments	5	0	0%
Public Schools	0	0	0%
SNAP-Authorized Retailers	248	6	2.4%
Urgent Care Centers	3	0	0%
Wastewater Treatment Plants	7	3	42.9%
All Types	**1,035**	**11**	**0.01%**

Source: Kleinfelder

If any of these facilities flood, persons with medical conditions and social service recipients would feel the impacts of building closures and potentially destroyed interiors. Flooded wastewater treatment plants may also lead to job losses and service interruptions. **Figure 13** shows a map of all critical facilities in the 500-year floodplain.

Figure 13 - Critical Facilities Exposed to a 500-year Flood Event



The location of these critical facilities in an area with a 1% and/or 0.2% chance of flooding in any year puts them at risk of operation failures or damages when storms occur. It is important to identify critical facilities in floodplains because many of them provide basic needs and essential services for the population. **Table 15** summarizes the critical facilities, with names and addresses, in the 100- and 500-year floodplain.

Table 15 - Detailed Summary of Critical Facilities in 100- and 500-Year Floodplain

Name	City	County	Critical Facility Type	100-Year	500-Year
Food Lion Pharmacy	Roxboro	Person	Dialysis Centers	Yes	Yes
Duke Energy Progress - Roxboro	Roxboro	Person	Landfills (Closed)	Yes	No
Food Lion Pharmacy	Roxboro	Person	Pharmacies	Yes	Yes
Quality Mart 14 1714	Roxboro	Person	SNAP-Authorized Retailers	Yes	Yes
Food Lion 67	Roxboro	Person	SNAP-Authorized Retailers	Yes	Yes
Sheetz 539	Roxboro	Person	SNAP-Authorized Retailers	Yes	Yes
Dollar General 9758	Roxboro	Person	SNAP-Authorized Retailers	Yes	Yes
Fueltime Express LLC	Roxboro	Person	SNAP-Authorized Retailers	Yes	Yes
Flowers Bakery Outlet 1210	Henderson	Vance	SNAP-Authorized Retailers	Yes	Yes
Reeds Creek	n/a	Granville	Wastewater Treatment Plants	Yes	Yes
Tar River	n/a	Franklin	Wastewater Treatment Plants	No	Yes
@ Fishing Creek	n/a	Warren	Wastewater Treatment Plants	Yes	Yes

Source: Kleinfelder

4.1.1.3 Extreme Heat & Critical Facilities

Extreme heat can cause significant damages to infrastructure. When several factors align, such as prolonged periods of extremely hot temperatures, road surfaces crack as asphalt softens.

Heat-induced expansion can also cause train rails to buckle, disrupting service. High demand on the electrical grid during periods of extreme heat can cause the temperature of powerlines to increase, resulting in sagging powerlines and occasional fires. One important cascading impact of extreme heat is that increased usage of air conditioning systems can strain the power grid, triggering power outages which can lead to adverse health impacts. More commonly, the consequences of extreme heat led to heat-related illnesses and agricultural losses.

4.1.1.4 Wildfire & Critical Facilities

Wildfire is a naturally occurring event, but it can be attributed to negligent human actions such as smoking in wooded areas. Wildfires can cut off access to utilities, emergency services, and impact evacuation routes. They can spread quickly and, in some cases, cause damage to buildings and critical facilities operations. Most of the critical facilities in Kerr-Tar region currently have a low probability of being affected by wildfire. Over the next 30 years, a majority of the region's critical facilities have a minor risk of wildfire according to First Street Foundation's Risk Factor tool. See **Table 16** for more information.

Table 16 - Wildfire Risk to Critical Facilities

County	Risk Level	% of CF impacted
Franklin	Moderate	98%
Granville	Moderate	99%
Person	Minor	81%
Vance	Minor	79%
Warren	Minor	74%
Regionwide	**Minor**	**88%**

Source: (First Street Foundation, n.d.)

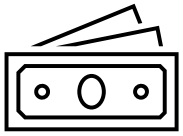
4.1.1.5 Severe Weather & Critical Facilities

Storm surge caused by heavy rainfall may impact transportation and other infrastructure upon which the chronically ill rely (North Carolina Department of Health and Human Services, Division

of Public Health). Location of heavy rainfall influences communities downstream, as water flows over land into streams and rivers, and sometimes has a greater impact after the initial storm event. The project team performed an analysis of heavy rainfall upon critical facilities and found that all 1,035 critical facilities in the region have equal chance of exposure to the 1% 24-hour rainstorm.

Other types of severe weather (i.e., thunderstorms, wind, lightning, hail) and hurricanes and tropical storms also have a tremendous impact on critical facilities like the health services infrastructure. These hazards may limit access to life-saving medicines, and may overwhelm or close hospitals, clinics, and doctors' offices (North Carolina Department of Health and Human Services, Division of Public Health).

4.2 Regional Economy



- Top industries in the Kerr-Tar region are manufacturing, healthcare and social assistance, and retail trade. Disruptions to the supply chain, logisitics, and transportation routes caused by hazards like flooding, hurricanes, and severe weather can affect these industries and the regional economy overall.
- Power outages and property damage to stores and farms resulting from storm events halt business operations.
- Business owners experience financial losses, and their employees may lose their jobs due to natural hazard events.

The Kerr-Tar region's economy is historically based on the tobacco, lumber, and agriculture industries as well as manufacturing and textiles. The Tar River and other water bodies played a significant role in its economic growth to transport goods across state lines. Some parts of the region are still agriculture-focused economies but not as predominant as it was in the past. In Warren County, for example, agri-business is the prime source of revenue, centered on tobacco and swine farming, but the declining tobacco and textile industries affect the local economy (Warren County, NC, 2022).

Over time, the region's economy and workforce transformed into primarily a service and manufacturing-based economy. Local industries, including wood products, telecommunications, and software development, also play a role in the region's economy. Franklin, Granville, Person, and Warren counties are part of the Research Triangle Region which is a booming area for industry, growth, and innovation.

Table *17* shows the industries with the highest number of employees in the region. The manufacturing industry employs the most people in the region at 9,902 followed closely by the health care and social assistance industry that employs 9,420 persons in the region.

Table 17 - Top Industries by Sector in Kerr-Tar Region, Annual 2021

Rank	Industry Sector	Number of Establishments	Number of Employees
1	Manufacturing	183	9,902
2	Health Care and Social Assistance	393	9,420
3	Retail Trade	645	7,187
4	Public Administration	95	6,000
5	Educational Services	131	5,120
6	Accommodation and Food Services	289	4,169
7	Transportation and Warehousing	170	3,976
8	Construction	570	2,898
9	Administrative and Support and Waste Management	316	2,669
10	Wholesale Trade	146	1,561

Source: (North Carolina Department of Commerce, Labor and Economic Analysis Division, U.S. Department of Labor's Bureau of Labor Statistics (BLS), 2022)

More information about the regional economy can be found in the Appendix.

Table 34 shows a ranked list of the largest employers each of the five counties in the region in 2021 and **Table 35** shows annual Employment Totals across all Industries.

4.2.1.1 Economic Losses Due to Climate Hazard Events

The Kerr-Tar region's economic sector is vulnerable to weather hazards and financial losses due to disruptions can be substantial. The agricultural industry is highly susceptible to natural hazards that can cause both crop and livestock losses. **Table 18** presents data about farm operations across the region and how much acreage will be impacted by hazard events. Regionwide, approximately 20% of farm acreage has crop insurance, putting farmers at risk of negative economic impacts if a hazard causes crop damages or losses.

Table 18 - Agricultural Sector's Exposure to Climate Hazard Events

County	# of Farms	Avg Size Farm (acres)	Farmland (acres)	Acreage with Crop Insurance	Est. Value of Land and Buildings
Franklin	538	201	107,967	24,174 (22%)	$383,906,000
Granville	557	224	124,813	14,157 (11%)	$434,850,000
Person	393	209	82,194	29,592 (36%)	$310,527,000
Vance	238	278	66,157	8,698 (13%)	$197,034,000
Warren	267	228	60,778	12,965 (21%)	$176,793,000
Regionwide	**1,993**	**228**	**441,909**	**89,586 (20%)**	**$1,503,110,000**

Source: (United States Department of Agriculture (USDA), 2017)

The cost of natural hazards can be calculated using FEMA's National Risk Index (NRI) tool and its Expected Annual Loss (EAL) formula. EAL represents the average economic loss, expressed in dollars, resulting from natural hazards each year in terms of buildings, people, and agriculture. EAL is calculated with the following equation:

Expected Annual Loss = Exposure × Annualized Frequency × Historic Loss Ratio

The calculated figure incorporates exposure to a natural hazard occurrence, the annualized frequency or the likelihood of the occurrence, and the historic loss ratio (or the estimated value expected to be damaged by the occurrence) (Federal Emergency Management Agency (FEMA), n.d.). **Table 19** depicts economic losses in the Kerr-Tar region due to natural hazards. In total, the annual cost of hazards is approximately $30 million for the entire region. Franklin County has the greatest losses at $9.3 million per year and is rated as 'Relatively Moderate' compared to the rest of the country.

Table 19 - Economic Losses from Natural Hazards: Expected Annual Loss (EAL) Overview

County	Composite EAL	Building Value	Agriculture Value	EAL Rating
Franklin	$9,340,150	$5,358,355	$2,059,870	Relatively Moderate
Granville	$5,933,341	$4,284,845	$0	Relatively Low
Person	$5,155,960	$2,709,926	$1,241,442	Relatively Low
Vance	$5,754,522	$3,880,489	$641,327	Relatively Low
Warren	$3,755,950	$1,772,721	$1,355,242	Relatively Low
Regionwide	**$29,939,922**	**$18,006,336**	**$5,297,880**	**n/a**

Source: (Federal Emergency Management Agency (FEMA), n.d.)

4.2.1.2 Impacts of Hazards on the Regional Economy

Climate hazards damage economic assets to varying degrees. Property damage may be widespread. Power outages from downed trees and powerlines are probable occurrences during hurricanes, high wind, and storms. Both property damage and power outages can harm businesses and individuals, leading to financial losses and unemployment. There may be prolonged periods of rebuilding communities and the economy, further putting a strain on this sector. During extreme heat events, the increased use of air conditioning can strain the power grid triggering power outages. Customers may opt to stay indoors in cooler temperatures instead

of supporting local businesses. Outdoor workers may suffer heat-related illnesses and business operations may slow down. Agricultural losses are as well. Droughts and wildfire impact the economy by reducing tourism and recreational opportunities. Property values may decline because of climate hazards.

4.2.1.3 Flooding

Flooding poses a significant risk to the regional economy of the Kerr-Tar region and may cause serious losses across the entire supply chain. First Street Foundation's Flood Factor tool quantifies data about property's current and future risk of flooding, flood history, and how flood risk changes over time. A property's Flood Factor is a comprehensive risk assessment including 30-year risk of flooding from heavy rainfall, overflowing rivers and streams, high tides, and storm surge (First Street Foundation, n.d.). Using the tool to quantify flood risks for the commercial sector, the project team found that 6% of all commercial properties in the region are at some risk of flooding. **Table 20** shows flood risks to businesses over the next 30 years. Overall, the region has a minor to moderate risk of flooding to its commercial sector. The risk level is expected to increase over the coming years due to a changing climate.

Table 20 - Flood Risks to Commercial Properties

County	# of Commercial Properties at Risk	Total # of Commercial Properties	% of Total	Risk Level
Franklin	95	1,194	8%	Moderate
Granville	27	925	3%	Minor
Person	47	496	9%	Moderate
Vance	38	967	4%	Minor
Warren	21	405	5%	Moderate
Regionwide	**228**	**3,987**	**6%**	**n/a**

Source: (First Street Foundation, n.d.)

The Kerr-Tar region is connected to surrounding areas via its transportation network. The ability to carry goods, services, and persons across geographies in an efficient manner is essential in sustaining the region's economy, vitality, and livelihood.

Table *21* shows the number of road miles at risk of becoming impassable due to flooding.

Table 21 - Road Miles Subject to Flooding

County	# of miles of roads at risk	Total # of miles	% of Total
Franklin	199	2,176	9%
Granville	217	2,055	11%
Person	188	1,721	11%
Vance	109	1,286	8%
Warren	122	1,536	8%
Regionwide	**835**	**8,774**	**10%**

Source: (First Street Foundation, n.d.)

4.2.1.4 Other Climate Hazards

Supply chain and logistics can be affected by severe weather, hurricanes, and other hazards happening in different locations. This results in delays and increased timelines for deliveries of goods and services. Water damage to building infrastructure can also cause businesses to close for a period, affecting profit and job stability for employees. Closed businesses that were the cornerstone of certain communities impacts individuals who relied on that business for food or daily goods. Heavy rain, flooding, and extreme temperatures may lead to school closures, disrupting teaching and learning. Droughts will make water more expensive, which will affect the cost of raw materials and production (Cho, 2019). Every industry in the Kerr-Tar region has felt the impacts of climate hazards. Therefore, it is imperative they prepare and become resilient for the future.

4.3 Historical and Cultural Resources

- Flooding poses the most significant climate risk to historical and cultural resources because it is difficult to physically move these resources from their existing locations.
- Three sites on the National Register of Historic Places are located in the 100-year floodplain (out of 147 sites total).
- Assets are not impacted by wildfire or other lower risk hazards.

The Kerr-Tar region is rich in cultural resources such as historic and archeological sites, museums with artifact collections, historic districts, and archival records. These types of resources are unique and irreplaceable assets that are equally vulnerable to climate-related hazards. It is increasingly important to preserve and protect these resources.

In the Kerr-Tar region, there are 147 sites in the National Register of Historic Places (NRHP). Established by the 1966 National Historical Preservation Act, the NRHP is the nation's official list of historic places worthy of preservation for their significance in American history, architecture, archaeology, and culture (North Carolina Department of Natural and Cultural Resources). The list includes districts, sites, buildings, structures, and objects of historical significance. Additionally, in the Kerr-Tar region, there are 3,592 sites on the "Study List" evaluated by the North Carolina Historic Preservation Office (NCHPO) for inclusion in the NRHP. The Study List identifies properties and districts that are likely to become eligible for NRHP inclusion in the future (North Carolina Department of Natural and Cultural Resources, 2015).

4.3.1.1 Impacts of Hazards on Historical and Cultural Resources

4.3.1.2 Flooding

The phrase "water-where-it-doesn't-belong" represents the biggest threat to historical and cultural resources (State of North Carolina, 2020). Floods caused by hurricanes and tropical storms, heavy rainfall, and other weather events pose the highest risk to the sector. Cultural resources located in areas with repetitive floods are inherently more sensitive to flood-induced damages. It can be difficult to reduce these sites' exposure to flooding due to structural or legal issues. With

climate change, increased or more frequent flooding may inundate and potentially destroy more cultural resources.

The project team conducted a risk analysis of NRHP sites and Study List sites to analyze how many of them are at risk of flooding for the 100-year floodplain. **Table 22** shows the results of the analysis. Of the 147 sites on the NRHP in the Kerr-Tar region, three of them are in the 100-year FEMA floodway and/or floodplains, or approximately 2%. Of the 3,592 sites on the Study List, 37 are in the 100-year floodplain, or approximately 1%.

An inventory of NRHP and Study List sites in the Kerr-Tar region that will be impacted by flooding can be found in the **Appendix**.

Table 22 – Flood Impact to National Register of Historic Places Sites

County	# of NRHP sites	# of NRHP sites in 100-yr floodplain	% of NRHP sites in 100-yr floodplain	# of Study List Sites	# of Study List sites in 100-yr floodplain	% of Study List sites in 100-yr floodplain
Franklin	40	2	5%	1,298	20	2%
Granville	47	1	2%	987	2	0.2%
Person	12	0	0%	269	5	2%
Vance	23	0	0%	367	4	1%
Warren	25	0	0%	671	6	0.8%
Regionwide	**147**	**3**	**2%**	**3,592**	**37**	**1%**

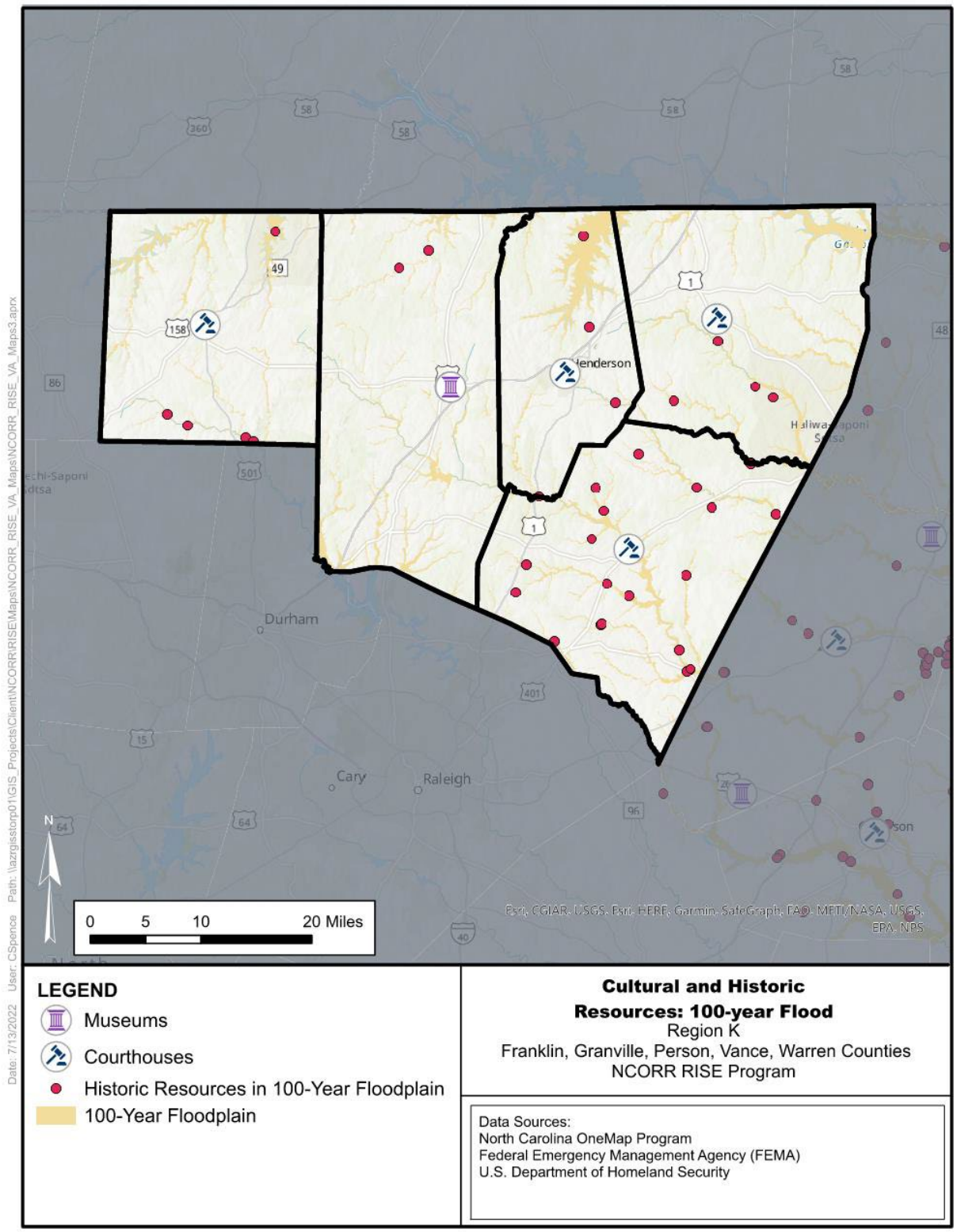
Source: NRHP

Figure 14 shows sites that are significant in preserving and storing historical and cultural information (Museums and County courthouses) and NRHP sites, both in relation to the 100-year FEMA floodplain. Below is a summary of the regionwide findings:

- NRHP Sites: 147 sites in the region, three are in the 100-year floodplain and two are in close proximity to it

- Museums: Out of 54 museums identified statewide, one is in the Kerr-Tar region: the Harris Hall Museum located in Granville County. It is not within or in proximity to current floodplain boundaries.
- County Courthouses: None of the courthouses are within or in proximity to current floodplain boundaries.

Figure 14 - Cultural and Historic Resources in the 100-year Floodplain



4.3.1.3 Other Hazards

Damages caused from wildfire and drought are a secondary climate-related hazards to cultural and historical resources. The United States Department of Agriculture (USDA) Wildfire Risks to Communities Map tool assessed the risk of wildfire to cultural and historical resources within the Kerr-Tar Region. it was determined that all five counties were low-risk areas, therefore the risk to their historical and cultural resources is low.

4.4 Natural Environmental Systems

- The region's vast amount of conservation areas and natural and working lands reduce diaster-related impacts to communities. They provide natural solutions for flood control, filtering pollutants, and air quality improvements.
- Protecting wetlands and other ecologically sensitive lands from development is essential.
- Numerous animal and plant species are listed as endangered, threatened, or of special concern in the region. They are vulnerable to climate impacts that can permanently change their habitat, such as higher temperatures.

Natural environmental systems, or ecosystems, are defined as a community of organisms living in a particular environment and the physical elements in which they interact. An ecosystem can be as small as a field or as large as the ocean. Ecosystems sustain human societies by providing agricultural, environmental, cultural, recreational, and aesthetic resources. Ecosystem services, defined as the direct and indirect contributions of ecosystems to human wellbeing and survival, include crops, livestock, fish, wood, clean water, energy, oxygen, and wildlife. Without natural environmental systems, human life could not exist.

4.4.1.1 Kerr-Tar Ecosystems and Ecosystem Services

The Kerr-Tar region is home to unique ecosystems that include rivers, streams, wetlands, managed forests, and working lands. Ecosystem services are the economic, social, and environmental benefits that ecosystems provide to human society. Wetlands and other aquatic habitats buffer hurricane and severe weather impacts by providing water storage and flood control. They also improve water quality by filtering pollutants and nutrients from water supplies, provide fish and wildlife habitat, and hold water during droughts. Managed forests supply lumber, reduce inland flooding, and provide recreational opportunities. Working lands or agricultural lands, are the farms that produce food, feed communities, and drive regional economies. Each ecosystem provides benefits to climate resiliency work. Planning and development decisions

occasionally fail to consider connections throughout the surrounding environment which impacts ecosystem services. Therefore, it is important to recognize the value of each ecosystem and preserve these lands for future generations.

4.4.1.2 Natural and Working Lands

Natural and working lands are made up of forests, farmland, and wetlands that cover more than 88% of North Carolina's landmass (Warnell, Jaffe, & Olander, n.d.). Researchers found that there are approximately 1.1 million acres of natural and working lands that are not currently under conservation in the Kerr-Tar region but fifty-six thousand three hundred acres of land are under conservation (Duke University Nicholas Institute, n.d.).

> *Natural and working lands are made up of forests, farmland, and wetlands. They are managed for natural purposes, to support food and fiber production, and for human communities. Examples include public and private forests, cropland, pastureland, grassland, wetlands, salt marsh, recreational areas, and 'development lands,' which refer to natural and managed lands within urban and rural communities* (NC Department of Environmental Quality, 2020).

Natural and working lands reduce disaster-related impacts to communities. Forests and wetlands slow water flow, reduce downstream flooding, contain contaminated floodwaters, and filter pollutants (Warnell, Jaffe, & Olander, n.d.). Keeping these natural areas intact within the floodplain, rather than developed land and populated areas, reduces the risk of disaster to people and property. Additionally, these natural and working lands accumulate and store carbon, preventing it from escaping from tree biomass and soils. Once these lands are disturbed or developed, the stored carbon is released into the atmosphere, adding to greenhouse gas emissions (Warnell, Jaffe, & Olander, n.d.).

In the Kerr-Tar region, wetlands, agriculture, and forests are key resources that can aid in resilience to climate hazards. The collaboration amongst agencies to produce the *North Carolina Natural and Working Lands Action Plan* and accompanying data is important for stakeholders in the region to use when considering ways to address resilience. The Plan provides recommendations for the best opportunities to pursue actions.

4.4.1.3 Wildlife and Biodiversity

Climate change and climate hazards pose a threat to vulnerable species by altering habitats. Altering habitats leads to changes in breeding patterns, decreases in habitat suitability, competition among species, and ecosystem alterations. It is important to consider vulnerabilities of wildlife due to their significance in our ecosystem.

Animals and plants most likely to be affected by the negative impacts of climate change are endangered, special concern, and threatened species. In North Carolina, Endangered (E), Threatened (T), and Special Concern (SC) animals have legally protected status through the North Carolina Wildlife Resources Commission (NCWRC) and plants have legally protected status through the North Carolina Plant Conservation Program (NCPCP). See Glossary for definitions of each classification. Across the Kerr-Tar region, there are 59 unique species: 26 endangered species, 11 species of special concern, and 22 threatened species (North Carolina Natural Heritage Program, 2022). **Table 37** in the **Appendix** contains full details of these species. **Table 23** details fourteen species found in four or more counties.

Table 23 – Species of Interest

Taxonomic Group	Common Name	NC Status	Habitat Comments
Freshwater Bivalve	Atlantic Pigtoe	E	Roanoke, Tar, Neuse, Cape Fear, Yadkin-Pee Dee drainages
Freshwater Bivalve	Dwarf Wedgemussel	E	Tar and Neuse drainages, mainly near Fall Line
Freshwater Bivalve	Yellow Lampmussel	E	Chowan, Roanoke, Neuse, Tar, Cape Fear, Lumber, Yadkin-Pee Dee drainages
Freshwater Bivalve	Yellow Lance	E	Tar and Neuse drainages
Amphibian	Four-toed Salamander	SC	Pools, bogs, and other wetlands in hardwood forests
Amphibian	Neuse River Waterdog	SC	Rivers and large streams in Neuse and Tar drainages (endemic to North Carolina)

Taxonomic Group	Common Name	NC Status	Habitat Comments
Crustacean	North Carolina Spiny Crayfish	SC	Rivers and streams in the Chowan, Roanoke, Neuse, and Tar drainages
Bird	Bald Eagle	T	Mature forests near large bodies of water (nesting); rivers, lakes, and sounds (foraging) [breeding evidence only]
Freshwater Fish	Carolina Madtom	T	Tar and Neuse drainages (endemic to North Carolina)
Freshwater Bivalve	Creeper	T	Roanoke, Tar, Neuse, Cape Fear, Yadkin-Pee Dee, Catawba, Broad, and French Broad drainages
Freshwater Bivalve	Eastern Lampmussel	T	Chowan, Roanoke, Tar, Neuse, Cape Fear, Yadkin-Pee Dee drainages
Freshwater Fish	Mimic Shiner	T	New, French Broad, Little Tennessee, Tar, and Neuse drainages
Freshwater Bivalve	Notched Rainbow	T	Roanoke, Tar, Neuse, Yadkin-Pee Dee, and Catawba drainages
Freshwater Bivalve	Triangle Floater	T	Roanoke, Chowan, Tar, Neuse, Cape Fear drainages

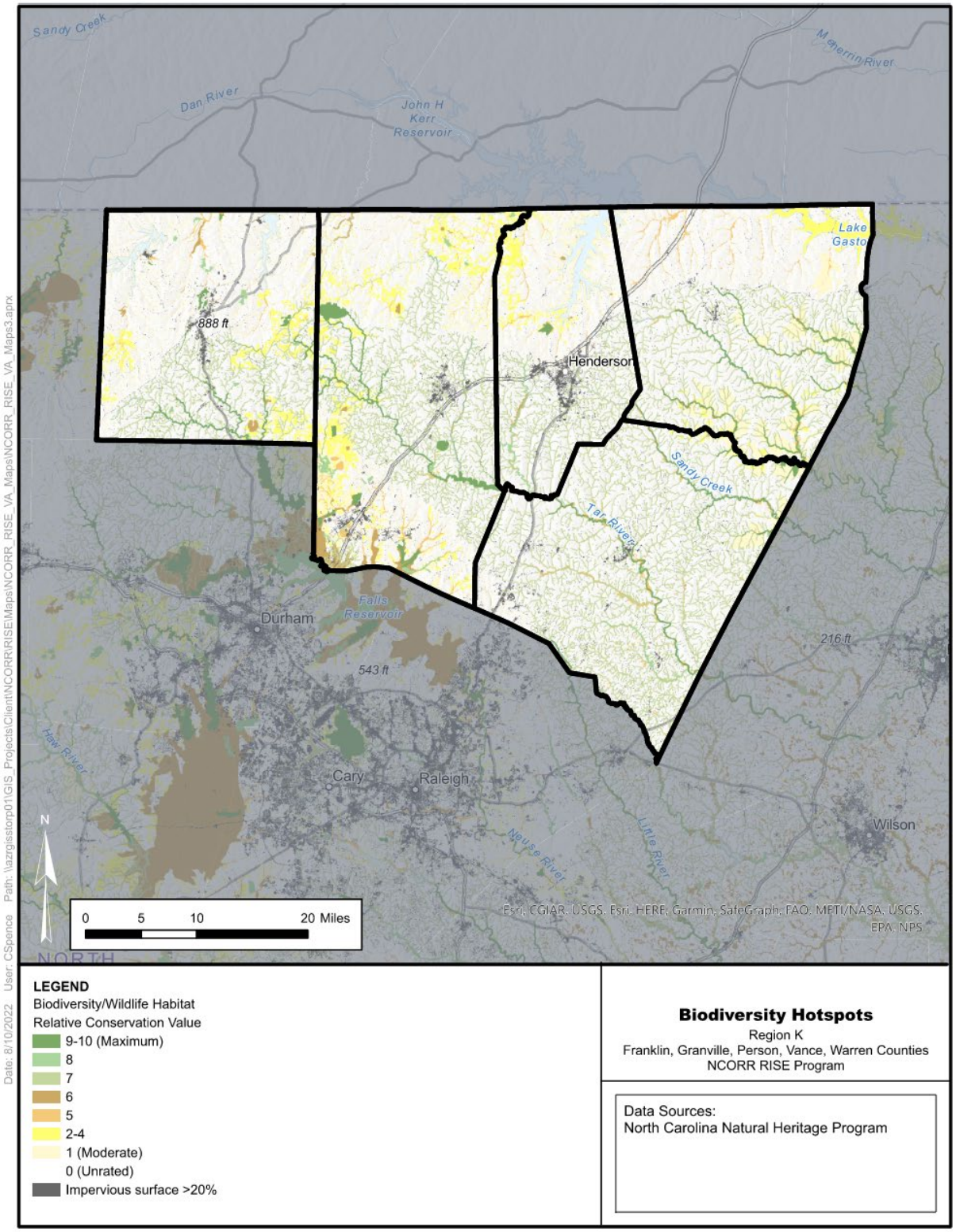
Source: (North Carolina Natural Heritage Program, 2022)

Biodiversity in the Kerr-Tar Region

The North Carolina Natural Heritage Program (NCNHP) created the Biodiversity and Wildlife Habitat Assessment to identify, evaluate, and prioritize areas that are important for maintaining healthy and sustainable ecosystems (North Carolina Natural Heritage Program, 2021). Stakeholders such as local governments, state agencies, regional councils of governments, and private sectors use Habitat Assessments to support planning and decision-making for land use, conservation, mitigation, and transportation projects (North Carolina Natural Heritage Program, 2021).

Figure 15 depicts the biodiversity and wildlife habitats in the Kerr-Tar region along with their relative conservation value. Data inputs for the assessment include natural heritage natural areas, rare species occurrences, core wildlife habitats and their connections, important aquatic resources, wetlands, and watershed priorities. Combined, areas receive a rating from 1 to 10, where areas rated five and above are deemed significant to conservation efforts.

Figure 15 – Priority Biodiversity Locations in the Kerr-Tar Region



In the Kerr-Tar region, areas with the highest conservation values lie along rivers and watersheds-specifically Tar River and Sandy Creek. These areas have a greater conservation value compared to areas with impervious surfaces such as towns, buildings, and roads.

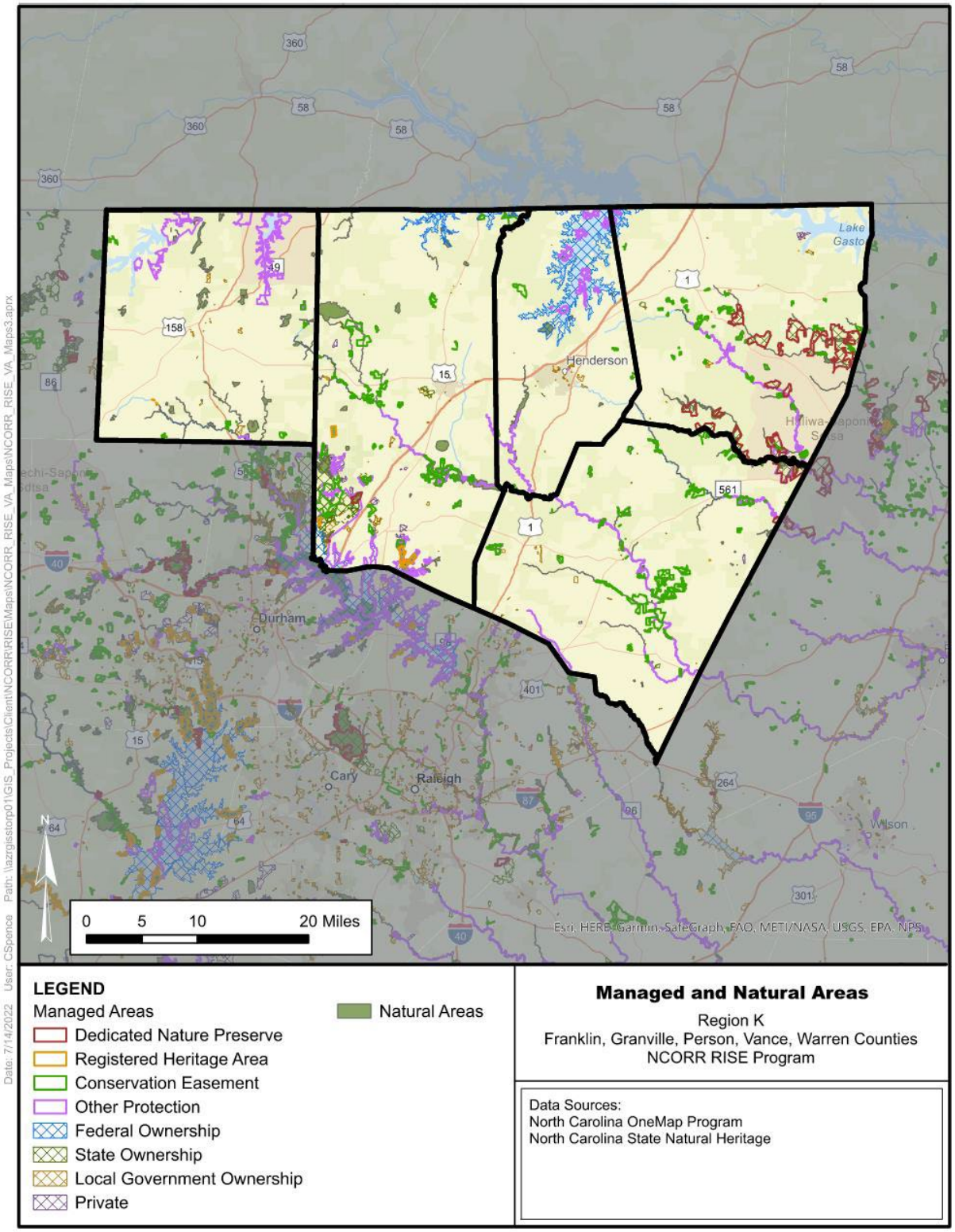
Managed and Natural Areas

Figure 16 depicts the Natural Heritage Program's (NHP) high-quality natural areas and managed areas within the Kerr-Tar region. A natural area is a site (terrestrial or aquatic) of special biodiversity significance due to the presence of rare species, unique natural communities, important animal assemblages, or other ecological features (North Carolina Department of Natural and Cultural Resources, n.d.) . Many of these areas are on private land and are not open to the public. Managed areas are a collection of properties and easements where conservation of biodiversity and ecosystem function are among the goals of the land management programs (North Carolina Department of Natural and Cultural Resources, n.d.). These areas are important to identify because they provide ecosystem services and protection for flora and fauna. Additionally, they play a role in climate resilience through supporting wildlife, retaining floodwaters, and providing habitats.

Knowing where there are areas that are home to important species will help prioritize voluntary conservation activities for landowners, land managers, local planners, and funding agencies (Wojcik, 2018). Conservation easements are tools that land managers and conservationists can encourage as they prohibit the development, farming, timbering, and mining on the land – but still allow for passive and low-impact recreation activities like hunting, fishing, and educational uses (North Carolina Department of Environmental Quality, Stewardship Program, n.d.). By ensuring these natural areas are under protection and cannot be developed will reduce the risk that people will be subjected to flooding, and that the land can perform its natural function to slow and hold floodwater.

A conservation easement is a voluntary legal agreement designed to ensure the long-term viability and protection of the natural resources within a surveyed and recorded boundary. The easement planning process establishes allowances and restrictions that are beneficial to the landowner, the easement holder, and the environment. (Source: NC DEQ)

Figure 16 - Managed and Natural Areas



4.4.1.4 Impacts of Hazards on Natural Environments

4.4.1.5 Severe Weather & Natural Environments

Heavy rainfall can damage riverine systems by causing excessive flooding, increasing water volumes and velocities, resulting in increased erosion and scouring. The number one pollutant in North Carolina's waterways is sedimentation, which is influenced by heavy precipitation events.

High winds damage trees and forested areas. Wind intensity and frequency are key factors that affect forest dynamics and diversity. Wind damage can create gaps in forest canopy, which can invite exotic species or shade-intolerant plants, thereby altering the native ecosystem.

4.4.1.6 Extreme Heat & Natural Environments

Extreme heat increases water temperatures that in turn decrease dissolved oxygen, impacting aquatic species. Low dissolved oxygen levels cause physiological stress that interfere with feeding and reproduction. When dissolved oxygen levels drop too low, fish and other aquatic species die. Algal blooms can occur which harm aquatic species and contaminate drinking water sources. Terrestrial species are also intolerant of increasing temperatures. Studies show that warmer daytime and nighttime temperatures affect animal breeding behavior, gender, parasites, and food availability.

4.4.1.7 Drought and Wildfire & Natural Environments

Droughts can cause water shortages and create an increased risk of wildfire. The hazard can reduce the amount of suitable habitat for wetland and aquatic species and can kill species that cannot migrate to wetter areas. Drought intolerant flora are also affected during dry spells.

Fire is important to many natural ecosystems, as it constitutes change and allows for regeneration. However, it can threaten conservation and working lands if it is not properly managed. Climate change projections show increased frequency of wildfires which could negatively impact functions of an ecosystem.

4.4.1.8 Invasive Species & Natural Environments

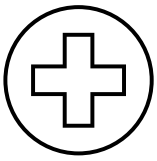
Over time, milder winters and warmer weather may lead to greater numbers of invasive exotic species that change native landscapes. Cogon grass (Imperata cylindrica), Chinese tallowtree (Triadica sebifera), and fire ants (Solenopsis invicta) are just a few examples of invasive species. Similarly, studies show that climate change has contributed to the increased prevalence of ticks. Warming temperatures in the next 30-50 years could extend the period that ticks are active during the year and increase the time people could be exposed to disease (United States Environmental Protection Agency, 2021).

4.4.1.9 Impacts of Non-Climate Stressors on Natural Environments

One of the biggest threats to natural environments in the Kerr-Tar region is converting undeveloped lands into developed land. As the Kerr-Tar region continues to expand in several areas, the region should take caution to protect vulnerable ecosystems. One example is Warren County's Fishing Creek. It is known for excellent bioclassification with more species than any other site in the Tar-Pamlico River Basin and is home to endangered mussel species (Warren County, NC, 2022). Another example is in Vance County where environmentalists worry about certain species of mussels that are very sensitive to water quality, stating that if these mussels begin to die off, we need to be concerned about our water quality (Vance County, North Carolina, 2010).

Additionally, changes to local hydrology via floodplain alteration, groundwater depletion, water withdrawal, damming of rivers and streams, and water pollution, threaten the region's natural resources. Impacts to existing streams and waterways damage the health of river systems and create issues for bank stabilization and filtration of pollutants and nutrients.

4.5 Public Health



- Natural hazards, particularly hurricanes, flooding, and extreme heat, can have direct impacts on physical and mental health.
- A high percentage of residents in the Kerr-Tar region report poor physical and mental health. People in poor health may feel the impacts of climate change more intensely than others.
- The Kerr-Tar region has a high number of elderly residents who are more susceptible to heat-related illnesses.
- Climate change may worsen water quality and land use. There are polluted water bodies, animal feed operation sites, and contaminated waste sites within the region that, if disrupted by hazard events, may cause public health concerns.

According to the World Health Organization, climate change is the single biggest health threat facing humanity (World Health Organization, 2021). The climate-induced health risks include, but are not limited to, heat-related illness, respiratory illness, water borne diseases, injury and mortality from extreme weather events, vector borne diseases, malnutrition and food borne diseases, and mental health issues (World Health Organization, 2021). Impacts to public health will become more pronounced as climate conditions continue to change. The primary indicators to monitor include physical health, mental health, heat-related issues, water quality, and contaminated waste sites.

Identifying sites that may be affected by, or contribute to, the climate hazards is a necessary first step in building a more resilient region. Knowledge of hazardous waste sites or the population's health statistics, for example, may help county officials and other advocates plan for future changes. Furthermore, any irregularities to these indicators can be a sign of worsening climate conditions. For example, as the number of very hot days increases, there will be an uptick in the number of heat-related illnesses, and, during drought events, communities may experience water supply and water quality issues.

The following section discusses the health indicators listed above and their vulnerabilities in the Kerr-Tar region. Public health officials can track these indicators to help inform resiliency measures and programming.

4.5.1.1 Physical and Mental Health Conditions

Physical Health

Physical health is vital to one's quality of life, and individuals in poor health will more likely be harmed by climate change. Researchers have found that underlying disease burdens make certain populations more vulnerable to climate health effects and affect people's resilience during and after extreme events (Thie & Tart, 2018). For example, with increasing severe weather events and coinciding power outages, persons reliant on electronic medical devices should be monitored in case of an evacuation or life-threatening emergency.

Table *24* shows health statistics of Kerr-Tar region's residents with a high-level summary of physical health and mental health conditions, as well as disability and health insurance data among residents. This data shows that an average of 14% of the regional population is self-reported to have fair or poor physical health.

Table 24 - Health Indicators

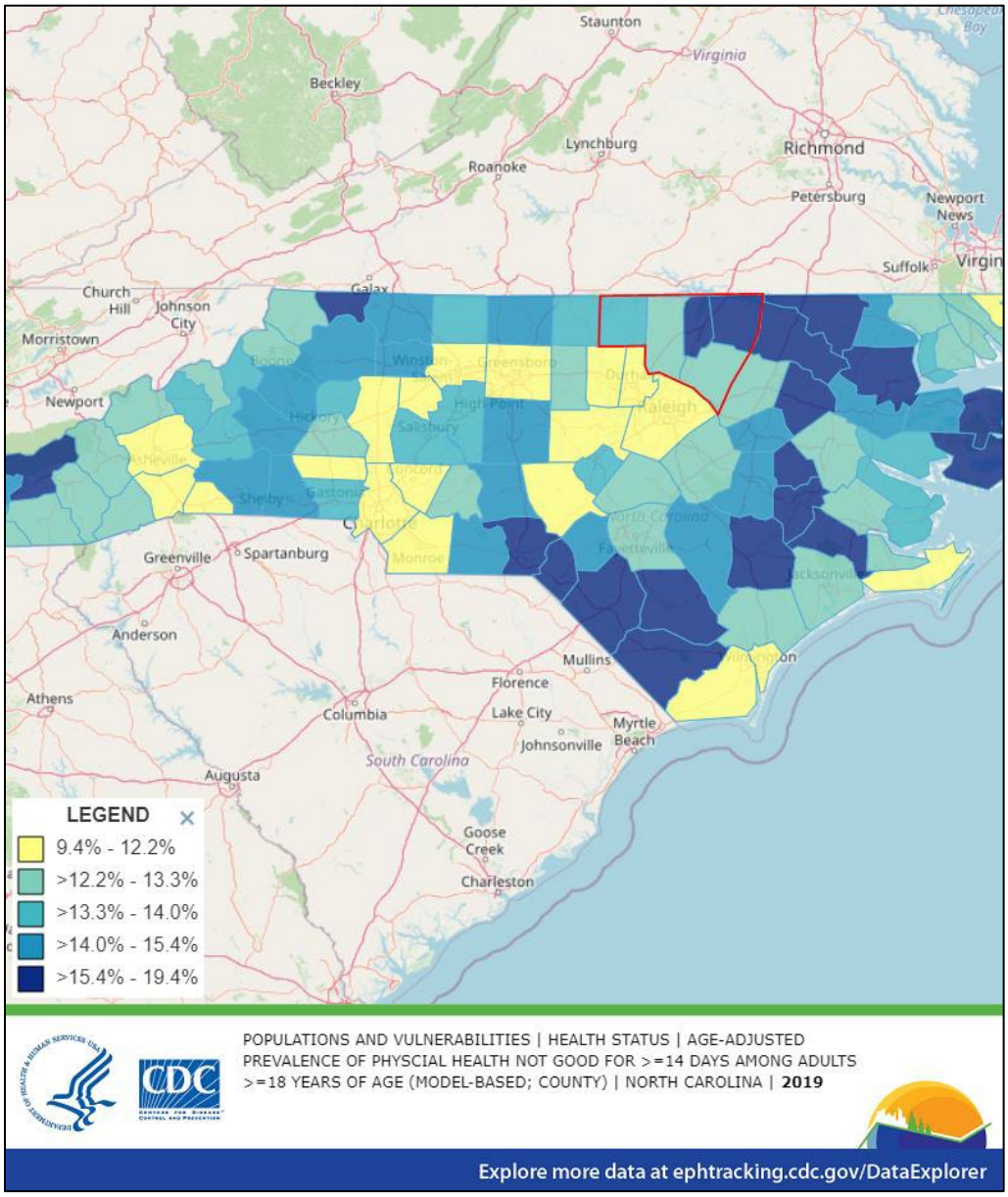
Health Indicators						
	Franklin	**Granville**	**Person**	**Vance**	**Warren**	**Regionwide Average**
Prevalence of Adults with Less than Good Physical Health[3]	13%	13%	14%	16%	16%	**14%**
Prevalence of Adults with Less than Good Mental Health[4]	15%	15%	16%	17%	17%	**16%**
With a disability, under age 65 yrs, 2016-2020	11%	10%	15%	14%	13%	**13%**
Persons without health insurance, under 65 yrs	14%	13%	13%	15%	17%	**14%**

Source: (Centers for Disease Control and Prevention, 2019), (United States Census Bureau, 2020)

Figure 17 shows that the region has moderate to high percentage of population who reported less than good health, as compared to the rest of North Carolina. It is therefore important for the Kerr-Tar region, especially Vance and Warren Counties who reported the highest percentages of poor health, to invest in public health to increase resilience.

[3] Age-adjusted estimate of the prevalence of adults aged 18 years or older with 'less than good' health for more than 14 days. 'Less than good health' data was generated as respondents reported their general health status as 'fair' or 'poor.'
[4] Age-adjusted estimate of the prevalence of adults aged 18 years or older living in the Kerr-Tar region with 'less than good' mental health for more than 14 days during the previous 30 days. 'Less than good health' data was generated as respondents reported their general health status as 'fair' or 'poor.'

Figure 17 - Population and Vulnerabilities – Physical Health (2019)



Source: (Centers for Disease Control and Prevention, 2019)

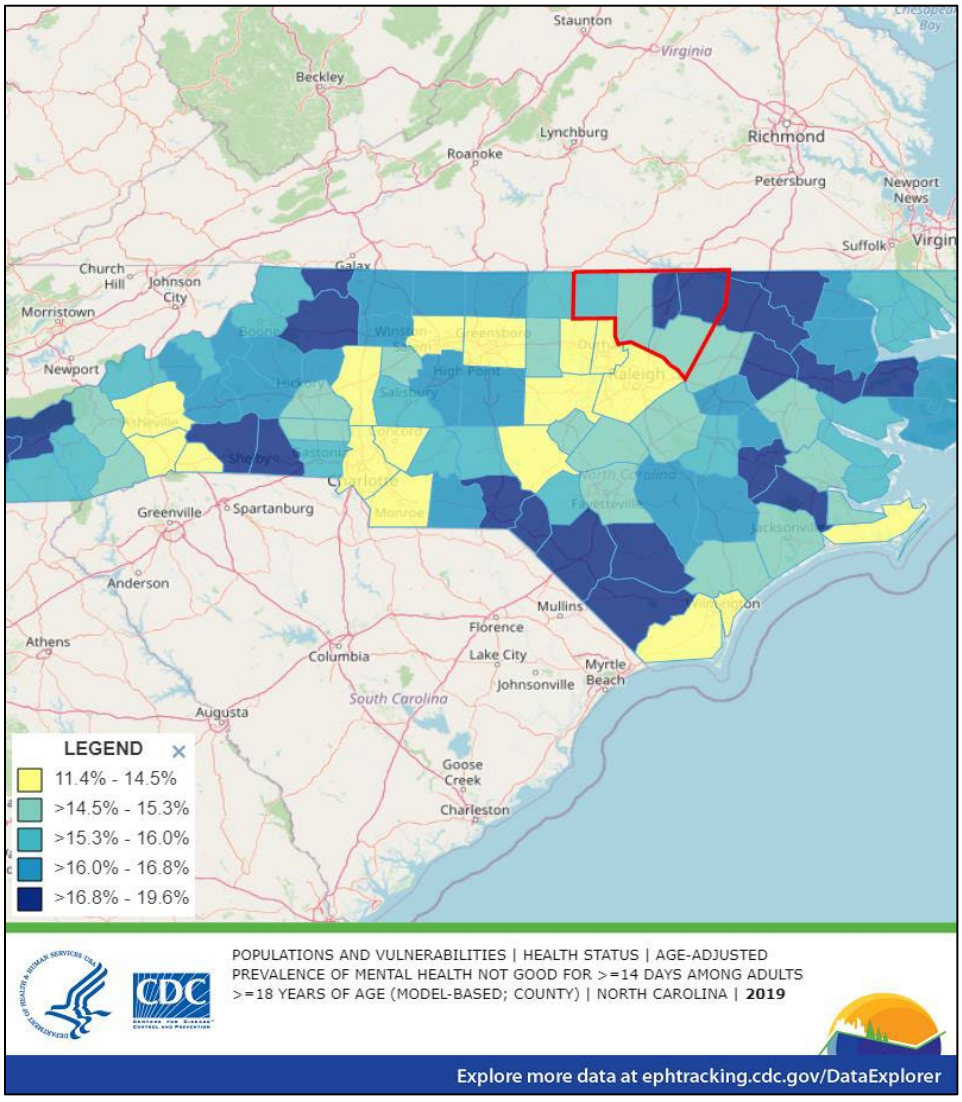
As the climate changes, people with poor health may experience more severe impacts and negative outcomes from additional pressures. Investments in public health will benefit entire communities. Examples include improving access to medical facilities, starting a disease prevention informational campaign, eliminating food deserts through increased access to affordable nutritious food or encouraging exercise with improvements to public parks and trails.

Mental Health Conditions

Loss of housing, income, or livelihoods contribute to mental stress, mental health disorders, and an increased demand for mental health services (North Carolina Department of Health and Human Services, Division of Public Health). Mental health conditions can be triggered or exacerbated by extreme weather events that lead to traumatic experiences. As an example, a hurricane can increase one's mental stress by affecting access to adequate housing and other essential needs such as life-saving medicines and treatments (North Carolina Department of Health and Human Services, Division of Public Health). In addition, individuals struggling with poor mental health are more vulnerable to risky behaviors, such as binge drinking, smoking, little physical activity, and sleeping less than seven hours (Health Risk Behaviors Measure Definitions, 2021). Extended periods of risk behavior can then lead to increased vulnerability.

Table *24* data show Vance and Warren Counties reported the most prevalence of poor mental health in the Region, at 17.2% and 17% respectively. Mental health statuses are also reflected in **Figure 18**. Therefore, any regional-scale mental health initiatives related to climate should begin in Vance and Warren Counties, as these have the highest percentage of adults with less than good mental health.

Figure 18 - Population and Vulnerabilities – Mental Health (2019)



Source: (Centers for Disease Control and Prevention, 2019)

4.5.1.2 Heat-Related Issues

Heat-related illnesses are common during extreme heat events and are the result of the bodies lowered ability to cool itself. Extreme heat is a major cause of death and is often known as the 'silent killer' because it does not cause environmental damage like other weather hazards and lacks sufficient data and monitoring (Jacks, 2014). Rising temperatures also contribute to poorer air quality.

Hotter temperatures and poor air quality have disproportionate impacts on maternal and infant mortality, young children, older adults, and individuals with pre-existing health conditions. Furthermore, individuals living below the poverty line may lack access to adequate cooling. Nearly 17% of the Kerr-Tar region's population lives in poverty. Older adults are at risk of social isolation and have decreased ability for the body to cool itself. Those living on fixed or limited incomes limits their ability to afford rising energy costs associated with home cooling. Individuals with respiratory illnesses such as asthma or chronic obstructive pulmonary disease (COPD) are particularly vulnerable to extreme heat stresses. Athletes and laborers working outside are also highly susceptible to heat related illness. Impaired air quality from wildfire smoke, pollen, ozone, and PM 2.5 levels may also contribute to increased emergency department visits for individuals with asthma, cardiovascular disease, and diabetes.

4.5.1.3 Water Quality

Access to clean water is an essential component of public health. Communities rely on clean water for drinking and daily living. However, climate change will likely impact water resources thus affecting human health and the environment. The *Climate Ready North Carolina* report states that increased and more intense precipitation can affect the quality and quantity of clean water available, when heavy rainfall events cause inundation of stormwater and sewage systems, toxic waste facilities, or livestock waste lagoons (North Carolina Interagency Leadership Team, 2012). Persons particularly vulnerable to water quality-related health risks include those with pre-existing health conditions, children, first responders, persons that consumed food grown in contaminated irrigation waters, shellfish harvesters, and others who work closely with contaminated water (North Carolina Interagency Leadership Team, 2012). Assessing the vulnerabilities of impaired waters, animal feed operation sites, and well water to climate change is important in resiliency planning. These focus areas inform public health measures for ensuring safe water quality.

4.5.1.4 Impaired Waters

In 1970, the United States Congress passed the Clean Water Act (CWA) with the goals of protecting waters from pollution, improving water quality, and maintaining clean, healthy waters. Section 303(d) of the CWA established the Impaired Waters List which requires states to evaluate and identify impaired and threatened waterways (e.g., stream/river segments, lakes) based on certain water quality indicators. Water quality is evaluated based on its designated use, such as

drinking water supply, recreation, or shellfish propagation. Point source pollution such as discharges from industrial facilities, and non-point source pollution such as sedimentation from construction sites, leaking septic tanks, agricultural runoff, and other chemical contributions contaminate and degrade water quality leading to impairment.

Since the Kerr-Tar region is located in three river basins (Tar-Pamlico, Roanoke, and Neuse), there are hundreds of miles of waters on the impaired waters list. Within the Kerr-Tar region, there are several segments listed as Category 5 for impairment including South Hyco Creek, Marlowe Creek, Tar River, North Fork Tar River, Fishing Creek, Ledge Creek, Knap of Reeds Creek, Neuse River, Nutbush Creek, Blue Mud Creek, Smith Creek, Sandy Creek, Cedar Creek, Crooked Creek, and Lick Creek (North Carolina Department of Environmental Quality, 2022).[5] These water resources exceed maximum standards for a range of indicators including for pH, dissolved oxygen, benthic organisms, chlorophyll-a, copper, and zinc. The North Carolina Department of Environmental Quality (NCDEQ) maintains an online mapping system that depicts current impaired waters. Please follow this link to view the latest information: NC 2022 Integrated Report Dashboard.

Increases in air and water temperature have a direct effect on the chemistry and biology of water resources. As regional temperatures continue to rise, so too will the number of impaired waters, thus directly affecting the health, safety, and wellbeing of its users, whether it be for drinking, recreation, or fisheries and shellfish. Knowing the location of impaired waters and the cause of its impairment is important in building regional resiliency because these water bodies may be especially vulnerable to climate hazards and affect public health.

4.5.1.5 Animal Feed Operation Sites

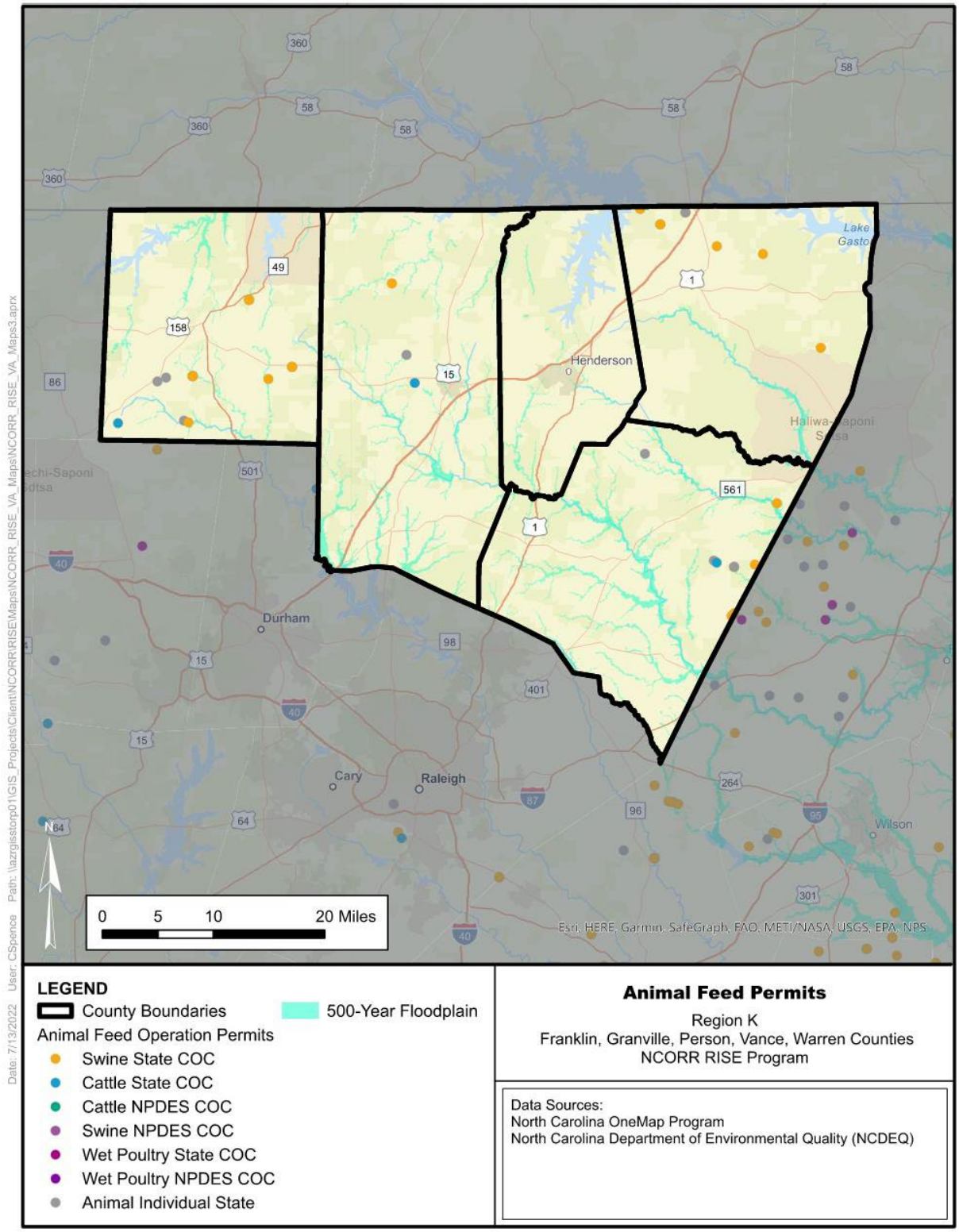
Animal feed operations and agricultural facilities located throughout the region can contribute to poor water quality when rain carries fertilizer and animal waste into waterways. The surrounding land and soils may become unusable as well, impacting the food supply. Furthermore, the untreated waste from waste treatment plants or animal operations can be released into drinking

[5] Streams designated as Category 5 require participation in a Total Maximum Daily Load (TMDL) program, which determines the maximum amount of a pollutant (i.e., bacteria, nutrients, metals) the waterbody can receive daily and still meet water quality standards.

water sources causing serious public health concerns (North Carolina Interagency Leadership Team, 2012). As the climate changes, hurricanes and heavy rainfall events are likely to become more frequent and intense. These hazards create more surface water runoff and flooding, moving pollutants into waterways faster and in higher quantities.

Figure 19 shows the locations of animal feed operation sites in the Kerr-Tar region, in relation to the 500-year floodplain. NCDEQ regulates animal feed operation sites which include swine farms, wet poultry, and cattle. There are approximately 33 permitted animal feed sites. Person County has the most animal feed operations sites with 13 sites, some of which lie or are in close proximity to the floodplain. Analyzing animal feed and agricultural sites' vulnerability to climate hazards is important in building regional resilience because of the public health implications and environmental contamination. Note, in the figure, the acronym COC stands for Certificate of Completion.

Figure 19 - Animal Feed Operation Permits



4.5.1.6 Well Water

Private wells are a key source of drinking water for many North Carolina residents, including the Kerr-Tar region, particularly in rural communities that are not connected to municipal water systems. Community and individual water supplies, including wells, will be impacted by climate change especially flooding and drought. Wells collect groundwater for drinking and other purposes and can vary in depth. Flooding from severe storms and hurricanes can result in increased pollution and surface runoff, which can inundate wells and cause contamination. Often this contamination is a result of bacteria and nitrates that can cause short-term illnesses, especially dangerous to vulnerable populations like children, pregnant women, elderly, or immunocompromised individuals. Common contaminants detected in private well water in North Carolina include arsenic, cadmium, lead, and manganese (UNC Superfund Research Program, n.d.).

Conversely, droughts result in less water entering the ground because rainfall is not replenishing underground aquifers. During this time, aquifers can become depleted when more water is pumped out for consumption than can be replenished by rain or other water sources (Uhlman, n.d.). Depleting groundwater can affect agriculture and strain other water sources.

4.5.1.7 Contaminated Waste Sites

Waste sites are integral to a community's function and proper management of them is necessary to protect human health. As the region prepares for climate change, it is imperative to account for impacts from climate hazards upon waste sites. Water contamination associated with waste sites is the biggest concern, particularly drinking water. Increased frequency and intensity of rain and storm events may disturb contaminated waste sites located throughout the Kerr-Tar region which could affect nearby resources. Heavy rainfall could inundate stormwater and sewage systems, toxic waste facilities, and livestock waste lagoons. These facilities may release sewage-related pathogens, nutrient pollution, animal wastes, and other toxic materials, especially if they are at risk to failure or overflow (North Carolina Interagency Leadership Team, 2012). During drought, contaminants can build up on the ground and subsequent rainfall generates flash floods that may overwhelm stormwater systems (North Carolina Interagency Leadership Team, 2012). Similarly, wildfires can damage site remedies and lead to the release of contaminants.

This section discusses several types of contaminated waste sites (brownfields, hazardous waste sites, Superfund sites, and coal ash sites) and the role of environmental justice in the region. **Figure 20** shows the contaminated waste sites across the region.

Brownfields

The potential contamination of brownfields often makes it difficult to redevelop the land due to Federal and State safety regulations however they can be remediated for certain future uses. However, brownfield sites located in proximity to waterways can have negative impacts on water quality when contaminants from the site enter water through surface runoff or underground leaching. For example, sites located in or near the floodplain are at higher risk of contaminant release during heavy rainfall and storm events.

> *Brownfields are lands previously developed for commercial or industrial purposes that have been compromised by something harmful, typically pollutants or chemicals* (Hazardous Waste Experts, 2014)

There are five recorded active brownfield sites in the Kerr-Tar region: one in Franklin County, two in Granville, one in Person, and one in Vance (North Carolina Department of Environmental Quality, 2022). There are none in Warren County. None of the brownfield sites are located in the 100-year floodplain or in an area with high risk of wildfire. As of spring 2022, there are approximately 13 sites in the region that started the enrollment process for the NCDEQ Brownfields Program. **Figure 20** depicts the locations of recorded sites and inactive sites. **Table** 36 in the Appendix contains an inventory of active brownfield sites.

Hazardous Waste Sites

Similar to brownfield sites, hazardous waste sites located in or near the floodplain are at higher risk of contaminant release during heavy rainfall and storm events. The Resource Conservation and Recovery Act (RCRA) is the federal law governing the disposal of solid and hazardous waste and is carried out by the Environmental Protection Agency (EPA). At the state level, NCDEQ implements waste programs under RCRA, issues permits to ensure compliance with EPA and state regulations, and collects site data. In the Kerr-Tar region, there are

> *A hazardous waste contains properties that are, or can, have harmful effects on human health or the environment, such as motor oil, car batteries, industrial chemicals, explosives, among others* (United States Environmental Protection Agency, 2021)

approximately 39 sites regulated by RCRA. All counties have at least one hazardous waste site, and Granville County has the most sites. None of the sites are located within the 100-year floodplain or in an area at high risk of wildfire. **Figure 20** shows the locations of hazardous waste sites.

Superfund Sites

In response to concerns over health and environmental risks posed by hazardous waste sites, Congress established the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), informally known as Superfund, in 1980 (United States Environmental Protection Agency, 2011). Superfund sites are "discovered" when the presence of hazardous waste is made known to EPA. These sites often include manufacturing facilities, processing plants, landfills, mining sites, and other toxic waste dump sites. If mismanaged, Superfund sites can danger human health, waterways, and the natural environment. Superfund sites are listed on the National Priorities List (NPL), which is EPA's published list of hazardous waste sites in the United States that are eligible for Superfund program funding.

> *Superfund allows EPA to clean up hazardous waste sites and to force parties responsible for the contamination to perform cleanups or reimburse the government for EPA-led cleanups* (United States Environmental Protection Agency, 2021)

There are three Superfund sites on the NPL in the Kerr-Tar region: two sites in Granville County and one in Person County. None of these sites are located within the 100-year floodplain or in an area at high risk of wildfire. **Figure 20** shows the locations of Superfund sites. Note, the site shown in Warren County was deleted from the NPL in 1986.

Coal Ash Storage Sites

Coal ash, or coal combustion residuals (CCR), is a byproduct of burning coal in coal-fired power plants containing contaminants like mercury and arsenic. Without proper management, these contaminants can pollute waterways, groundwater, drinking water, and the air (United States Environmental Protection Agency (EPA), 2022).

> *Coal ash, or coal combustion residuals (CCR), is a byproduct of burning coal in coal-fired power plants containing contaminants like mercury and arsenic.*

When coal ash storage sites are located in areas at higher risk of flooding from heavy rainfall and hurricanes such as a 100-year floodplain, any spillages/seepages may impact nearby communities' health and safety. In North Carolina, DEQ's Division of Waste Management regulates coal ash and the construction of structural landfills (North Carolina Department of Environmental Quality, n.d.). In the Kerr-Tar region, there are two coal-fired power plants with on-site landfills, both of which are located in Person County: the Mayo Steam Electric Generating Plant and the Roxboro Steam Electric Plant. They have a combined four ash ponds. **Figure 20** shows the locations of these coal ash storage sites. Neither are located within the 100-year floodplain or in an area at high risk of wildfire.

Environmental Justice and Waste Sites

Contaminated waste sites are often linked to environmental justice concerns because they are commonly located in communities of color. North Carolina has laws and regulations around how non-hazardous waste is managed, and each county or city manages waste more specifically. Typically, contaminated waste sites have distancing requirements for the amount of land and proximity from communities. However, their locations often coincide with lower income areas. Studies have shown that in the United States, 79% of municipal solid waste incinerators are in environmental justice communities, and the majority of landfills and burn facilities are located near these communities as well (Yang, 2021).

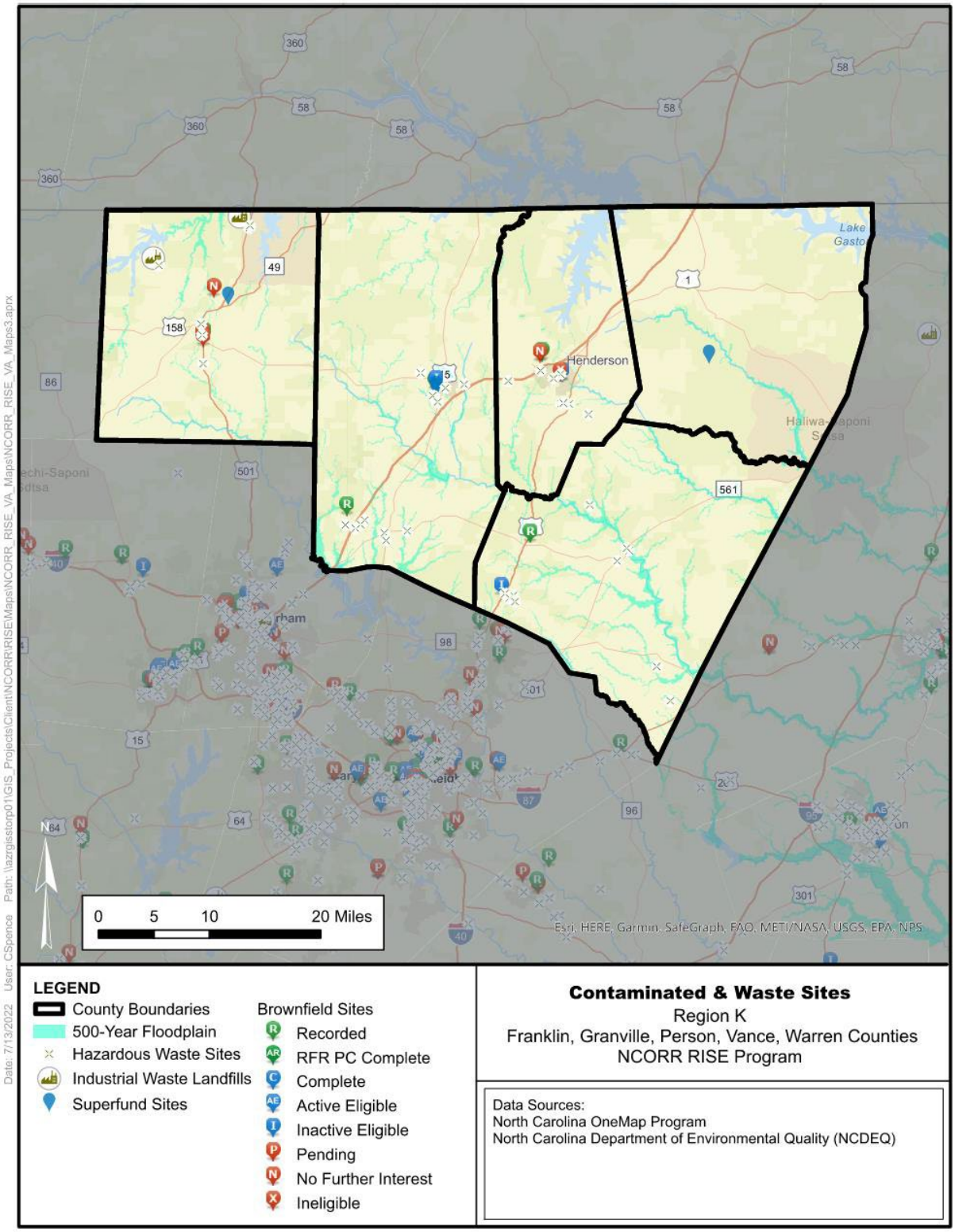
Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation and enforcement of environmental laws, regulations, and policies.

This goal will be achieved when everyone enjoys: The same degree of protection from environmental and health hazards, and, Equal access to the decision-making process to have a healthy environment in which to live, learn, and work. (Source: EPA)

The environmental justice movement was started primarily by people of color, who wanted to address the inequity of environmental protection in their communities, that came to light during the Civil Rights Movement of the 1960s (United States Environmental Protection Agency, 2022). Regarded as the catalyst for the environmental justice movement, was the nonviolent sit-in protest against a polychlorinated biphenyl (PCB) landfill in Warren County in September 1982 (United States Environmental Protection Agency, 2022). It began when a small, predominantly African American town protested the construction of

a hazardous waste landfill in their community. The landfill would contain PCB-contaminated soils and community members' concerns on chemicals leaching from the site were not addressed. The protests were aided by the National Association for the Advancement of Colored People (NAACP), Dr. Chavis from the United Church of Christ, and Delegate Walter Fauntroy from the U.S. House of Representatives. Over 500 environmentalists and civil rights activists were arrested, and the protests were unable to prevent the siting of the landfill. However, the event sparked a national movement for environmental justice which continues today.

Figure 20 - Contaminated Waste Sites in Relation to the 500-Year Floodplain



4.6 Social Vulnerability

- Social vulnerabilities are the individual characteristics that make it harder for a person to withstand and quickly recover from natural hazards and other stresses.
- The region has moderate to high levels of social vulnerability. Vance County residents, especially those living in the central portions of the county, are the most vulnerable group in the region, consistently reporting the highest vulnerability scores for all social indicators
- Individuals living in poverty (17% of the region's population) will face increased hardships during hazardous events.
- Storm preparedness, evacuation, and recovery is more difficult for persons with disabilities (13% of the population) and elderly persons (19% of the population).
- Presence of senior facilities and mobile home parks indicate areas with vulnerable populations.
- Planners can target their resiliency efforts in areas with high vulnerability levels where residents may require additional resources and support.

Social vulnerability is directly linked to community resilience. The higher the vulnerability level, the more hardships a community will encounter during and after hazardous events. Socially vulnerable populations such as youth, elderly, disabled persons, low-income persons, and those lacking vehicle access, among others, are at greater risk of harm from hazardous events than persons who do not identify in any of those groups. For example, persons with a limited income or who are unemployed may have difficulty rebuilding homes and businesses after a natural disaster. Those without personal transportation may have difficulty evacuating a hazardous area quickly. It is therefore imperative to understand the vulnerabilities of the community to develop targeted action plans and emergency preparedness measures to help those most in need.

Social vulnerability refers to factors that impact a community's ability to prevent and recover from hazard events. High social vulnerability levels can indicate challenges in a community's ability to

respond to such events. Communities can use social vulnerability information to prioritize preparedness actions, allocate emergency resources, and plan for recovery.

4.6.1.1 Background

The CDC's Social Vulnerability Index (CDC SVI or simply SVI, hereafter) was created to help public health officials and emergency response planners identify and map the communities that will most likely need support before, during, and after a hazardous event (Centers for Disease Control / Agency for Toxic Substances and Disease Registry, 2022). The SVI ranks each census tract on 15 social factors, and groups them into four themes listed below.

Theme #1 - Socioeconomic Status

1. Below Poverty
2. Unemployed
3. Income
4. No High School Diploma

Theme #2 - Household Composition and Disability

5. Aged 65 or Older
6. Aged 17 or Younger
7. Civilian with a Disability
8. Single-Parent Households

Theme #3 - Minority Status and Language

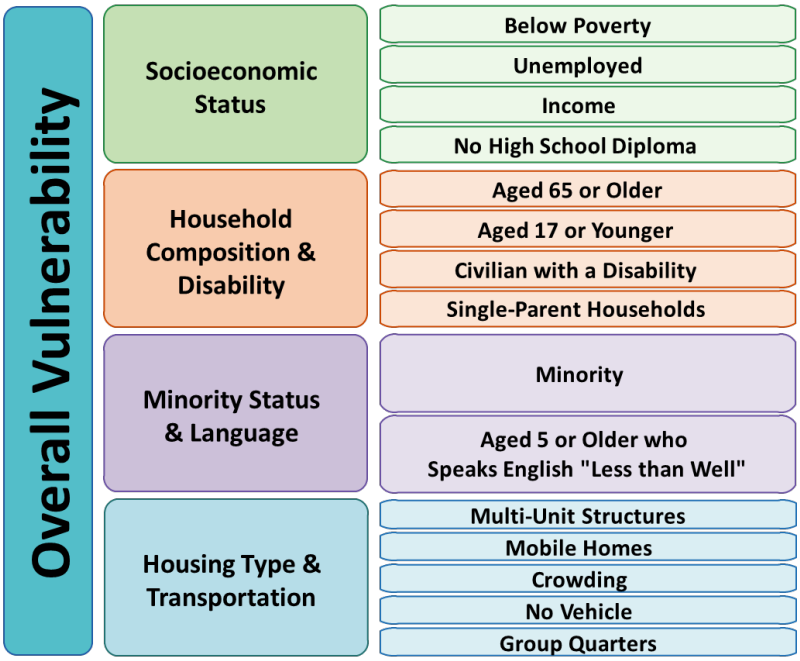
9. Minority
10. Aged 5 or Older Who Speaks English "Less Than Well"

Theme #4 - Housing Type and Transportation

11. Multi-Unit Structures
12. Mobile Homes
13. Crowding
14. No Vehicle
15. Group Quarters

The CDC uses social vulnerability indicator data (as shown in the third column in **Figure 21**) from the US Decennial Census and the American Community Survey (ACS) 5-year averages to assign each census tract and county a ranking for each of the four themes, as well as an overall ranking. These percentile rankings (or scores) are between zero and one, with zero as the lowest vulnerability and one as the highest vulnerability. The percentile rankings are based on social vulnerability indicators of the census tract or county compared against other census tracts or counties in North Carolina (as opposed to the entire country). A percentile score of 0 to 25 is considered a low vulnerability score, 26 – 50 is considered low to moderate, 51 – 75 is considered moderate to high, and 76 – 100 is considered a high vulnerability score.

Figure 21 - SVI Themes and Variables



Source: (Centers for Disease Control / Agency for Toxic Substances and Disease Registry, 2022)

For example, census tract 9608 in central Vance County has a socioeconomic status ranking of 99th, which means that it has greater compounded vulnerability indicators than 99% of all other census tracts in North Carolina because of the percentage of its population below poverty, unemployed, low-income, and without a high school diploma. The analysis below highlights which of these variables drives the combined vulnerability percentile ranking in census tract 9608 so that the region can understand how best to prepare residents in that census tract for a natural disaster. A different census tract in the region with the same or a similar vulnerability percentile

ranking may reach that ranking through another combination of high and low indicator scores, for example high percentage of the population aged 65 years or older and low percentage of the population with disabilities.

4.6.1.2 Socioeconomic Status

The socioeconomic theme combines data on persons below poverty, unemployed (individuals aged 16 years or older), per capita income, and no high school diploma (persons aged 25 years or older). The overall socioeconomic vulnerability score for all counties within the Kerr-Tar region, as compared relative to all counties in North Carolina, is moderate to high. The average county-level socioeconomic vulnerability score for Franklin, Granville, Person, and Warren counties is within the moderate to high range, while Vance County has a high score. Table 25 depicts these results.

Table 25 - Socioeconomic Status

Socioeconomic Status Rankings		
County	**Percentile Score**	**Vulnerability Level**
Franklin	57th percentile	Moderate to High
Granville	57th percentile	Moderate to High
Person	61st percentile	Moderate to High
Vance	76th percentile	High
Warren	64th percentile	Moderate to High
Regionwide	**63rd percentile**	**Moderate to High**

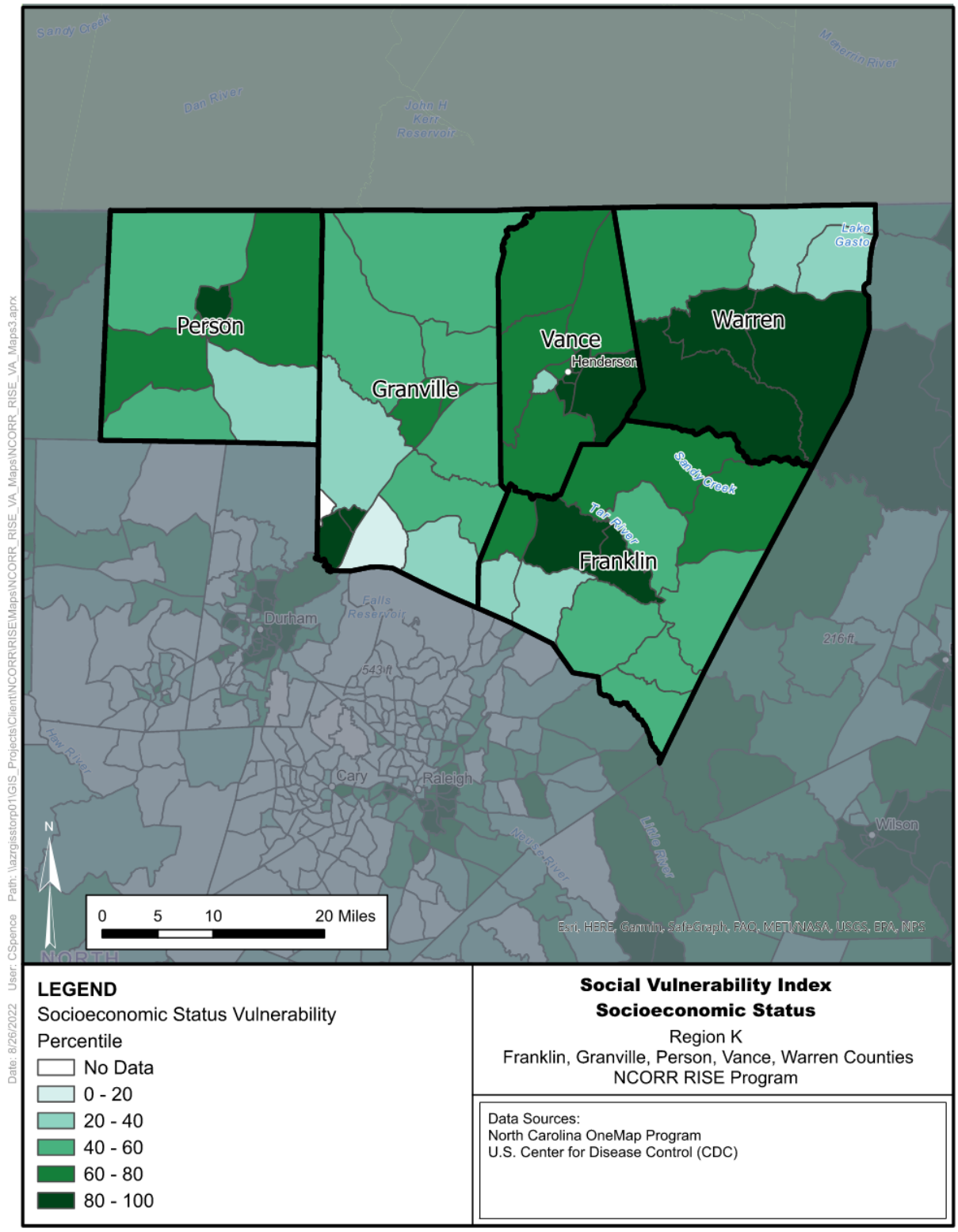
Source: (Centers for Disease Control and Prevention/ Agency for Toxic Substances and Disease Registry/ Geospatial Research, Analysis, and Services Program, 2018)

Figure 22 shows the socioeconomic vulnerability scores, represented by color, for census tracts within the region. The three census tracts with the lowest socioeconomic vulnerability in the region are in southern Granville and Franklin Counties, along the Wake County line. The three census tracts with the highest socioeconomic vulnerability are in central Vance County, in and near the city of Henderson. All three high vulnerability tracts are in the 90th percentile for populations in

poverty and without a high school diploma. They also have high percentage of unemployed population and low per-capita income levels.

Regionwide, the socioeconomic vulnerability scores for all tracts in the five counties range from the 19th to the 99th percentile. This wide range of vulnerability within the region shows that some areas may be more prepared to respond to and recover from a natural disaster than others. As such, planners can target their resiliency work to the areas identified as high vulnerability (i.e., parts of central Vance County) as these persons may require additional resources and support. Support may come in the form of financial aid and/or free emergency supply kits for example.

Figure 22 - Social Vulnerability Index – Socioeconomic Status for the Kerr-Tar Region



4.6.1.3 Household Composition and Disability

The overall household composition and disability score for the Kerr-Tar region is moderate to high. The average household composition and disability vulnerability score for Franklin, Granville, Person, and Warren counties is within the moderate to high range, while Vance County has a high vulnerability score. Results are shown in **Table 26**. The household composition and disability theme combine data on persons aged 65 or older, persons aged 17 or younger, persons with a disability and single-parent households (with children under 18 years old).

Table 26 - Household Composition and Disability

Household Composition and Disability Rankings		
County	**Percentile Score**	**Vulnerability Level**
Franklin	52nd percentile	Moderate to High
Granville	63rd percentile	Moderate to High
Person	68th percentile	Moderate to High
Vance	79th percentile	High
Warren	66th percentile	Moderate to High
Regionwide	**66th percentile**	**Moderate to High**

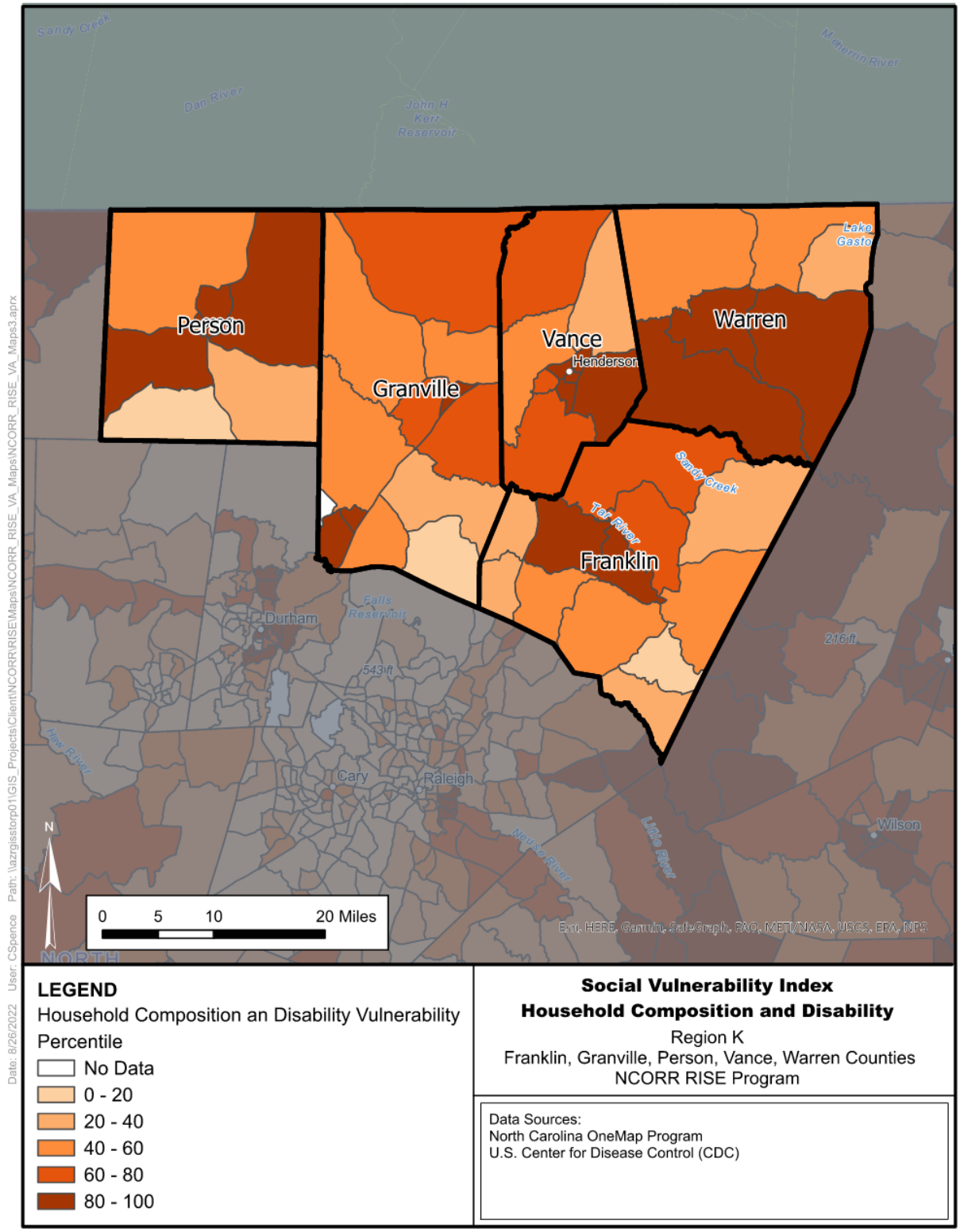
Source: (Centers for Disease Control and Prevention/ Agency for Toxic Substances and Disease Registry/ Geospatial Research, Analysis, and Services Program, 2018)

Figure 23 shows household composition and disability vulnerability scores for census tracts within the Kerr-Tar region represented by color. The most vulnerable census tract is in central Franklin County, just south of the town of Louisburg. This tract ranks in the 90th percentile for those with disabilities and single parent households. The next two most vulnerable census tracts are located within central Vance County. Two of these three tracts rank within the 90th percentile for population less than 17-years old, those with disabilities and single parent households. Census tract 9605 has the highest household composition and disability vulnerability in Vance County, at 99th percentile. A major contributing factor is single-parent households at approximately 25%.

Regionwide, the household composition and disability vulnerability scores for all five counties range from 11th to 100th percentile. Like the socioeconomic status' findings, this wide range of

vulnerability within the region shows that some areas may be more prepared to respond to and recover from a natural disaster than others. As such, planners can focus their resiliency work to the areas identified as high vulnerability as these persons may require additional resources and support. For example, additional resources may come in the form of targeted outreach tailored to each person's needs (i.e., communications materials in braille for visually impaired persons) about how to prepare for a natural disaster.

Figure 23 - Social Vulnerability Index – Household Composition and Disability for the Kerr-Tar Region



4.6.1.4 Minority Status and Language

The minority status and language theme combine data on minorities (all persons except white, non-Hispanic) and persons aged 5 years or older who speak English "less than well." The overall minority status and language score for the Kerr-Tar region is moderate to high. The average minority status and language vulnerability score for Franklin, Granville, Vance, and Warren counties is within the moderate to high range, while Person County has a low to moderate vulnerability score. **Table 27** shows all results.

Table 27 - Minority Status and Language

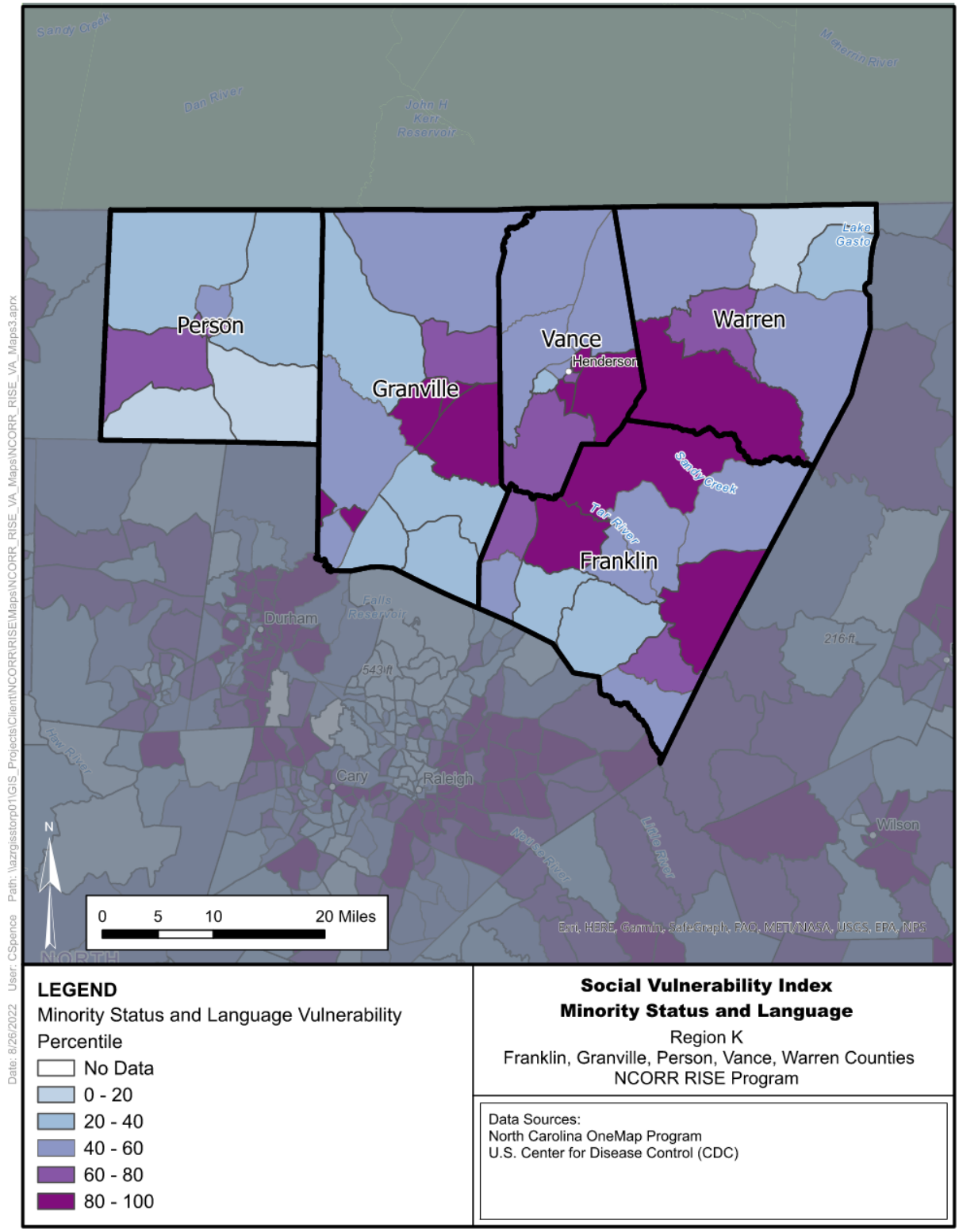
Minority Status and Language Rankings		
County	**Percentile Score**	**Vulnerability Level**
Franklin	59th percentile	Moderate to High
Granville	59th percentile	Moderate to High
Person	40th percentile	Low to Moderate
Vance	65th percentile	Moderate to High
Warren	50th percentile	Moderate to High
Regionwide	**55th percentile**	**Moderate to High**

Source: (Centers for Disease Control and Prevention/ Agency for Toxic Substances and Disease Registry/ Geospatial Research, Analysis, and Services Program, 2018)

The three most vulnerable census tracts are in central Vance (tracts 9606 and 9608 with vulnerabilities in the 89th and 93rd percentile, respectively) and southwestern Granville County, near the town of Butner (tract 9707.02 with vulnerability in the 89th percentile). The high vulnerability score is explained by the fact that more than 80% of the Vance County tracts populations are considered minorities, while the highest vulnerability Granville County census tract has 60% minority populations, with approximately 5% who speak English "less than well". **Figure 24** shows the minority status and language vulnerability scores for census tracts within the region represented by color.

Regionwide, the minority status and language vulnerability scores within the five counties range from 8th to 93rd percentile. Resiliency work may be directed to the most vulnerable areas for minority status and language theme: parts of central Vance and Granville County. Educating persons about the impacts of climate change using materials in multiple languages would be a positive, near-term action for county government officials.

Figure 24 - Social Vulnerability Index – Minority Status and Language for the Kerr-Tar Region



4.6.1.5 Housing Type and Transportation

The housing type and transportation theme combine data on multi-unit structures (housing in structures with 10 or more units), mobile homes, crowded housing (more people than rooms at the household level), households without a vehicle and persons living in institutionalized group quarters.[6] The overall housing type and transportation score for the Kerr-Tar region is moderate to high. The average housing type and transportation vulnerability score for Franklin, Granville, Person, and Warren counties is within the moderate to high range, while Vance County has a high vulnerability score. **Table 28** contains all results.

Table 28 - Housing Type and Transportation

Housing Type and Transportation Rankings		
County	**Percentile Score**	**Vulnerability Level**
Franklin	53rd percentile	Moderate to High
Granville	53rd percentile	Moderate to High
Person	60th percentile	Moderate to High
Vance	72nd percentile	High
Warren	63rd percentile	Moderate to High
Regionwide	**60th percentile**	**Moderate to High**

Source: (Centers for Disease Control and Prevention/ Agency for Toxic Substances and Disease Registry/ Geospatial Research, Analysis, and Services Program, 2018)

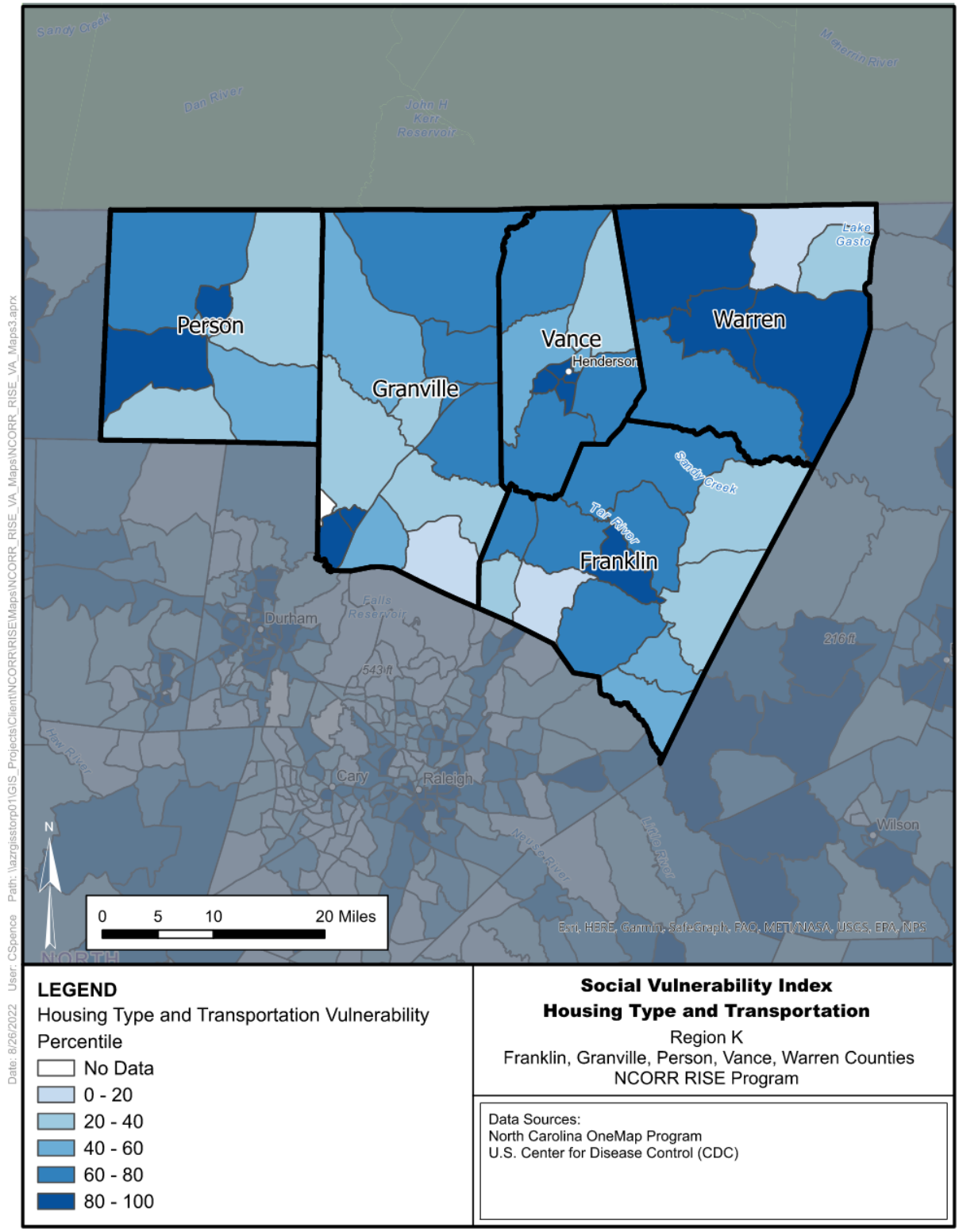
The census tract with the highest vulnerability is in central Franklin County, just south of the town of Louisburg. The percent of the population in that tract living in institutionalized group quarters or without access to a vehicle are both in the 90th percentile at 9% and 24%, respectively. The presence of nursing homes in the Louisburg area may drive these findings. The next most vulnerable tract is in Vance County, with approximately 9% of the population living in crowded housing and 19% of households without access to a vehicle (both of with are in the 90th percentile

[6] The Census Bureau classifies all people not living in housing units (house, apartment, mobile home, rented rooms) as living in group quarters. There are two types of group quarters: 1) Institutional, such as correctional facilities, nursing homes, or mental hospitals, and 2) Non-Institutional, such as college dormitories, military barracks, group homes, missions, or shelters (United States Census Bureau, 2021)

for North Carolina). **Figure 25** shows the housing type and transportation vulnerability scores for census tracts within the region represented by color.

Regionwide, the housing type and transportation vulnerability scores for all tracts range from 9th to 99th percentile. In terms of increasing resiliency in the region, planners should consider the needs of these populations during emergency situations. For example, in advance of a hurricane, providing a new bus route or on-demand transportation service in areas where there are high numbers of persons without vehicle access or nursing homes, would help evacuation efforts.

Figure 25 - Social Vulnerability Index – Housing Type and Transportation for the Kerr-Tar Region



4.6.1.6 Overall Social Vulnerability

The CDC provides an overall vulnerability score, which is a cumulative score of all four vulnerability themes discussed above, for each census tract. The overall vulnerability score for the Kerr-Tar region is moderate to high. The average overall vulnerability score for Franklin, Granville, Person, and Warren counties is within the moderate to high range, while Vance County has a high vulnerability score. The percentile rankings are based on social vulnerability indicators of the census tract or county compared against other census tracts or counties in North Carolina (as opposed to the entire country). **Table 29** shows all results.

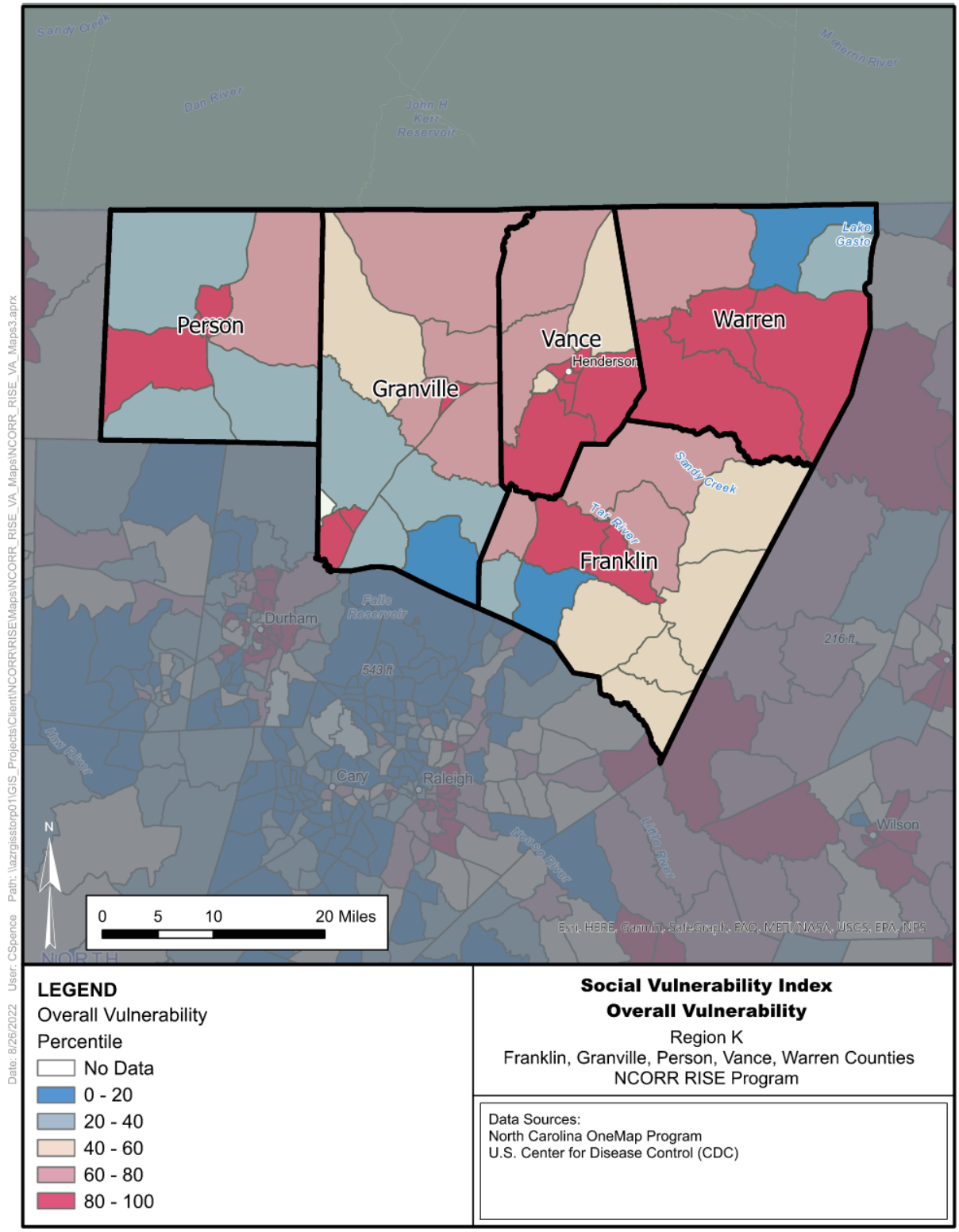
Table 29 - Overall Vulnerability

Overall Vulnerability Rankings		
County	**Percentile Score**	**Vulnerability Level**
Franklin	58th percentile	Moderate to High
Granville	59th percentile	Moderate to High
Person	62nd percentile	Moderate to High
Vance	79th percentile	High
Warren	65th percentile	Moderate to High
Regionwide	**64th percentile**	**Moderate to High**

Source: (Centers for Disease Control and Prevention/ Agency for Toxic Substances and Disease Registry/ Geospatial Research, Analysis, and Services Program, 2018)

Figure 26 shows the overall vulnerability scores for census tracts within the region represented by color. The overall vulnerability scores for all tracts in the region range from the 9th to 100th percentile. Central Vance County has some of the highest vulnerability scores in the Kerr-Tar region across all measured variables, which increases the overall vulnerability for the County. Vance County residents, specifically near the county seat of Henderson, should be considered the most vulnerable group in the region. Therefore, planners can target their resiliency work in this census tract. Programming and projects tailored to these residents should be implemented in all resiliency efforts.

Figure 26 - Social Vulnerability Index – Overall Vulnerability for the Kerr-Tar Region



5.0 Regional Climate Vulnerability Hot Spots

The project team identified locations where multiple hazards intersect with communities of high vulnerability. These locations are within proximity to the 100-year floodplain, have a greater number of high heat days, have more impervious surface area, and have a greater number of mobile homes and nursing homes. Areas with a large amount of impervious surface – e.g., concreate and asphalt – correspond to areas with increased surface heat, otherwise known as heat islands. Mobile home parks and nursing homes are noted as additional locations of vulnerable communities. As seen in **Figure 27** and **Figure 28**, the following census tracts are highly exposed to flooding and heat with higher numbers of mobile homes and nursing homes compared to other areas. **Table 30** contains full results of the analysis. Regionwide there are 22 nursing homes and 67 mobile (manufactured) home parks.

Table 30 - Hot Spot Analysis Results

Location	Census Tract	County	Social Vulnerability Score	# of Nursing Homes	# of Mobile Home Parks	# of Days over 90°F
SW Louisburg	603.02	Franklin	0.9972	1	1	51-60
Butner	9707.03	Granville	0.9283	0	5	51-60
Butner	9707.02	Granville	0.9792	0	4	41-50
Creedmoor and Butner	9706.03	Granville	0.3114	0	6	51-60
Henderson	9605	Vance	0.9306	2	0	41-50
Henderson	9607	Vance	0.9704	1	0	41-50
Henderson	9608	Vance	0.9995	0	0	41-50

Source: Kleinfelder

Figure 27 - Climate Vulnerability Hot Spots in the Kerr-Tar Region

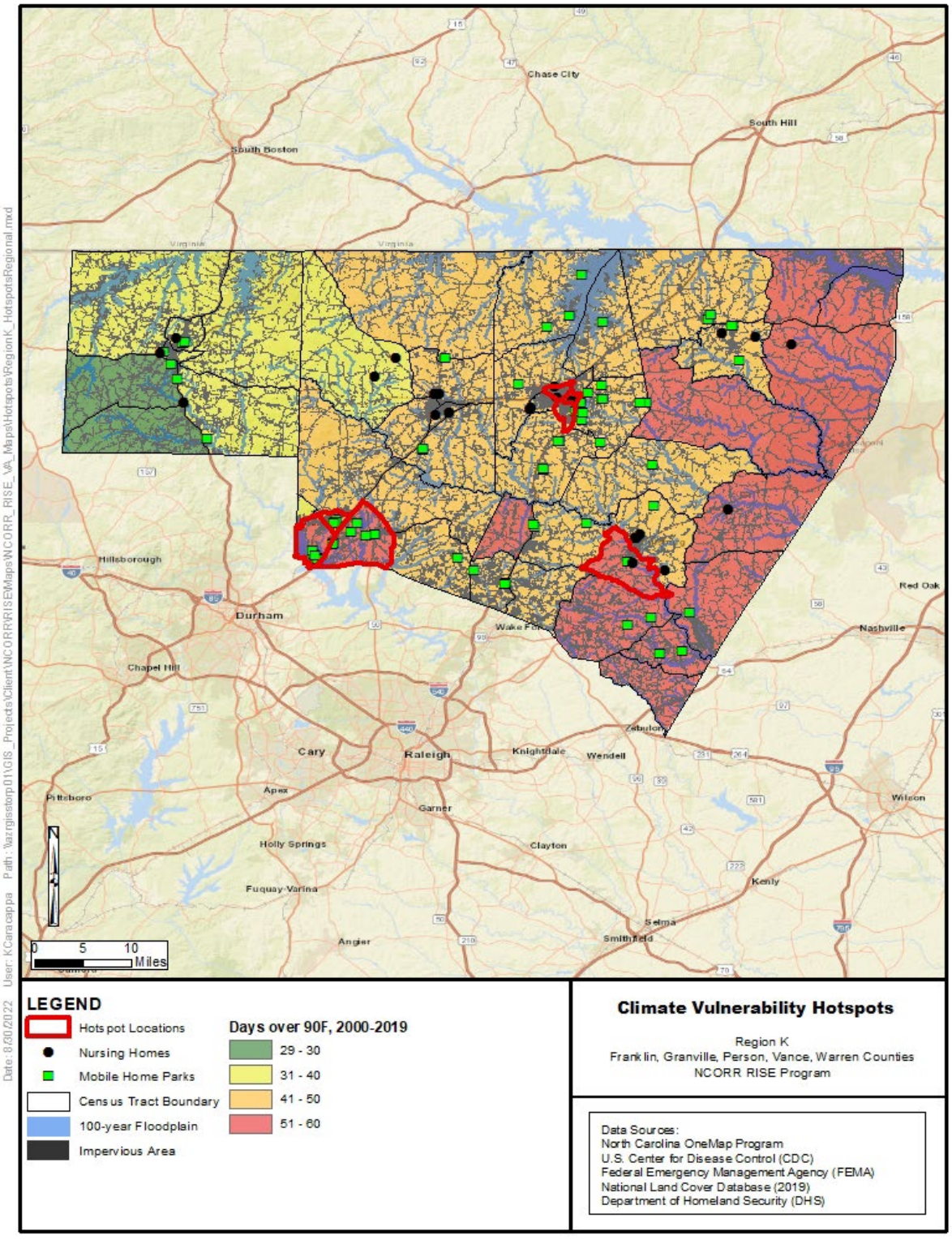
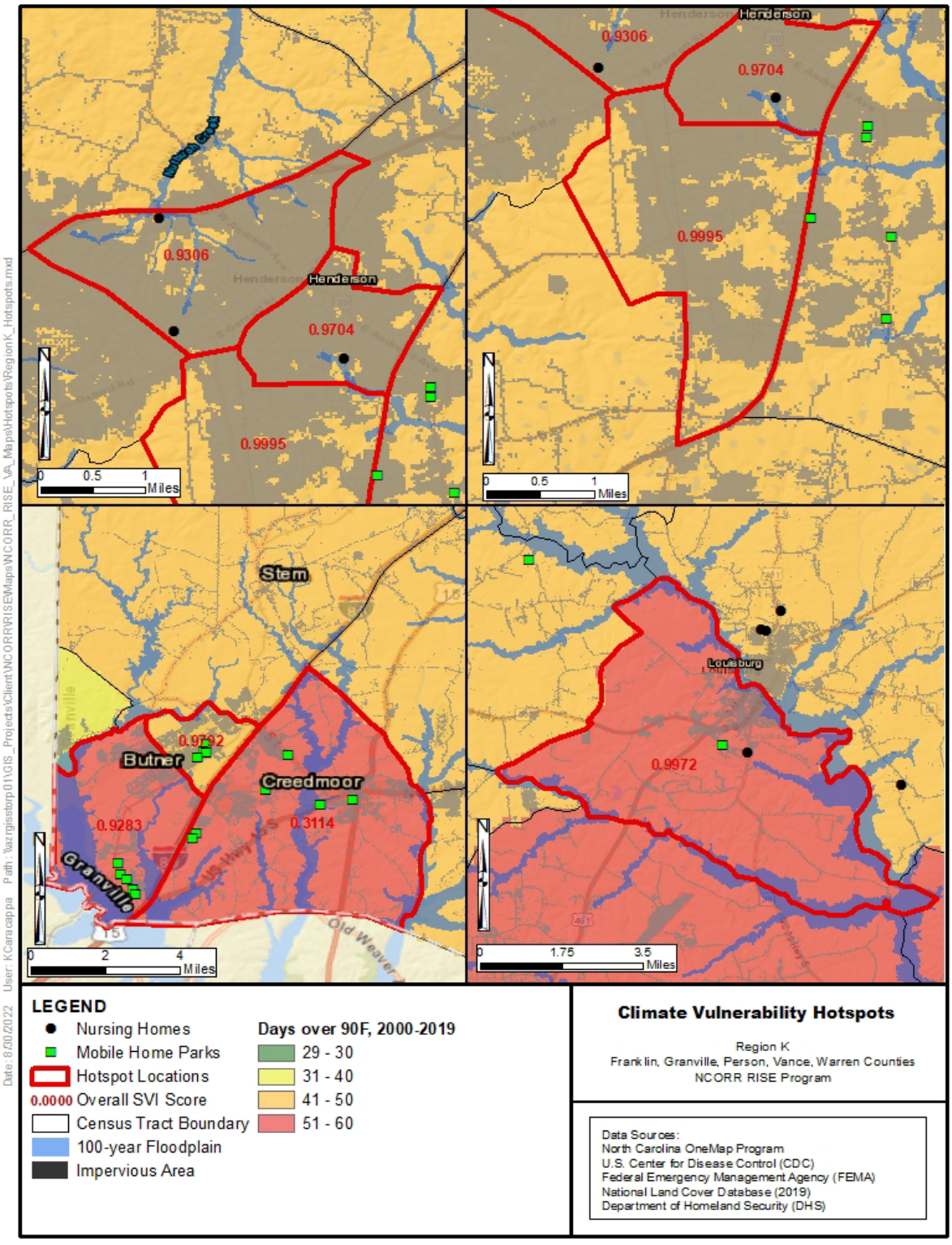


Figure 28 - Climate Vulnerability Hot Spots



6.0 Conclusion

The findings from the vulnerability assessment reveal the importance of developing a regional approach with priority actions to reduce risk and enhance resilience in the Kerr-Tar region. Proactive measures to address climate change are required because indecision may threaten people's livelihoods, communities, assets, resources, and the environment. Over the next 30 years, residents can expect increases in the intensity and frequency of extreme weather events in the region due to climate change. Based on research from scientific reports, regional planning documents, and localized knowledge obtained from the stakeholder partnership group, the most prominent, high-impact climate hazards in the Kerr-Tar region today are severe weather (specifically heavy rainfall and winds), hurricanes, and ice/winter storms. Other high-risk hazards include wildfire and flooding. Extreme heat and drought are lower-risk hazards seen in selected areas across the region, however communities will experience their effects more noticeably over the coming years.

The Kerr-Tar region's housing stock is particularly vulnerable to the impacts of climate change due to the high concentration of aging homes, mobile homes, and houses with inefficient heat and/or cooling systems. There are approximately 135 housing structures in the 100- and 500-year floodplain and others lie in areas with higher wildfire risk. In the future, warmer temperatures and heavier rainfall will have greater effects on the housing sector than they do today. Similarly, there are several major assets that are exposed to climate hazards including major roadways, businesses, medical centers, historic and cultural resources, and schools. Eleven critical facilities are in the 100- and 500-year floodplain including a dialysis center and two wastewater treatment plants, among others. Hundreds of miles of roads in the region are at risk of becoming impassable due to flooding. Flooding is already a concern in the Kerr-Tar region and increased frequency and severity of flooding is plausible in the future. Regional adaptation efforts should focus on shielding the highest-priority critical facilities and roadways from extreme weather events.

The region's economy and top industries are highly susceptible to climate change impacts. Disruptions to the supply chain, logistics, and transportation routes caused by hazards like flooding, hurricanes, and severe weather can affect the economy. Power outages and property damage to businesses resulting from weather events can halt operations, cause financial losses, and spark job losses. Stakeholders and residents encourage new economic development

activities to strengthen the regional economy, support local businesses, attract companies, and retain workers. Manufacturing is the top industry in the region but other industries like healthcare, tourism, and agriculture play an important role as well. These industries' operations are also highly dependent on weather events.

The Kerr-Tar region's natural environment and plentiful ecological resources is a defining trait of the area. The region is highly rated for its biodiversity and conservation value. Changing climatic conditions directly affect natural environmental systems and animal and plant species. Protecting ecologically sensitive lands like wetlands and forestlands, and the numerous endangered species is essential. These lands provide natural solutions for flood control, filtering pollutants, and air quality improvements.

Social vulnerabilities are the individual characteristics that make it harder for a person to withstand and quickly recover from natural hazards and other stresses. The Kerr-Tar region contains a significant number of socially vulnerable populations. Supporting people who are elderly, in poverty, disabled, in poor health, or do not have a car is a major concern during extreme weather events. Storm preparedness, evacuation, and recovery is more difficult for these individuals. Vance County residents, especially those living in the central portions of the county, are the most vulnerable group in the region consistently reporting the highest vulnerability scores for all social indicators ranging from education level to housing conditions. Residents are interested in collaborative regionalized approaches to support all people and address climate change, all while maintaining its unique character.

Next Steps

By participating in the RISE program, the Kerr-Tar region demonstrates its commitment to increasing its resilience against climate hazard events. The vulnerability assessment incorporates research gathered from planning documents, science reports, and localized knowledge obtained from a series of stakeholder meetings and open houses. It is the foundation for the next phase of the RISE program: the project portfolio. The project portfolio is a collection of five to ten resiliency projects designed to address the identified regional vulnerabilities. Project selection is primarily based on public input collected at stakeholder meetings and open houses, as well as a standardized method that assesses and prioritizes projects. The prioritization tool eliminates biases by using a comprehensive set of criteria. The final project portfolio will be published by

spring 2023. Through the RISE program, one project in the portfolio will be partially funded through a Duke Energy Foundation grant. Stakeholders may use the project portfolio as they see fit, whether it be to inform future projects and programs or, for grant applications for additional funding opportunities.

Below is a draft list of potential projects that have been discussed for initial inclusion in the project portfolio.

Projects Under Consideration	Description
Dam inspection and action plan	Work with NC Office of Dam Safety to inspect high-hazard dams
Food network and agriculture resilience plan	Enhance the local food network across the region to address food insecurity issues; Build redundancy into food systems; Protect agricultural assets that are not climate-resilient; Study soil health conditions; support agricultural workers
Update planning and zoning documents	Address floodplain management and land use planning; incorporate climate resiliency planning and planning for future conditions
Regional analysis of emergency shelters	Regional, year-round emergency shelter (new build, retrofit); Identify public facilities to act as shelters for hazards. Upgrade current shelters to serve greater capacity. Provide Alternative power/heat sources at shelters
Critical facilities assessment	Identify at-risk facilities and potential mitigation measures; Retrofit existing critical facilities. Assets identified in STIP (or other State plans), local plans, regional plans, by MPOs/RPOs, by highway districts and/or by residents as problematic or challenging may require additional analysis and study.
Community emergency preparedness plan	Pre-hazard event preparation - create plan to treat residential roads; Post-hazard event cleanup - create plan to clear downed trees; Maintenance programs (i.e., debris removal program)

Projects Under Consideration	Description
Guide for backup generators	Supply backup generators (possibly solar and/or battery powered)
Regional culvert analysis and improvements	Study needed. Assets identified in STIP (or other State plans), local plans, regional plans, by MPOs/RPOs, by highway districts and/or by residents as problematic or challenging may require additional analysis and study.
Address flooding issues in key spots	Potential sites include: US 501 in Roxboro Project ID is U-5969; River Bend Park, Hwy 158, segments of US-15, Long Ave / US-501, Morehead Street/US-501 (N Madison Blvd), Hwy 58 flooding in Warren County (Submitted a BRIC app-waiting to hear back); DOT working on Rt. 501 project in Creedmoor; Study needed. Transportation assets identified in STIP (or other State plans), local plans, regional plans, by MPOs/RPOs, by highway districts and/or by residents as problematic or challenging may require additional analysis and study.
Address aging stormwater infrastructure	US 501 in Roxboro Project ID is U-5969 in STIP-Study needed. Assets identified in STIP (or other State plans), local plans, regional plans, by MPOs/RPOs, by highway districts and/or by residents as problematic or challenging may require additional analysis and study.
Regional watershed assessment	Conduct watershed study and develop a watershed model; hydrologic study; Develop watershed restoration plans; Study needed
Integrated water resources management plan	Address water supply and demand issues and projected growth, Elements include Conduct analysis of the water table and an investigation of well water; Align with the State's pollution discharge and stormwater mandates
Housing analysis	Advance affordable housing building efforts (workforce housing/not low income); Ensure housing is safe and up to building code

Projects Under Consideration	Description
Environmental justice and health vulnerability assessment	Identify at-risk, vulnerable populations - work with community organizations on outreach efforts
Resilient economic development plan	Community hub, placemaking, attract employers, retain employees, flex spaces, anchor institutions, “greening” businesses and sustainable design
Flood gauges and monitoring program	Install/improve flood warning system; refer to planning documents’ that identify potential locations -see Hurricane Matthew plan for background
Broadband access and digital inclusion plan	Enhance broadband infrastructure and connectivity options Regionwide. Locations can be identified using NC State tools.
Environment & Natural Resources project	Add stormwater control measures to identified assets
Stream Restoration	Stream restoration projects
Alternative Power Supply	Community solar programs for power generation

7.0 Appendices

7.0 Glossary

Key Definitions provided by FEMA (unless otherwise stated) used throughout the vulnerability assessment include:

Assets are determined by the community and include but are not limited to: people; structures; systems; natural, historic, and cultural resources; and/or activities that have value to the community.

Endangered - any native or once-native species of wild animal whose continued existence as a viable component of the State's fauna is determined by the Wildlife Resources Commission to be in jeopardy or any species of animal determined to be endangered pursuant to the Endangered Species Act (State of North Carolina, 2019).

Natural hazards are a source of harm or difficulty created by a meteorological, environmental, or geological event. Natural hazards, such as flooding and earthquakes, impact the built environment, including dams and levees. [Note that natural hazards and climate hazards may be used interchangeably in the vulnerability assessment.]

Resilience is the capacity of a community, business, or natural environment to prevent, withstand, respond to, and recover from a disruption (United States Global Change Research Program, 2021).

Risk for the purpose of hazard mitigation planning is the potential for damage or loss created by the interaction of natural hazards with assets, such as buildings, infrastructure, or natural and cultural resources.

Social vulnerability is understood as the potential for loss within an individual or social group, recognizing that some characteristics influence an individual's or group's ability to prepare, respond, cope, or recover from an event. These characteristics can overlap within populations to

create heightened vulnerability, which may be compounded by infrastructure deficiencies within communities and historic or existing discriminatory government policies.

Special Concern any species of wild animal native or once native to North Carolina which is determined by the Wildlife Resources Commission to require monitoring (State of North Carolina, 2019)

Threatened any native or once-native species of wild animal likely to become endangered within the foreseeable future throughout all or a significant portion of its range, or one that is designated as a threatened species pursuant to the Endangered Species Act (State of North Carolina, 2019)

Vulnerability is a description of which assets, including structures, systems, populations, and other assets as defined by the community, within locations identified to be hazard-prone, are at risk from the effects of the identified hazard(s).

7.1 Open House Summary

Summary of Kerr-Tar Region Open Houses on April 28, 2022

Attendance at the virtual morning session (10:30 am – 12:00 pm) totaled approximately 16 participants in addition to the six core planning team members. The hybrid (in-person + virtual) evening session (6:00 pm – 7:30 pm) had approximately seven participants in addition to the six core planning team members. At both sessions, the first question discussed was, "What is a weather hazard that impacts you and your family? How so?" The second question discussed was, "What locations in your community are being impacted by weather hazards?" The following document summarizes key themes and important points of information gained from both Open House sessions.

Ice / winter storms

- Ice is near the top of the list for weather hazards in the region. Issues compound during/after ice storms.
- Ice affects power for most of the region and causes folks to lose food
- Power outages have lasted for days, and it is hard to get the power back on, especially in rural parts of the region
- Loss of internet connection impacts the ability to work from home
- Ice also makes travel dangerous – those willing to try and commute cause dangerous situations and often require emergency services to respond
- Takes a while to clear downed trees off roads after ice storms, also contributing to dangerous travel situations and road closures
- Duke Energy does clear power lines for topping and maintenance and the program has done well over the years
- The ice storm of 2000 impacted the region
- Northern and southern ends of Granville County typically encounter ice storm damage – snow and ice fall vary across the county
- Disjunction between state and local government when treating roads during storm events. Some state roads go through town, and DOT takes care of those roads because they lead to emergency services. Residential roads are at the bottom of the priority list.

Energy security

- Difficult to do community scale solar in NC
- One individual has solar on their house with two batteries for storage because a family member requires oxygen and power was frequently out. They purchased this system to ensure stability for oxygen-dependent individual. It's a costly option because of the high upfront expense but solar options/programs could be incentivized. A fully charged battery can run power for about 1-2 days. Southern Energy Management installed the solar on the roof and totaled about 25 years' worth of power bills paid up front.
- Medical equipment is affected when there's a loss of power
- There are two Duke Power stations in the region
- Power outages have occurred due to hurricanes

Sheltering

- The region lacks shelters and the ones that are operational don't always have reliable back up power sources. It may be worse to stay at a shelter than stay at your house without power
- A question was asked about the possibility of grant money to upgrade current shelters to serve greater capacity? Could make buildings multi-use. BRIC grant funding to build a regional shelter as a potential option.
- Vance county has a winter shelter with a generator, but it is expensive to use
- During weather hazard event, recreational facilities, and assets first plan is to evacuate to cars, but there are indoor shelter areas nearby

Economic development

- How do you incentivize a diversity of businesses?
- How do you replace tax revenue from an anchor institution that will no longer be operating, such as the QVC plant in Rocky Mount? The whole community will be impacted by loss of factories
- The last three years of the COVID pandemic have shown that emergency management and economic development are more linked together – schools and businesses need to be reopened after disasters so people can work and start contributing to the economy again

- There are issues from consolidation occurring. Economic activity tends to be bigger and clustered in specific areas. Energy systems are not dispersed, the food system is fragile because its dependent on only a few supply lines. There is a need to build in redundancy into systems to increase resilience.
- Economic development and climate are closely linked
- Unsure if region is ready for another economic shutdown
- Need the resources to keep businesses going
- Consider creating a community hub where business owners can get together and network and obtain resources
- There has been an economic impact on county facilities, shutting down for real estate transactions. The tax office is shutting down too.
- There need to be support systems for businesses
- Lots of restaurants are strictly drive through now
- It's difficult to discuss the loss of revenue out in the open because it will indicate a lack of services

Food security

- Food security is a big issue across the whole region. Residents must travel long distances to get to grocery stores.
- Dollar General went into smaller communities in the region but it's not a satisfactory grocery store
- Are weather hazards causing or contributing to the issue of food deserts in the region?
- Changes in weather, such as variations in rainfall intensity, are affecting farmers – farms now need more irrigation lines than they used to and it's challenging for lots of people. Too much rain and not enough rain impact crops – fields are too wet
- Farming is financially difficult when the weather is inconsistent. Some almost lost strawberries due to late frost this year (2022). Summer hailstorms come in and destroy crops; wind can destroy corn. Paying more for farm infrastructure now, which is particularly harder for smaller farmers.
- Weather impacts food production but more so supply chain
- There is a Food Lion distribution center in Benson, NC (Johnston County, south of Raleigh). Weather disruptions in that area may impact food supply in Kerr-Tar
- The outskirts of Warren and Vance County experience food shortages.

- Granville County set up food distribution for school children during pandemic.

Heat + Drought + Wildfire

- Stakeholders shared that it is harder to work outside when it's hot
- Crop losses $1M/yr. from drought
- There has been an increase in the number of no-burn permits
- Bright sunny days make people go out and do dumb things, causing more visits to the hospital
- The region is a hub for water – southwestern Virginia feeds Kerr Lake, which feeds Lake Gaston, which feeds Virginia Beach
- Lake Kerr and Gaston were built for flood control reservoirs only – but used for drinking water and recreation uses
- Water security is another major problem facing the region– if a dam breaks, flooding kills people down-stream, while people up-stream lack water. The region and beyond is growing, drawing water from the region.
- Majority of the region is on well water and could run out if there is a drought. Most well systems are 350 ft deep.
- Has there been an analysis of the water table in the area?
- Drought as a long-term hazard is a concern
- The elderly population is vulnerable to heat stress
- Tree species are impacted due to hotter weather
- Overall, extreme heat is not a major issue in the region although some reported cases of heat strokes during the summer
- Wildfires might be a hazard

Communications + preparedness

- The Code Red system is used in some municipalities and all counties have the ability use this system, but it's hard to collaborate because everyone uses a different company and it's costly. It also takes time to set up text messages. May not be a feasible resiliency project
- Most residents use the alert system for safety
- Granville Senior Services Department assists senior populations during winter and summer seasons. They also have a social media presence to communicate with seniors.

- Granville County Emergency Services works with the community on weather-related preparedness
- Flyers are put up in pharmacies to communicate with folks in the community
- Storm preparedness and personal home preparedness are important.
- Families are separated daily when going to work or school, and weather can cause an unplanned externality to the day. It's important to have a Plan A and Plan B for these cases.
- Can't monitor every hazard but if you always keep it in the back of your mind, you can be prepared
- How do you get back on your feet as fast as possible after an event?
- It's incredibly hard to plan for "pop-up" events like tornadoes, release of chemicals, active shootings
- Is communication about actual flooding timely? Do flashing high water signs indicate high water, or is the sign always on?
- The Roxboro core is well-developed

Wind + thunderstorms

- Wind damages houses and renders them uninhabitable
- Brings trees down and damages structures, roads impassable
- Increased number of tornadoes in recent years
- Granville County has severe thunderstorms that cause power outages and structural damage
- Thunderstorms are very hard to prepare for
- Windy conditions and pollen seasons tend to be longer
- Tree impacts to pedestrian bridge in Creedmoor along Hwy 56
- Trees down on Hwy 158 W near Cornwall Road, along main power lines
- Could there be support for increasing the wind rating that infrastructure must be built to? How much more would it cost to build a bit stronger? - A participant expressed concern that roof may blow off during high wind event
- Southern end of Granville County impacted by wind events
- Straight-line wind events can be highly disruptive and dangerous
- Wind events build on Kerr Lake then travel down Gaston River

Hurricanes

- Granville County experienced damages from Hurricane Michael. The Administration office, Tax & Finance Department, and Emergency Management office were on generator power after the hurricane. Sewer and wastewater infrastructure was damaged as well.
- Hurricane Florence caused damage to bridges and roads
- During and after hurricanes, need support from EMS, public works, fire, and police
- Bridge on Enon Road was damaged during Florence and has been repaired
- Hurricane Fran was the last hurricane that seriously affected the region in 1996

Water + flooding

- Region has aging stormwater infrastructure
- Intense rain causes stormwater issues
- Flood events can cause habitat change in the streambed, making recovery efforts for some threatened and endangered species more difficult. The Upper Tar area is home to important aquatic species that are threatened/endangered.
- Ridgeway near the Interstate (specific location TBD) had creek flooding in September 2021 and a woman drowned. Flooding at the location has gotten worse over time.
- There is a need to clean out storm drains annually
- Roxboro (US-501 & N Madison Blvd) – impacted by flash flooding
- Roxboro – Marlowe Creek causes flooding around the city, caused a sink hole on Madison Blvd
- Roxboro (US-501 & Long Ave) – can be impassible when rain/flooded
- Lake Roxboro and Sir Isaac Walton (TBD) are municipal water sources
- City of Henderson Operations Department could assist on specific locations impacted by stormwater issues
- Hwy 158 in Warren County floods
- Hwy 58 has flooding from creek (location TBD), flooded twice in 2021 but there are no plans by DOT to address it
- Granville County – creeks with low bridges overflow; flash flooding along roadways in the southern portion of the county; Harry Davis Road floods from the Roanoke River; longer lasting flooding in northern portion of the county near the lake
- Autozone off Hwy 158 in Warrenton floods
- Campgrounds at Kerr Lake have flooded

- "Gen X" (an unknown substance) was released into the water supply. Unable to swim, fish in Crabtree Lake and Crabtree Creek (unconfirmed location?)
- River Bend Park (Louisburg/Franklin County) is low-lying and experiences flooding
- Home built on slab foundation floods
- Warren County (MLK Blvd/St. Rte. 1001) – experiences flooding
- People who live in areas that flood know which locations will flood because they happen repeatedly
- All the areas that flooded years ago still flood today
- Flooding is usually more of an inconvenience, causing people to drive a bit longer than usual to get where they are going.
- Flash floods tend to recede quickly.
- Heavy rains wash away dirt roads and impact travel to and from houses
- Places in Warrenton (along Hwy 158 between Norlina and Warrenton) do have flash floods that might not have happened previously.
- Granville County along US-15 floods (US-15 & Tar River/Bollens Creek/Hachers Run/Jordan Creek?)
- Bridges that cross the lakes are vulnerable to flooding
- Water managers try to keep Lake Gaston and Kerr Lake at 297-300 level and the highest they can go is 319 before the floodgates are open
- It would take significant amounts of rain to fill the lakes up and the location of the rain is really what affects the lake levels – heavy rainfall upstream in Virginia could influence lake levels, but heavy rainfall downstream of a lake won't influence lake levels
- Important to keep an eye downstream so you don't flood other communities
- Most flood gates are original from the initial build of the lake. Unaware of recent studies on the status of flood gates
- NCEM has a list of dams at risk
- Rt. 50 dam is considered high hazard
- Tributaries are running freely
- Tar River Lands Conservancy might have insight about community assets at risk
- Owens Rd (location TBD) experiences flooding

Community

- Volunteerism is dropping, neighbors aren't helping each other as much, people are migrating in and don't know their community well
- Need access to communication hubs
- Detention center (location TBD) is impacted by weather hazards
- Recreational opportunities are impacted by weather hazards
- Oxford experiencing a lot of growth- 3500 new units around the town
- Coal ash bust in region

Transportation

- Warren County has no public transportation
- Weather can impact EMS access
- NCDOT is undertaking a Congestion Study (location TBD) with controlled access 4 lane with median, to start in 2025
- DOT staff has decreased by two thirds over the last decade

Changing Weather Conditions

- Drought and precipitation change daily
- Has the development of Hidden Lake subdivision impacted downtown Louisburg? The subdivision is not part of city limits
- The 5-county region really experiences very different weather patterns
- Region has been fortunate in that the hazardous haven't been as extreme as other parts of the state. However, that's not to say that there won't be issues in the future.

7.2 Tables

Table 31 - Demographic Information

	Franklin	Granville	Person	Vance	Warren
Race and Hispanic Origin					
White alone	70.1%	64.5%	70.0%	45.1%	40.5%
Black or African American alone	25.9%	31.9%	26.8%	51.5%	51.4%
American Indian and Alaska Native alone	0.9%	0.9%	0.9%	1.0%	5.7%
Asian alone	0.7%	0.7%	0.4%	0.8%	0.4%
Native Hawaiian and Other Pacific Islander alone	0.1%	0.1%	Z	0.1%	Z
Two or More Races	2.2%	1.9%	1.9%	1.6%	2.0%
Hispanic or Latino	9.0%	8.5%	4.5%	8.3%	3.9%
White alone, not Hispanic or Latino	63.0%	57.8%	66.3%	39.0%	38.2%
Population					
Population 2010	60,619	59,916	39,464	45,422	20,972
Population 2020	68,573	60,992	39,097	42,578	18,642
% Change	13%	2%	-1%	-6%	-11%
Age and Sex					
Persons under 5 years, %	5.6%	5.1%	5.3%	6.2%	4.5%
Persons under 18 years, %	21.8%	20.5%	20.6%	23.4%	17.9%

	Franklin	Granville	Person	Vance	Warren
Persons 65 years and over, %	17.1%	17.7%	20.1%	19.1%	26.2%
Female persons, %	50.5%	49.2%	51.7%	53.3%	50.5%
Population Characteristics					
Veterans, 2016-2020	4,008	3,634	2,555	2,197	1,261
Foreign born persons, %, 2016-2020	5.6%	4.5%	3.2%	5.1%	2.4%
Housing					
Housing units, July 2021	30,524	24,609	18,471	19,363	11,408
Owner- occupied housing unit rate, 2016-2020	73.2%	75.0%	78.2%	58.0%	71.7%
Median value of owner-occupied housing units, 2016-2020	$161,500	$168,900	$134,100	$103,700	$89,500
Median selected monthly owner costs -with a mortgage, 2016-2020	$1,253	$1,372	$1,143	$1,082	$1,085
Median selected monthly owner costs -without a mortgage, 2016-2020	$403	$426	$384	$382	$389
Median gross rent, 2016-2020	$855	$849	$709	$689	$634
Building permits, 2021	1,141	217	129	166	272
Families & Living Arrangements					
Households, 2016-2020	25,729	21,567	16,153	16,895	8,122
Persons per household, 2016-2020	2.58	2.6	2.42	2.6	2.32
Living in same house 1 year ago, % of persons age 1 year+, 2016-2020	89.8%	87.9%	92.6%	88.0%	90.1%
Language other than English spoken at home, % of persons age 5 years+, 2016-2020	7.0%	7.7%	4.5%	7.9%	4.3%

	Franklin	Granville	Person	Vance	Warren
Computer and Internet Use					
Households with a computer, %, 2016-2020	86.4%	91.4%	89.2%	84.8%	80.3%
Households with a broadband Internet subscription, %, 2016-2020	81.9%	83.8%	80.6%	74.5%	65.0%
Education					
High school graduate or higher, % of persons age 25 years+, 2016-2020	86.5%	86.1%	88.2%	83.1%	83.8%
Bachelor's degree or higher, % of persons age 25 years+, 2016-2020	21.2%	23.8%	15.7%	17.5%	15.3%
Health					
With a disability, under age 65 years, %, 2016-2020	11.4%	10.3%	14.9%	14.4%	13.3%
Persons without health insurance, under age 65 years, %	13.8%	13.2%	12.7%	14.6%	17.0%
Economy					
In civilian labor force, total, % of population age 16 years+, 2016-2020	61.0%	58.0%	62.8%	58.6%	49.6%
In civilian labor force, female, % of population age 16 years+, 2016-2020	56.7%	58.5%	60.6%	57.7%	50.6%
Total accommodation and food services sales, 2012 ($1,000)	27,796	52,427	41,293	56,983	8,908
Total health care and social assistance receipts / revenue, 2012 ($1,000)	86,887	149,269	98,851	204,965	19,962
Total manufacturers' shipments, 2012 ($1,000)	1,047,254	3,020,569	841,222	756,187	128,855
Total retail sales, 2012 ($1,000)	353,700	349,961	378,438	527,895	72,351
Total retail sales per capita, 2012	$5,754	$5,791	$9,637	$11,697	$3,516
Transportation					

	Franklin	Granville	Person	Vance	Warren
Mean travel time to work (minutes), workers age 16 years+, 2016-2020	32.8	29.2	30.8	24.9	27.4
Income & Poverty					
Median household income (in 2020 dollars), 2016-2020	$58,172	$56,924	$57,323	$41,827	$37,476
Per capita income in past 12 months (in 2020 dollars), 2016-2020	$27,588	$27,723	$31,605	$23,911	$25,340
Persons in poverty, %	12.0%	15.0%	13.5%	21.3%	22.8%
Businesses					
Total employer establishments, 2020	1,123	896	705	840	257
Total employment, 2020	11,190	16,717	8,352	13,350	1,887
Total annual payroll, 2020 ($1,000)	526,938	693,339	319,235	491,959	61,120
Total employment, percent change, 2019-2020	0.20%	6.40%	-1.60%	1.00%	-7.40%
Total nonemployer establishments, 2019	5,036	3,614	2,278	2,371	1,105
All employer firms, Reference year 2017	973	732	663	653	217
Men-owned employer firms, Reference year 2017	589	417	365	397	115
Women-owned employer firms, Reference year 2017	246	S	94	78	S
Minority-owned employer firms, Reference year 2017	107	75	60	S	S
Nonminority-owned employer firms, Reference year 2017	790	548	509	437	169
Veteran-owned employer firms, Reference year 2017	45	S	29	S	S
Nonveteran-owned employer firms, Reference year 2017	838	536	493	496	168

Source: (United States Census Bureau, 2020)

Table 32 - Critical Facilities in the Kerr-Tar Region, organized by Sector

	Sector Name																	
County	**Food and Agriculture**	**Banking and Finance**	**Chemical & Hazardous**	**Commercial**	**Communications**	**Critical Manufacturing**	**Healthcare**	**Emergency Management**	**Government Facilities**	**Defense Industrial Base**	**IT**	**National Monuments & Icons**	**Nuclear Reactors, Materials & Waste**	**Postal and Shipping**	**Transportation Systems**	**Energy**	**Emergency Services**	**Water**	**Total No. of Critical Facilities**
Franklin	3,881	12	0	871	1	213	44	0	204	0	0	0	0	0	161	23	19	3	5,432
Granville	3,211	21	0	770	0	206	109	0	211	1	0	0	0	0	116	6	19	1	4,671
Person	2,397	15	0	754	0	190	54	18	129	0	2	0	0	0	99	63	2	7	3,730
Vance	2,354	14	0	938	1	320	62	0	196	0	0	0	0	0	148	17	11	1	4,062
Warren	1,144	3	0	339	0	19	7	0	109	0	0	0	0	0	19	1	16	4	1,661
All Counties	12,987	65	0	3,672	2	948	276	18	849	1	2	0	0	0	543	110	67	16	19,556

Table 33 - Identified Critical Infrastructure-related Projects in Hazard Mitigation Plans

Mitigation Action	Status
Franklin County	
Work with the NC Office of Dam Safety (ODS) to inspect high-hazard dams	To be continued. Greater coordination needed.
Work with the North Carolina Department of Transportation (NCDOT) to convene a working group (county-wide or local) to develop solutions to localized drainage issues caused (in part or in whole) by NCDOT maintained drainage facilities.	To be continued. Some of NCDOT project's local drainage issues were addressed but many drainage issues remain throughout the county that need to be resolved.
Apply for FEMA's High Hazard Dam Repair Program funding for relevant mitigation measures[7]	New action
Implement public education efforts to inform the public of their exposure to all natural hazards and of actions they can take to mitigate the damages to their health and property from them.	To be continued. County worked with the American Red Cross (ARC) to improve efforts by the public to mitigate damage, but significant work to be done.
Granville County	
Work with the NC Office of Dam Safety (ODS) to inspect high-hazard dams	To be continued. Greater coordination needed.
Provide backup power for critical facilities	New action

[7] Mitigation measures related to high-hazard dames include: 1) Geotechnical investigation to establish data for risk analysis and development of engineering designs/solutions, 2) Build upstream dam to reduce load on existing dam, 3) Property Acquisition in inundation areas below dam, 4) Raise crest of dam to increase storage capacity, 5) Add additional spillways, widen or lower existing spillways to increase discharge capacity, 6) Warning systems to alert downstream areas of potential dam failure, 7) Improve flow path below dam to increase conveyance capacity, 8) Encourage conservation or re-forestation of upstream land to reduce runoff, 9) Development of community Stormwater Management Plans for upstream communities, and 10) Complete an Emergency Action Plan in conjunction with the North Carolina Department of Environmental Quality (NCDEQ) for all High Hazard Dams in the county (AECOM, 2021).

Mitigation Action	Status
Work with NC State Highway Patrol to replace existing metal communications equipment sheds with a NC FHP concrete structure.	New action
Work with local ARC officials to develop a plan and implementation goals for ensuring that all county-sponsored shelters meet ARC shelter operations standards for mitigation from all hazards, most especially wind and flood hazards.	To be continued. The county has worked with ARC officials to ensure that identified shelters are protected as effectively as possible.
Provide information to residents via various communication methods: the name and location of the closest, county-approved shelter, a general identification of the local flood hazard, flood safety, flood insurance, property protection, floodplain development permit requirements, and drainage system maintenance.	To be continued. County has not been able to reach all residents, additional work needed.
Implement public education efforts to inform the public of their exposure to all natural hazards and of actions they can take to mitigate the damages to their health and property from them.	To be continued. The county implemented public education efforts in the past such as GranvilleAlert.com but will need to re-evaluate its outreach efforts in the future.
Person County	
Incorporate a stand-alone element for hazard mitigation and involve citizens in comprehensive planning activities that identify and mitigate hazards during next Land Use Plan update	Carried forward from previous HMP. Land Use Plan update is in progress
Identify at risk-populations that may be exceptionally vulnerable in the event of long-term power outages.	New action
Identify at risk facilities and evaluate potential mitigation techniques for all hazards	New action

Mitigation Action	Status
Retrofit existing public facilities and critical facilities to withstand impacts from all hazards	New action. Grant application in progress.
Identify and strengthen public facilities to act as shelters for all hazards	New action Grant application in progress.
Inspect all portions of buildings that were submerged for any length of time for flood related damage and other conditions that could endanger lives, health or property	Carried forward from last HMP. Building Inspections done on a case-by-case basis. Reevaluation needed in future.
Encourage the identification and retrofitting of safe rooms in public buildings, critical facilities, schools, and nursing homes.	New action
Ensure adequate evacuation warning in case of major hazard event.	Carried forward from last HMP. County has several warning procedures like emergency notification system, social & news media, message boards, etc. Continually reevaluates effectiveness.
Maintain/improve shelter capacities with alternative power/heat sources.	Carried forward from last HMP. Shelters do not have alternative power sources. Grant application in progress
Identify alternate/new Emergency Operations Center (EOC) locations.	Carried forward from last HMP. Current EOC is inadequate. The EOC location and Alternate location are ID'ed in the EOP and tested.
Continue to maintain a debris removal program for problem sites.	Carried forward from last HMP. Some work completed, further may be necessary.
Vance County	

Mitigation Action	Status
Prohibit future development of county critical facilities and structures in identified 100-year floodplains (per current/updated FEMA flood maps).	In Progress. Recent county developments (animal shelter and farmers market) have not been developed in 100-year floodplain area and the county will ensure that in any updates to ordinances or plans that this standard is maintained.
Identify/apply for funding to address all hazard concerns.	In Progress. County attempted to identify funding sources in the past with only minor success
Support the current Land Use Plan policies encouraging preservation of 100-year floodplain areas for conservation; consideration of revisions to ordinances that direct development away from the floodplains (limit development in these areas; enforce more strict guidelines when development does occur).	In Progress. County enforces its Flood Damage Prevention Ordinance which directs development away from 100-year floodplain and requires elevating structures 3 feet above base flood elevation. To be re-evaluated in the future
Consider revising the county subdivision regulations to enhance existing policies prohibiting development of critical public facilities in the 100-year floodplain (where viable alternatives exist), encourage alternatives to placing lots in flood-prone area; minimize impervious surface coverings.	In Progress. County zoning ordinance encourages cluster development and incentivizes smaller lots for clustering away from wetland and flood prone areas. Additional improvements to be implemented.
Coordinate with the ODS to ensure that all dams in Vance County for which the ODS has jurisdiction are inspected on a regular basis	In Progress. County needs to obtain current data
Ensure manufactured housing meets the minimum state requirements for proper installation.	To Be Continued. County enforces state building code for manufactured homes.

Mitigation Action	Status
Consider revising ordinance to require new manufactured housing units to have permanent foundations.	In Progress.
Coordinate with NCDOT to address localized drainage issues caused (in part or in whole) by NCDOT's maintained drainage facilities.	In progress.
For any interested homeowners located in floodplain areas, the county will consider applying for mitigation grant funding to acquire or elevate the homes on a strictly voluntary basis for the homeowner.	To be continued. New Action.
Warren County	
Inspect all portions of buildings that were submerged for any length of time for flood related damage and other conditions that could endanger lives, health or property	To be continued
Construct new EOC to withstand tornado/hurricane/thunderstorm force winds	In progress. County to construct new EOC
Address previous flooding issues at critical facilities (e.g., wastewater treatment plant) via retrofitting, better drainage, other mitigation protection projects.	In progress. addressing previous flooding issues at critical facilities.
Ensure adequate evacuation warning in case of major hazard event.	In progress.
Improve shelter capacities with alternate power/heat sources.	To be continued. County has made little progress due to lack of funding

Mitigation Action	Status
Identify alternate detour routes from major arteries in the county.	To be continued: Alternate detour routes were identified in some cases, but there is not a comprehensive plan in place.
Develop grant application(s) to install generators at critical facility locations throughout the county.	In progress.

Table 34 - Largest Employers in the Region by County, Annual 2021

Franklin County

Rank	Company Name	Industry	Employment Range
1	Franklin County Schools	Educational Services	1000+
2	County Of Franklin	Public Administration	500-999
3	Novozymes North America Inc	Manufacturing	500-999
4	Captive-Aire Systems Inc.	Manufacturing	250-499
5	K-Flex USA Llc	Manufacturing	100-249
6	Wal-Mart Associates Inc	Retail Trade	100-249
7	Team Manufacturing East West	Manufacturing	100-249
8	Dept Of Public Safety	Public Administration	100-249
9	Palziv North America Inc	Manufacturing	100-249
10	Majestic Marble & Glass Co (A Corp)	Manufacturing	100-249

Source: (North Carolina Department of Commerce Labor and Economic Analysis Division, 2022)

Granville County

Rank	Company Name	Industry	Employment Range
1	State Of Nc Dept Of Health & Human	Health Care and Social Assistance	1000+
2	U S Department Of Justice	Public Administration	1000+
3	Food Lion	Transportation and Warehousing	1000+
4	Granville County Schools	Educational Services	500-999
5	Revlon Consumer Products Corp	Manufacturing	500-999
6	Altec Industries Inc	Manufacturing	500-999
7	Granville Medical Center	Health Care and Social Assistance	500-999
8	County Of Granville	Public Administration	250-499
9	Dept Of Public Safety	Public Administration	250-499
10	Food Lion	Transportation and Warehousing	250-499

Source: (North Carolina Department of Commerce Labor and Economic Analysis Division, 2022)

Person County

Rank	Company Name	Industry	Employment Range
1	Person County Schools	Educational Services	500-999
2	Gkn Driveline, Inc.	Manufacturing	500-999
3	County Of Person	Public Administration	250-499
4	Poly Wood LLC	Wholesale Trade	250-499
5	Wal-Mart Associates Inc	Retail Trade	250-499
6	Progress Energy Service Co	Utilities	100-249
7	Dlp Person Memorial Hospital	Health Care and Social Assistance	100-249
8	Spuntech Industries Inc	Manufacturing	100-249
9	Piedmont Community College	Educational Services	100-249
10	Eaton Corporation	Manufacturing	100-249

Source: (North Carolina Department of Commerce Labor and Economic Analysis Division, 2022)

Vance County

Rank	Company Name	Industry	Employment Range
1	Variety Wholesalers Inc	Transportation and Warehousing	500-999
2	Wal-Mart Associates Inc.	Transportation and Warehousing	500-999
3	Vance County Schools	Educational Services	500-999
4	Dlp Person Memorial Hospital	Health Care and Social Assistance	500-999
5	County Of Vance	Public Administration	250-499
6	Vance Granville Community College	Educational Services	250-499
7	Ardagh Glass Inc	Manufacturing	250-499
8	City Of Henderson	Public Administration	100-249
9	M R Williams Inc	Wholesale Trade	100-249
10	United Call Center Solutions Inc	Professional, Scientific, and Technical Services	100-249

Source: (North Carolina Department of Commerce Labor and Economic Analysis Division, 2022)

Warren County

Rank	Company Name	Industry	Employment Range
1	Warren County Schools	Educational Services	250-499
2	Dept of Public Safety	Public Administration	250-499
3	County of Warren	Public Administration	250-499
4	Glen Raven Inc	Manufacturing	100-249
5	Food Lion	Retail Trade	100-249
6	Comfort of Home Care Agency Inc	Health Care and Social Assistance	50-99
7	Cast Stone Systems Inc	Manufacturing	50-99
8	Smoke House Lumber Company	Manufacturing	50-99
9	The Pointe Cafe LLC	Accommodation and Food Services	50-99
10	Elberta Crate & Box Co	Manufacturing	Below 50

Source: (North Carolina Department of Commerce Labor and Economic Analysis Division, 2022)

Table 35 - Employment Totals, Annual 2021, All Industries

County	# of Establishments	Average Employment	Total Wages	Average Weekly Wage
Franklin	1,305	12,333	$598,305,620	$933.00
Granville	990	20,258	$1,022,078,745	$970.00
Person	758	9,517	$425,737,161	$860.00
Vance	881	13,863	$579,498,072	$804.00
Warren	307	2,977	$109,388,791	$707.00
All Counties	**4,241**	**58,948**	**$2,735,008,389**	**$854.80**

Source: (North Carolina Department of Commerce, Labor and Economic Analysis Division, U.S. Department of Labor's Bureau of Labor Statistics (BLS), 2022)

Table 36 - Historic and Cultural Sites

This table identifies sites that will be impacted by flood events. Properties in **bold** are on the National Register of Historic Places.

Site ID	Site Name	Description
Franklin		
FK0526	A.T. Neal Brick Building (Gone)	
FK0299	Alford-Whitaker Mill Ruin (Gone)	
FK0026	**Baker Farm**	**3-phase 19th c. 2-story frame farmhouse**
FK0602	Bridge	1954 bridge
FK0609	Bridge	1946 bridge
FK0289	Bridge #64 (Cedar Creek Bridge)	1962 concrete bridge
FK0567	Bridge No. 42 (Replaced)	steel frame bridge
FK0568	Bridge No. 55 (Replaced)	
FK0569	Bridge No. 68 (Replaced)	
FK0570	Bridge No. 99 (Replaced)	Low steel truss bridge w/ two spans & angle iron type railings
FK0001	**Cascine**	**18th-19th c. plantation complex; Georgian, Greek Revival**
FK0318	Cascine Mill	c. 1825 4-story frame mill
FK0024	**Clifton House (Relocated) and Mill Site**	**Mid-19th c. 2-story frame Greek Revival house, 15-foot-high stone dam & ruins of mill**
FK0024	**Clifton House (Relocated) and Mill Site**	**Mid-19th c. 2-story frame Greek Revival house, 15-foot high**
FK0554	Franklin County Training School - Riverside Union School	1951-1968 African American school complex
FK0802	Gupton Millpond Dam	c. 1900 dam
FK0465	Ira Weldon's Mill	Dam, mill, and store
FK0387	Jackson Mill Pond	1 1/2-story front gable frame mill
FK0011	**Laurel Mill**	**Mid-19th C. frame grist mill**
FK0282	**Louisburg Historic District**	**19th-early 20th c. courthouse town**
FK1265	**Louisburg Historic District Boundary Increase**	

Site ID	Site Name	Description
FK0015	**Massenburg Plantation**	**Early 19th c. & 1838 Federal 2-story frame house, outbuilding**
FK0868	Mitchiners Fishing Club	c. 1930
FK0414	Moore's Mill Pond	Dam, mill ruins, wheel
FK0019	**Person-McGhee Farm**	**c. 1890 Queen Anne 2-story frame house and farm**
FK0572	Raleigh & Gaston Railroad Cedar Creek Bridge Piers	1830s tapered stone bridge piers for original rail bridge over creek
FK0689	Seaboard Coast Line Tar River Bridge	
FK0285	**Speed Farm**	**1847 2-story frame house and farm**
FK1270	Water pump station and water tower (Gone)	c. 1925 concrete reservoir w/ wood frame & sheet metal roof
Granville		
GV0003	**Abrams Plains**	**1770s-1830 Federal/Greek Revival 2-story frame house**
GV0689	Bridge No. 141	
GV0666	Currin-Bowling Farm	
GV0010	**Eldon B. Tunstall Farm**	**1907 I-house and farm**
GV0106	**James Blackwell House**	**1820s and later Federal house**
GV0018	**Lewis Wimbish Plantation (Gone?)**	**1850s Greek Revival 2-story frame house**
GV0972	**Oxford Historic District Add Doc, Boundary Decrease, Boundary**	**c. 1845-c.1965 district eligible under Crit A and Crit C**
GV0667	Oxford Water Works	
GV0175	**Rose Hill**	**1834 Greek Revival 2-story brick house**
GV0059	**Rufus Amis House and Mill Boundary Amendment**	**1850s house and grist mill**
GV----	Watkins Farm Rural Historic District	
Person		
PR0011	**Burleigh**	**Mid-19th c. Greek Revival 2-story frame house; outbuildings**
PR0022	Davis Mill (Approximate site)	
PR0033	Harris Mill	
PR0089	Hurdle Mill	

Site ID	Site Name	Description
PR0102	Moore's Mill (ruin)	
PR0326	**North Roxboro Residential Historic District**	**c. 1842-present**
PR0328	**Reamstown Residential Historic District**	**c. 1890-present**
PR0290	Truss Bridge #35	c. 1900 pin-connected Pratt half-hip pony truss (DOT 720035)
Vance		
VN0015	**Belvidere**	**1850 Greek Revival/Italianate 2-story frame house**
VN0082	Hibernia (Hargrove Place) (Gone)	c. 1800 2-story side gable frame house w/ 3 exterior chimneys
VN0014	**LaGrange**	**Mid-19th c. Greek Revival 2-story frame house**
VN0113	Mabry's Mill (Gone)	19th C. frame grist mill
VN0341	Raleigh and Gaston Railroad Bridge Piers	c. 1840 tapered, granite pylon; remains of original bridge
VN0341	Raleigh and Gaston Railroad Bridge Piers	
VN0386	**Thomas A. Morgan Farm**	**Thomas A. Morgan Farm. Farm complex includes 12 properties**
VN0035	Weldon's Mill	Late 19th c. 2-story side gable frame grist mill w/ outbuildings
Warren		
WR0316	Bridge No. 4	1934 timber stringer/multi-beam (DOT 920004)
WR----	Bridge No. 74 on SR 1641	
WR0390	Bridge No. 9	1920 reinforced concrete slab (DOT 920009)
WR0251	**Buxton Place**	**1857 Greek Revival/Italianate 2-story frame house**
WR0107	Davis Mill	
WR0197	Dr. Pitchford House	Mid-19th c. Greek Revival 2-story frame house
WR0132	Hamme's Mill	c. 1800, 1937 2-story front gable frame mill w/ weatherboard
WR0008	**Lake O'Woods**	**1852 Greek Revival 2-story frame house**
FK0690	Shocco Creek Bridge (Bridge No. 66)	1920 reinforced concrete tee beam (DOT 340066)

Table 37 - Endangered - Special Concern - Threatened Species in the Kerr-Tar Region

Species highlighted in yellow are found in four or more counties. There are 14 of them.

Taxonomic Group	Common Name	NC Status	Habitat Comments
Freshwater Bivalve	Atlantic Pigtoe	E	Roanoke, Tar, Neuse, Cape Fear, Yadkin-Pee Dee drainages
Freshwater Bivalve	Brook Floater	E	Cape Fear drainage, also along Blue Ridge escarpment of Catawba and Yadkin-Pee Dee drainages
Vascular Plant	Carolina Thistle	E	Forests and disturbed areas, mostly on basic soils
Freshwater Bivalve	Dwarf Wedgemussel	E	Tar and Neuse drainages, mainly near Fall Line
Vascular Plant	Glade Bluecurls	E	Diabase glades, other dry calcareous or mafic outcrops
Freshwater Bivalve	Green Floater	E	New, Watauga, Roanoke, Tar, Neuse and Yadkin-Pee Dee drainages
Vascular Plant	Harperella	E	Rocky riverbeds
Vascular Plant	Heller's Rabbit-Tobacco	E	Dry woodlands and openings (especially over mafic rocks), longleaf pine sandhills
Vascular Plant	Mead's Sedge	E	Low wet places over diabase
Vascular Plant	Michaux's Sumac	E	Sandhills, sandy forests, woodland, woodland edges
Vascular Plant	Narrow-leaved Smooth Aster	E	Forests, woodland borders especially over mafic rocks
Vascular Plant	Oak Barrens Barbara's-buttons	E	Clayey upland soils over diabase
Vascular Plant	Piedmont Fameflower	E	Shallow soil over mafic rock, where periodically wet by seepage
Vascular Plant	Prairie Blue Wild Indigo	E	Glades and open forests on basic soils
Vascular Plant	Prairie Goldenrod	E	Diabase glades

Taxonomic Group	Common Name	NC Status	Habitat Comments
Vascular Plant	Ringed Witch Grass	E	Dry sandy or rocky open woods and borders of thickets
Vascular Plant	Serpentine Aster	E	Diabase glades
Vascular Plant	Shale-barren Skullcap	E	Diabase glades
Vascular Plant	Smooth Coneflower	E	Glades, woodlands, and open areas over mafic rocks
Vascular Plant	Smooth-seeded Hairy Nutrush	E	Pine savannas over limestone, diabase glades
Vascular Plant	Southern Skullcap	E	Alluvial forests
Freshwater Bivalve	Tar River Spinymussel	E	Tar drainage, very rare in Neuse drainage (endemic to North Carolina)
Vascular Plant	Veined Skullcap	E	Alluvial forests
Vascular Plant	Yadkin Hedge-nettle	E	Sandy edges of forested floodplains
Freshwater Bivalve	Yellow Lampmussel	E	Chowan, Roanoke, Neuse, Tar, Cape Fear, Lumber, Yadkin-Pee Dee drainages
Freshwater Bivalve	Yellow Lance	E	Tar and Neuse drainages
Bird	Bachman's Sparrow	SC	Open longleaf pine forests, old fields [breeding evidence only]
Freshwater Fish	Carolina Darter	SC	Roanoke, Tar, Neuse, Cape Fear, Yadkin-Pee Dee, and Catawba drainages
Crustacean	Chowanoke Crayfish	SC	Streams and rivers in the Chowan and Roanoke drainages
Amphibian	Four-toed Salamander	SC	Pools, bogs, and other wetlands in hardwood forests
Amphibian	Gray Treefrog	SC	Deciduous or mixed forests, often near water; primarily near VA border

Taxonomic Group	Common Name	NC Status	Habitat Comments
Amphibian	Mole Salamander	SC	Breeds in fish-free semipermanent woodland ponds; forages in adjacent woodlands
Amphibian	Neuse River Waterdog	SC	Rivers and large streams in Neuse and Tar drainages (endemic to North Carolina)
Crustacean	North Carolina Spiny Crayfish	SC	Rivers and streams in the Chowan, Roanoke, Neuse, and Tar drainages
Freshwater or Terrestrial Gastropod	Ridged Lioplax	SC	Streams and rivers, well documented in Lake Waccamaw, possibly in decline there
Freshwater Bivalve	Roanoke Slabshell	SC	Roanoke, Tar, Neuse, White Oak, Cape Fear, Lumber, and Yadkin-Pee Dee drainages
Reptile	Timber Rattlesnake	SC	Wetland forests in the Coastal Plain; rocky, upland forests elsewhere
Bird	Bald Eagle	T	Mature forests near large bodies of water (nesting); rivers, lakes, and sounds (foraging) [breeding evidence only]
Vascular Plant	Buffalo Clover	T	Open woods and clearings
Vascular Plant	Carolina Birdfoot-trefoil	T	Woodlands and openings, generally on clayey soils, roadsides
Freshwater Fish	Carolina Madtom	T	Tar and Neuse drainages (endemic to North Carolina)
Freshwater Bivalve	Creeper	T	Roanoke, Tar, Neuse, Cape Fear, Yadkin-Pee Dee, Catawba, Broad, and French Broad drainages
Freshwater Bivalve	Eastern Lampmussel	T	Chowan, Roanoke, Tar, Neuse, Cape Fear, Yadkin-Pee Dee drainages
Vascular Plant	Granite Flatsedge	T	Granite flatrocks, other rock outcrops
Vascular Plant	Hoary Puccoon	T	Diabase glades, open woods over diabase
Vascular Plant	Horned Bladderwort	T	Bogs, limesink ponds
Vascular Plant	Indian Physic	T	Forests and open woods, mainly over mafic rocks

Taxonomic Group	Common Name	NC Status	Habitat Comments
Freshwater Fish	Least Brook Lamprey	T	Tar and Neuse drainages
Vascular Plant	Low Wild-petunia	T	Diabase glades
Freshwater Fish	Mimic Shiner	T	New, French Broad, Little Tennessee, Tar, and Neuse drainages
Freshwater Bivalve	Notched Rainbow	T	Roanoke, Tar, Neuse, Yadkin-Pee Dee, and Catawba drainages
Vascular Plant	Piedmont Quillwort	T	Granite flatrocks and diabase glades
Vascular Plant	Purple Fringeless Orchid	T	Bogs, forests
Vascular Plant	Small's Portulaca	T	Granite flatrocks and diabase glades
Vascular Plant	Tall Larkspur	T	Grassy balds, glades, woodlands, mostly over mafic rock
Freshwater Bivalve	Tidewater Mucket	T	Chowan, Roanoke, and Tar drainages, and abundant in Lake Waccamaw
Freshwater Bivalve	Triangle Floater	T	Roanoke, Chowan, Tar, Neuse, Cape Fear drainages
Vascular Plant	Wild Hyacinth	T	Rich levees, slopes, and bottomlands
Vascular Plant	Wiry Panic Grass	T	Glades and openings over mafic rocks

Source: (North Carolina Natural Heritage Program, 2022)

Table 38 - Recorded Brownfield Sites in the Kerr-Tar Region

Active Sites as of 7/1/22	County
Sterling Mill Lofts, 106 East Green Street in Franklinton	Franklin
Athol Manufacturing, 100 22nd Street; 403 East C Street; 106 20th Street in Butner	Granville
Oxford Printing, 8 Industry Drive in Oxford	Granville
Bromma Property II, 2285 Durham Road in Roxboro	Person
Burkhart Carolina, 1703 Dabney Drive in Henderson	Vance

Source: (North Carolina Department of Environmental Quality, 2022)

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