Flood Reduction Study
Problems and Opportunities Report

Town of Nichols

April 2020

WOOLPERT

ARCHITECTURE | ENGINEERING | GEOSPATIAL

1 Introduction and Background

The Town of Nichols is located in northeastern South Carolina, just upstream of the confluence of the Little Pee Dee and Lumber Rivers and has recently experienced two extreme flooding events – Hurricane Matthew (2016) and Hurricane Florence (2018). Both events created flows and water surface elevations at the Town of Nichols beyond the 100-year flood event. These events devastated the Town's infrastructure and building stock as nearly every structure within the Town limits experienced some form of damage. The entire Town felt the economic and social impacts of the devastation.

Being situated near the confluence of two major river systems in a relatively flat part of the State presents the Town of Nichols with unique flooding issues. Nichols has very little control of development patterns and densities in the 1,750 square mile Lumber River watershed, there is very little topographic relief within the Town, and there are no in-stream flood control structures to regulate flows.

The Town has, however, received Federal Emergency Management Agency (FEMA) Hazard Mitigation Grant Program (HMGP) funding to evaluate flood patterns and potential flood mitigation measures. This Problems and Opportunities report has been developed to identify the flood risks associated with the Town, present an economic analysis, discuss a range of potential solutions, and show hydrologic modeling evaluations of solutions that may be applicable to Nichols.

2 General Description of Flooding

Prior to the 2016 Hurricane Matthew, the Town of Nichols (Nichols) had a population of approximately 359 residents (http://www.city-data.com/city/Nichols-South-Carolina.html) with an estimated median household income of $31,665 –below the South Carolina median income level. The median household income decreased from $41,597 in 2000, and it is projected that the flood events further diminished the income levels and property values in Nichols. The economic analysis performed as part of this study (Section 3) will provide additional information related to home values and the economics of Nichols. The building stock for Nichols consists of primarily residential structures with some commercial and industrial properties. Many of these structures, both residential and commercial, including the Elementary School, have been abandoned as a result of the repetitive flooding. In 2015, unemployment in Nichols was almost double the State unemployment figures.

The two storm events that caused significant damages in Nichols were Hurricane Matthew in 2016 and Hurricane Florence in 2018. Both of these storms were extreme events that created flow rates and water surface elevations well above the 100-year flood elevations shown on the Flood Insurance Rate Maps (FIRMs). The Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) calculates the 100-year flow rate at the mouth of the Lumber River to be approximately 29,800 cubic feet per second (cfs), producing water surface elevations ranging from 52.0 feet to 54.0 feet from the downstream end to the upstream end of Nichols. The 2016 and 2018 events produced approximately 59,300 and 64,700 cfs, respectively, at the United States Geological Survey (USGS) Galivants Ferry river gaging station (Figure 1), which is double any flow seen at this station since 1940 and created water surface elevations within the Town of approximately 56.5 feet. These numbers begin to show the extreme nature of these two Hurricanes and explain why Nichols saw unprecedented flooding twice in the past five (5) years.

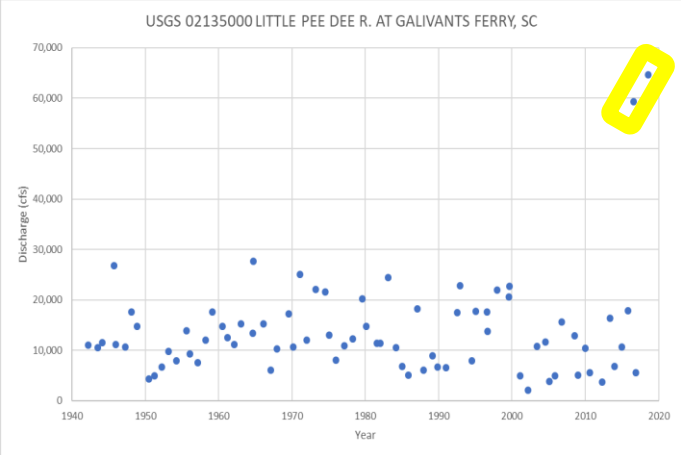

Figure 1: USGS Gage Data at Galivants Ferry

Preliminary hydraulic modeling indicates that flooding from these two storms likely occurred from flood waters that overtopped SC highway 9 to the north and backwater associated with the Little Pee Dee River to the south of town. The impact of these two flooding sources was to effectively cut-off access to and from Nichols, trapping residents that did not leave early. Not only was the depth of flooding significant, but the duration of flooding and the timing between floods was equally devastating. The model findings and results are further discussed in Section 7 of this Problems and Opportunities Report.

Figure 2: Flooding in Nichols
*(*source: www.postandcourrier.com)

A large percentage of structures, both residential and commercial/industrial, experienced some level of flooding during the storm events. Many of these owners did not have flood insurance and are struggling to pay for the thousands of dollars worth of damage. Residents were just beginning to finish repairs and get back to a normal routine after Hurricane Matthew with Hurricane Florence came through. Homes were not only damaged by floodwaters but faced dangerous mold and pest concerns by the time they could return to their homes.

Further inhibiting recovery is the National Flood Insurance Program substantial damage requirement. The vast majority of buildings within Nichols were constructed prior to the development and release of flood data and are at or below the 100-year base flood elevation (BFE). While some residents may be able to afford to make necessary repairs – many with assistance from disaster response groups – most do not have sufficient funding to meet the substantial damage requirement to elevate their home to meet current building regulations and protect it from possible future flooding.

2.1 FEMA Flood Maps

FEMA flood maps provide a public source of information for flood hazard information, specifically developed to support the National Flood Insurance Program (NFIP). These Flood Insurance Rate Maps (FIRM) show the extents of the floodplain as a result of the 100-year and 500-year storm events, denoted in the FIRMs as the "A" zones and the "X" zones, respectively. As shown on the FIRM for Nichols, map number 45067C0182E with an effective date of October 18, 2011, large areas of Nichols are within the 100-year floodplain Zone AE (Figure 3). These maps are used by FEMA to determine what structures are in a Special Flood Hazard Area (SFHA), and consequently the associated level of threat and flood insurance premiums. These maps are primarily concerned with the 1% chance of inundation in a given year (the 100-year storm event) so it is important to understand that not being included in the SFHA on a FEMA FIRM does not mean that a home will not flood. Rather, these maps provide a good baseline for guidance for homeowners and communities to assess potential flood hazards. Flood levels associated with the 100-year storm event are also used to determine required levels of protection for projects to be eligible for FEMA funding.

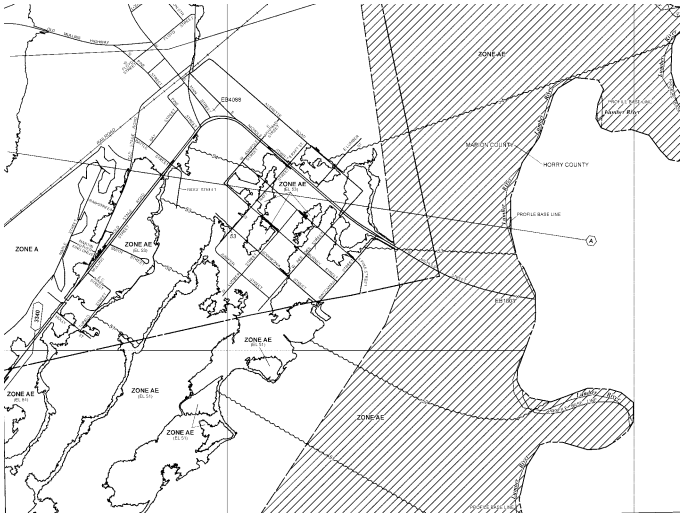

Figure 3: FEMA Flood Map for Nichols, SC

2.2 Existing 2019 Town Conditions

Driving around Nichols in 2019, three years after Hurricane Michael and a year after Hurricane Florence, the impact from the repeated flood events is glaring. Many homes and businesses have been abandoned; high water marks from the floodwaters are still evident in many areas. The elementary school stands empty, with mold and water damage causing it to be unusable and unsafe for children. Portable storage units and piles of personal belongings stored under tarps behind homes show the widespread impacts of the flooding. Volunteer groups are actively working to help many residents rebuild their homes and their lives. Numerous buildings will need substantial repairs or complete rebuilds prior to being livable again. While financial assistance and volunteers can help rebuild the structures in and around Nichols, the Town will also need to provide residents with morale and encouragement to return to their homes.

3 Economic Analysis

Understanding the economic impact of the storm events on the Town is critical to present a full story of the devastation caused by the rain, outside of the physical damage to structures and infrastructure. Given the size of Nichols, data collection of area economics was limited to available information from the Town and local utilities, and included the following sources:

- Marion County parcel data (2019 tax year)
- Census data was obtained from the U.S. Census Bureau. This data includes a combination of actual data from the 2010 Census as well as estimates from the American Community Survey (ACS). The ACS is an ongoing survey completed by the U.S. Census Bureau and provides multi-year estimates for data on populations, demographics, and economic indicators. This study utilized the 2013-2017 ACS data, the most recent data available at the time of this analysis.
- Door to Door Survey – A survey completed in 2014 by the Town of Nichols to better understand the current population and economic status after several large business closures including the closure of the Michels and Co. Pilliod plant in 2004.
- Grand Strand Water and Sewer Authority (Authority) provides water and sewer service for the Town of Nichols. Lists of active accounts for July 2014, September 2016, and April 2019 were obtained from the Authority.
- Business Licenses – The Town of Nichols provided a list of business licenses that were active during the 2014-2016, 2016-2017, and 2018-2019 time periods. The Town compiled this data to understand the impact of the storms on local businesses.

Based on the data available, a job opportunity analysis and an income analysis were completed to assess economic health and determine an economic baseline for the Town of Nichols. The job opportunity analysis evaluates the trends in business licenses as an indicator of job opportunities available and a population analysis as an indicator of people available to fill those job opportunities. The income analysis includes an evaluation of income levels reported in a door to door survey as well as a comparison to more recent income levels and state income levels.

3.1 Job Opportunities Analysis

Job opportunities play a key role in the economic health of a community. The flooding events from two storms had a significant impact on businesses. Data was available on the number of active business licenses during the period from 2014-2016, 2016-2017, and 2018-2019. The business licenses from 2014-2016 represents active businesses prior to Hurricane Matthew. The business licenses between 2016-2017 represent businesses prior to Hurricane Florence and after Hurricane Matthew. The businesses licenses during 2018-2019 represent businesses that were present after Hurricane Florence. As shown in Figure 4, during the time period from 2014-2019 there were 26 active businesses in Nichols at one point during the 5-year period. However, at the end of 2019 there were only 13 active businesses in the Town.

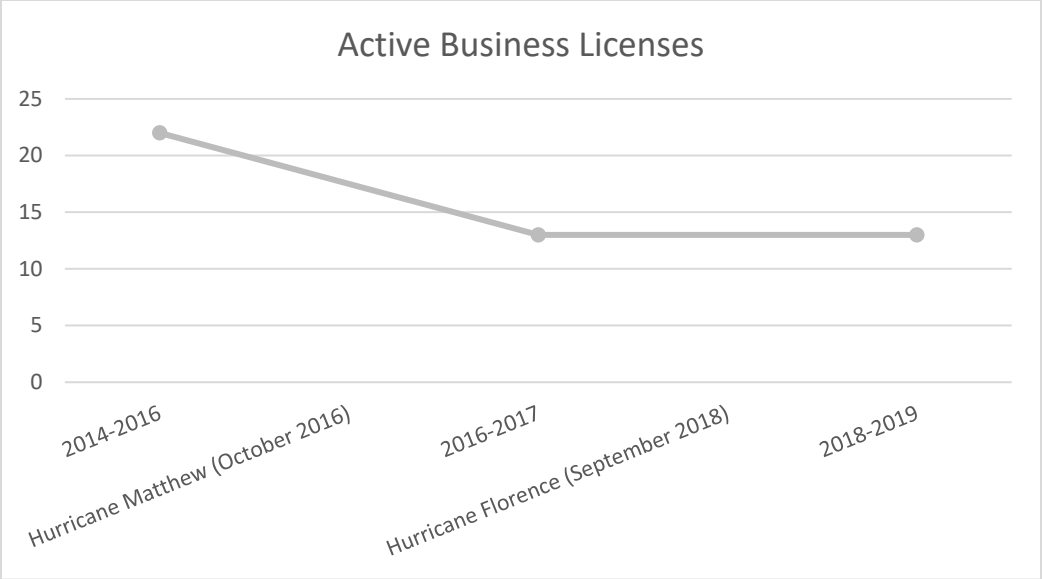

Figure 4: Town of Nichols Active Business Licenses: 2014-2019

Based on the trends in business licenses shown in Figure 4, the Town experienced a 46% reduction in businesses after Hurricane Matthew (2016). However, after Hurricane Florence (2018), the number of business licenses remained stable compared to the time period after Hurricane Matthew and before Hurricane Florence. Table 1 below shows active businesses over time broken down by category. The Town lost the most businesses in the business services, health and wellness, and landscaping sectors.

Table 1. Active Businesses by Category

	2014-2016	**2016-2017**	**2018-2019**
Automotive	7	6	6
Business Services	3	0	1
Food Service	1	1	1
Health and Wellness	3	1	1
Landscaping	2	1	0
Laundry	1	0	0
Shopping and Retail	3	3	3
Utilities	1	0	0
Wedding and Events	1	1	1

This stability in businesses licenses indicates that while the number of businesses in the community is lower than before both hurricanes, the number of businesses in the Town have potentially reached their lowest point and the Town is primed to experience a rebound in businesses.

The second portion of the job opportunity analysis includes as assessment of the population available to fill job opportunities. Census population data is available from 2010 (population 368), but this data is not available on a more refined time step to assess populations before, between, and after the hurricanes. Because Census population data is not available, active residential water accounts can be used to assess trends in population in the Town. Data on active water accounts was available for two time periods prior to both hurricanes (2014 and 2016)

as well as after both hurricanes (2019). Table 2 below shows the breakdown of residential and non-residential active water accounts.

Table 2. Active Water Accounts in the Town of Nichols

	2014	2016 (pre-hurricane)	2019
Residential	183	178	147
Non-Residential	32	18	26
Total	215	196	173

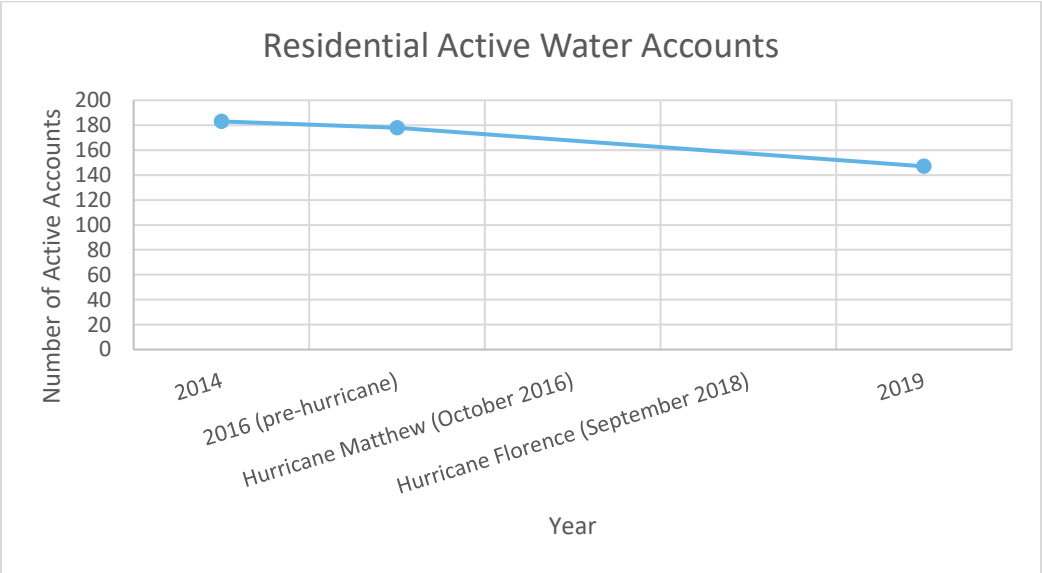

Figure 5: Town of Nichols Active Residential Water Accounts

As stated above, only active residential water accounts were used to serve as a proxy for population. Figure 5 shows the trends in the residential active water accounts during 2014, 2016 (pre-hurricane), and 2019. Prior to the hurricanes, active water accounts declined 3% between 2014 and 2016. After the hurricanes, there was a 20% decline in active water accounts in 2019 compared to 2014. The decline in the number of water accounts may indicate that the population of the Town is shrinking but may also indicate that the recovery from the storm events has been slow. Given the low-income levels, as discussed in the income analysis section, recovery from the storm events may be a longer process than in other communities with higher income levels.

3.2 Income Analysis

In 2014, prior to the hurricane events, the Town of Nichols complete a door to door survey on income levels in order to determine eligibility for Community Development Block Grant (CDBG) programs. A total of 145 residential properties were surveyed during the door to door survey. These grant programs are targeted a low- and moderate- income persons. The thresholds for low and moderate income are established by the economic and market analysis division of the US Department of Housing and Urban Development (HUD) and are unique to each local area.

The thresholds for low and moderate income are based on the median income for Marion County, SC. The median income for Marion County, SC is calculated using the American Community Survey 5-year estimate for median household income plus a Consumer Price Index (CPI) inflation factor and a margin of error. Then the remaining thresholds are set as follows, with allowances for factors for housing cost and location (metro or non-metro):

- **Very low- income**: 50% of the median income threshold
- **Extremely low income**: 60% below the very low-income threshold
- **Low income:** 60% above the very low-income threshold

The income limits used for the 2014 door to door survey in Nichols are provided in Table 3 below.

Table 3. Door to Door Survey (2014) Income Limits

Income Limit Category	Persons in Family							
	1	2	3	4	5	6	7	8
Extremely Low	$10,500	$11,450	$12,900	$14,300	$15,450	$16,600	$17,750	$18,900
Very Low	$16,700	$19,100	$21,500	$23,850	$25,800	$27,700	$29,600	$31,500
Low	$26,750	$30,550	$34,350	$38,150	$41,250	$44,300	$47,350	$50,400
Above limit	Over $26,751	Over $30,551	Over $34,351	Over $38,151	Over $41,251	Over $44,301	Over $47,351	Over $50,401

Because the door to door survey contained address information, the results of the survey can be visualized in a map as well as summarized in graphs.

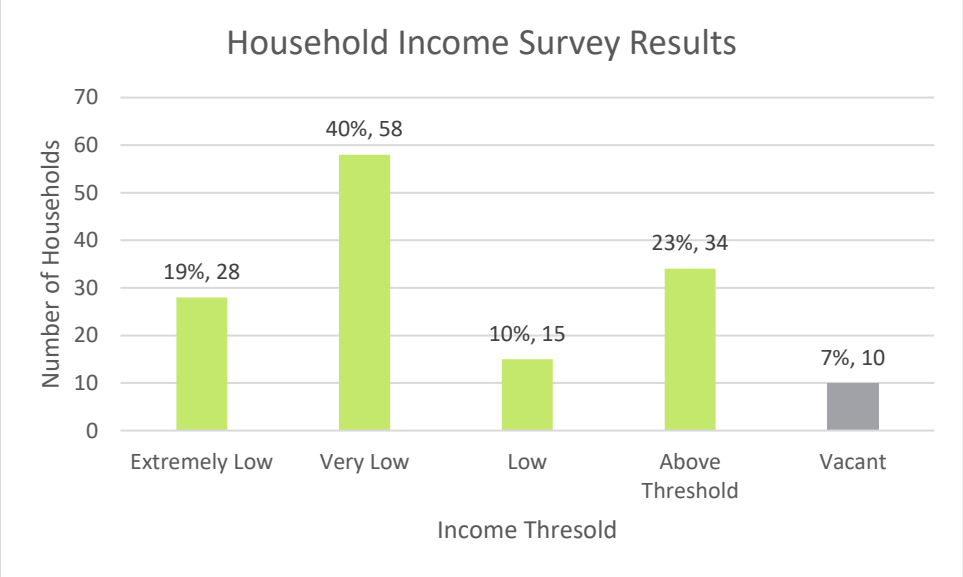

Figure 6: Town of Nichols Household Income Survey Results

In fiscal year (FY) 2013, the Marion County median income was $40,400 compared to a statewide median income of $55,000. In FY 2019, the median income was $41,600 compared to a statewide median income of $62,500. Marion County not only contains the Town of Nichols, but also contains the City of Marion, the City of Mullins, and the Town of Sellers and these income numbers represent the entire County. It is worth noting that during the period from FY2013 to FY2019, Marion County only experienced a 3% increase in their median income, compared to a statewide 13% increase in median income. The 5-year American Community Survey (2016) median household income (MHI) for the block group that contains the Town of Nichols was $33,261. This block group is smaller than the County and contains the Town of Nichols and surrounding unincorporated areas. This block group does not capture any of the other cities and towns in the County. Figure 8 below shows the Town of Nichols and the surrounding Census Block Group.

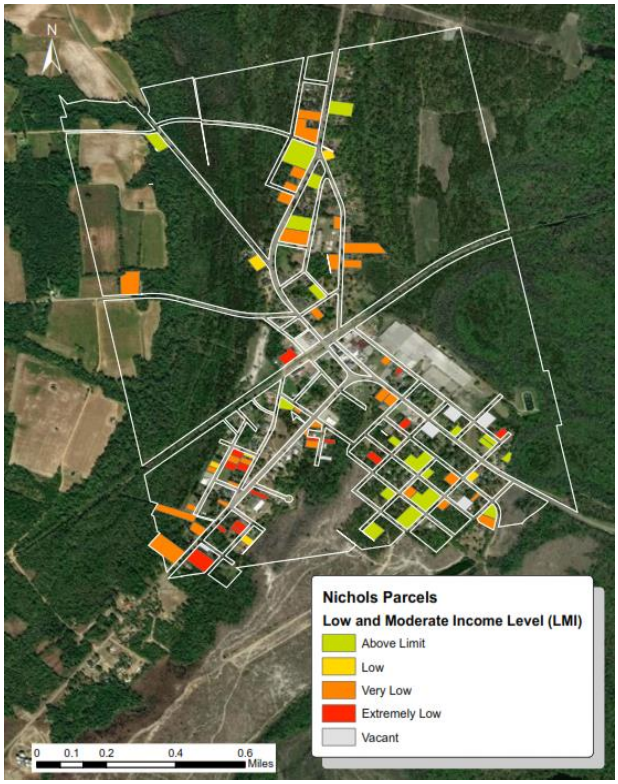

Figure 7: Door to Door Survey Low- and Moderate-Income Level Map

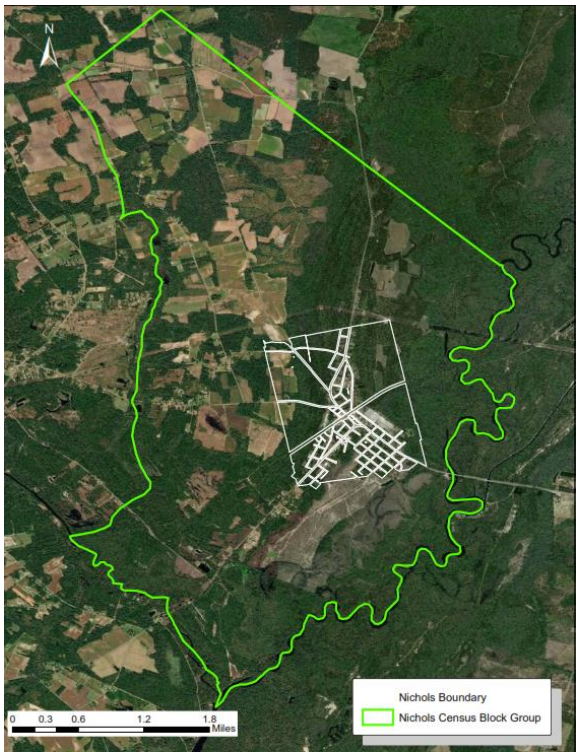

Figure 8: Town of Nichols and Census Block Group Boundary

The income limits for Marion County in FY2013 and FY2019 are provided in Table 4 and Table 5 below

Table 4. Marion County FY 2013 Income Limits

Income Limit Category	Persons in Family							
	1	2	3	4	5	6	7	8
Extremely Low	$10,000	$11,400	$12,850	$14,250	$15,400	$16,550	$17,700	$18,850
Very Low	$16,650	$19,000	$21,400	$23,750	$25,650	$27,550	$29,450	$31,350
Low	$26,600	$30,400	$34,200	$38,000	$41,050	$44,100	$47,150	$50,200
Above limit	Over $26,601	Over $30,400	Over $34,200	Over $38,000	Over $41,050	Over $44,100	Over $47,150	Over $50,200

Table 5. Marion County FY2019 Income Limits

Income Limit Category	Persons in Family							
	1	2	3	4	5	6	7	8
Extremely Low	$12,140	$16,910	$21,330	$25,750	$28,250*	$30,350*	$32,450*	$34,550*
Very Low	$18,350	$20,950	$23,550	$26,150	$28,250	$30,350	$32,450	$34,550
Low	$29,300	$33,500	$37,700	$41,850	$45,200	$48,550	$51,900	$55,250
Above limit	Over $29,301	Over $33,501	Over $37,701	Over $41,851	Over $45,201	Over $48,551	Over $51,901	Over $55,251

* Note that the methodology for calculating the "extremely low" threshold was modified in FY2014 to incorporate the Department of Health and Human Services (HHS) poverty guideline and as a result in some cases the "extremely low" and "very low" thresholds may be the same.

Depending on the threshold and number of people in the family, the income thresholds in Marion County between 2014 and 2019 increased between 9% and 15% in most cases. If the household income for the residents of the Town doesn't keep pace with the increase in the threshold levels, then some families will fall to a lower income range. For example, if a 4-person family had an income of $40,000 at the time of the door to door survey (2014), then that household would be above the low-income limit. If that same family did not experience any growth in their family income, in FY2019 that family would now fall into the low-income category instead of being above the threshold. Due to the decline in number of businesses and the economic impact of recovering from two large storms, if the results of the door to door were to be replicated again today, we would likely see a decline in the number of families above the low-income threshold and an increase in families in the low, very low, and extremely low-income categories.

3.3 Economic Analysis Summary

The Town of Nichols was unquestionably devastated by both Hurricane Matthew and Hurricane Florence. The back to back storms had significant impacts on property as well as the overall economy of the Town. The number of businesses in the Town decreased most significantly after Hurricane Matthew but has since remained stable. The population of the Town has declined since the storms. Household income levels in the Town were low at the time of the door to door survey in 2014 and given that the growth in median household income levels in Marion County is well below the growth in median household income levels for the state of South Carolina, we would expect that income levels in the Town of Nichols would remain low. Overall, the economy of the Town of Nichols appears to be at a stable, but low level.

Support for job opportunities and business development incentives would make a significant impact on the economic health of the Town of Nichols. The cost of creating jobs is not cheap. According to the World Bank, the cost of job creation is typically in the range of $500 to $3,000 per job but can in some cases cost more than $20,000 per job. Also, according to the World Bank, one of the best ways to create jobs is investment in infrastructure. In the Town Nichols, infrastructure is in desperate need of repair and improvement after the storm events. Moreover, improvement in infrastructure will subsequently attract businesses to the Town.

Based on the business licenses prior to the storms, there is significant capacity for growth in the number of businesses, resulting in growth in job opportunities for the residents of Nichols and surrounding areas. Once the infrastructure challenges of the Town have been addressed, additional economic opportunities will likely be created. For example, opportunities that leverage the Town's close proximity to the Lumber River, such as recreation, could do well in the Town. The Town is about one hour inland from the coast and at one point was a frequent stopping place for travelers on their way to Myrtle Beach. As a result of the Town's location near the coast, service industry-based businesses may also be successful.

4 Community Research

Nichols is not alone in their struggles to recover and rebuild from damages caused by the two flooding events. While Nichols suffered more damage and losses than many, communities across the country are focusing efforts on understanding, planning for, and protecting their homes from large flooding events. Woolpert reached out to five (5) communities who had been recently affected by flooding to discuss the impacts to their communities and how they were planning to recover and protect their communities in the future.

The Town of **Lumberton, NC** provided Woolpert with a lot of feedback and was eager to help Nichols any way they can. Brian Nolley, in charge of Lumberton community development, agreed that funding for repairs has been a struggle. They were able to secure a Community Development Block Grant (CDBG) through the NC Department of Commerce Neighborhood Revitalization Program to relocate seven or eight homes and raise 20 additional homes, as well as assist with repairing other homes. The Golden LEAF Foundation plans to construct a flood gate to alleviate impacts from future flood events. Thus far, all financial assistance has been secured for residential structures only. The Town plans to extend the sewer infrastructure in an effort to move businesses and bring jobs to the area. North Carolina offers zero interest loans that the Town is investigating to fund repair and restoration efforts, as well as additional grants. A landscape architecture program at NC State is helping the town identify how acquisition properties or areas for preservation could be used for parks and other recreational purposes for community development and suggested this would be a good option for Nichols.

The Town of **Fair Bluff, NC**, located just eight miles upstream along the Lumber River from Nichols, also experienced significant flooding during both Hurricanes Matthew and Florence and had approximately double the population of Nichols. The Town has received financial assistance for rebuilding efforts through FEMA, Hazard Mitigation Grant Program (HMGP) grants, the National Guard, the Council of Governments (COG), and Golden LEAF Foundation. Students at UNCH Chapel Hill created a recovery plan that included a greenway to protect the floodplain and provide recreational opportunities and investigated moving the Town further from the River. Currently, Town staff is evaluating these options further, and they are hosting their annual barbeque with the hope of bringing the community together and raising spirits. A similar community outreach event could be beneficial to the Town of Nichols to show residents that the Town officials are there, ready to rebuild better and stronger.

Andrews, SC experienced flooding three times in less than two years, from Hurricane Joaquin (October 2015), Hurricane Matthew (October 2016), and heavy rainfall in April 2017. The Town and residents feel that aging and undersized infrastructure and lack of maintenance caused many of the flooding issues in the Town. Georgetown County is currently working to perform a Town-wide evaluation of the stormwater infrastructure to determine recommended improvements to reduce flooding. This project is being funded through a FEMA 404 grant and is being managed by the County.

Thompsons, Texas, a community of similar size and demographics to Nichols, was devastated by Hurricane Harvey flooding. Woolpert reached out to the Mayor and was informed that the county, Fort Bend County, is providing substantial assistance to the Town. This includes road repairs, garbage clean-up, grant assistance, and increased building requirements to protect new and rebuilt structures from future events. Residents are also working with FEMA for damage assessments for either repairs or buy-outs.

Woolpert attempted to reach out to **Princeville, NC** but our messages have not been returned. Our understanding is that Princeville is considering relocation of all or substantial parts of the town. We will continue to monitor efforts in this community and update this report, as appropriate.

As requested by the Town of Nichols, Woolpert attempted to contact **Norfolk, Nebraska** in the wake of the extreme flooding in that area. Sadly, this area experienced very recent flooding in early 2019, including the death of one resident. In an attempt to respect the Town's immediate need to focus on emergency response, Woolpert halted efforts to reach out to Town officials. This Town may be contacted at a later date as the current emergency situation eases. There is a 4.5-mile levee protecting the town that was built in 1968 by the USACOE. It is unclear

from available information if this particular levee failed; however, the March 2019 flooding in Nebraska resulted in multiple levee failures.

4.1 Mitigation Matrix

Based on the conversations with similar, Woolpert developed a mitigation matrix of potential measures being considered or implemented in these communities. Each mitigation measure was then evaluated for applicability to Nichols.

Table 6. Mitigation Matrix

Community	Mitigation Measure	Applicability to Nichols
Lumberton, NC	State grants	USDA Community and Facilities Loan and Grant for schools, libraries, medical clinics, etc.
Lumberton, NC	Extend sewer infrastructure	If the study shows that moving parts of the town is a favorable option, extending infrastructure may be a good option to encourage this movement. Consider SC Rural Infrastructure Authority for financing.
Lumberton, NC	Identify areas for preservation	This report, as well as the assistance from Clemson, will identify areas for preservation.
Fair Bluff, NC	Assistance from the COG	PDCOG has been difficult to work with. Consider getting assistance from volunteers or Clemson to update LMI information and door-to-door survey
Fair Bluff, NC	Greenway for floodplain protection and recreation	Investigate locations that will double as floodplains and recreational opportunities for community growth and development
Fair Bluff, NC	Move the Town further from the river	Investigate potential alternative locations for parts of the Town, particularly businesses and public facilities
Fair Bluff, NC	Community Outreach: Annual BBQ	Nichols could host a public event to raise morale. This could double as an educational opportunity and to collect important information needed for grants and by the COG
Andrews, SC	Town-wide evaluation	Current effort underway
Thompsons, TX	Road repairs	Roads in Nichols did not suffer. Maintain and foster relationship with SCDOT for future needs and ongoing maintenance
Thompsons, TX	Garbage clean-up	Work with volunteer groups to offer residents free garbage pick-up and handling to encourage rebuilding efforts
Thompsons, TX	Increased building requirements	Release of building permits must balance the need to provide protection from future events with the desire to get residents back in their homes quickly.
Thompsons, TX	Individual FEMA assistance	Provide education and assistance to individuals to ensure all residents know their rights and options related to FEMA assistance.

5 Dam Analysis

There are dozens of dams within the Lumber River and Little Pee Dee River watersheds that are regulated by the South Carolina Department of Health and Environmental Control (SCDHEC) or the North Carolina Department of Environmental Quality (NCDEQ). To be regulated by SCDHEC, a dam must be at least 25 feet in height, hold back more than 50 acre-feet of water, or be likely to cause loss of human life. Dams are classified for hazard level based on the following criteria:

- **High-hazard:** Failure is likely to cause loss of life or serious damage to infrastructure
- **Medium-hazard:** Failure is not likely to cause loss of life but may cause damage to infrastructure
- **Low-hazard:** Failure may cause limited property damage

Only one of these regulated dams is located in-stream (Red Bluff Lake on the Little Pee Dee), while the remaining dams are located on tributaries to either the Little Pee Dee or the Lumber Rivers. No un-regulated in-stream dams are located within the vicinity of Nichols, so only regulated dams were evaluated. Impoundments can have a positive impact on flooding through attenuation of flood waters and, likewise, a profound negative impact by dam failure. It is important to be aware that dams could fail at any point in time. Lack of maintenance could result in a dam failure without any rain attributing to it, while additional pressures due to large rain events could cause failure to a well-designed and maintained dam.

Many factors affect flooding from dam failure including distance from the Town, size of the impoundment(s), type of failure, whether multiple dams fail in sequence or simultaneously, and timing of the failure with rain events. Woolpert performed a high-level evaluation of the potential impact on flooding in Nichols that could be attributed to dam failures. An assessment was performed on 158 regulated dams in South and North Carolina that are located in the Lumber River and Little Pee Dee River watersheds to determine the potential threat to Nichols. Impoundment volumes and GPS coordinates were gathered from SCDHEC and NCDEQ. Aerial imagery was used to determine the distance in river miles of each dam from Nichols, and this information was compiled to evaluate the threat level of each dam based on the criteria as shown in Table 7 below.

Table 7. Dam Threat Level Evaluation Criteria

	Impoundment Volume (ac-ft)		
Distance from Nichols (river miles)	**0-100**	**100-1000**	**>1000**
0 – 15	Low	Medium	High
15 - 50	Low	Medium	Medium
> 50	Low	Low	Low

Impoundment volume and the distance from Nichols were assessed and an overall threat of high, medium, or low was determined for each dam. There were no dams within the study area with a high threat level to Nichols, 18 dams classified under a medium threat level, and the remaining 140 dams were classified as a low threat level. Most of the medium threat dams were due to the size of the impoundment, and the average distance of these dams from Nichols is over 60 miles. Overall, the risk from dam failure on Nichols is very low. While this analysis did not reveal any High threat level dams, it is important to note that the effect of multiple dam breaches at a given time could result in disastrous water levels in the rivers surrounding Nichols. Figure 9 displays the dams in closest proximity to Nichols and the threat level associated with each. Yellow represents a Medium threat level and green represents a Low threat level.

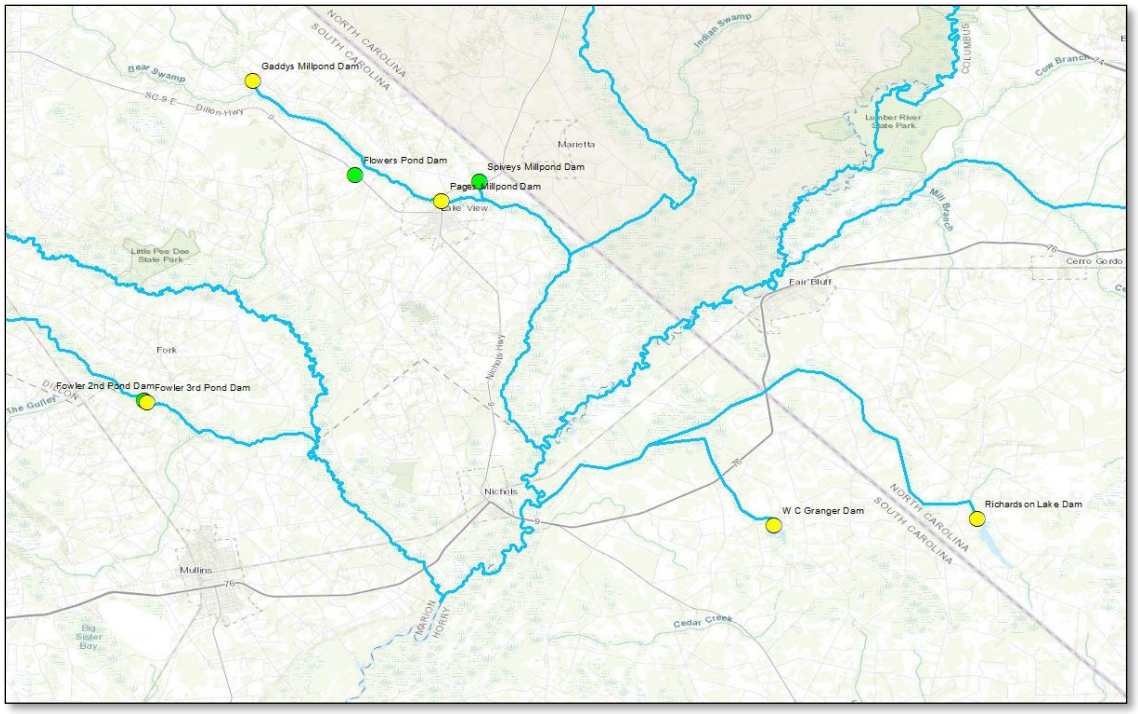

Figure 9: Dams in Close Proximity to the Town of Nichols

6 Flood Mitigation Activities

The location of the Town at the confluence of two major river systems presents unique challenges when trying to develop and implement flood mitigation activities. Woolpert evaluated current conditions in Nichols, potential solutions based on topography and known flooding patterns, and mitigation activities being considered and implemented by other communities to develop a preliminary list of potential mitigation activities that may be applicable in Nichols. There are also other groups assisting with the flood recovery efforts across the area following these large storm events with widespread impacts. Woolpert monitored these groups to attempt to supplement their efforts rather than duplicate them. These potential mitigation activities may include improvements to existing infrastructure, structural measures, or nonstructural activities.

6.1 Current Flood Mitigation Planning Efforts

Following the devastation of the flooding across the area, federal, state, and local entities were interested in preventing similar disasters in the future by more effectively preparing and protecting existing developments. Two of these groups, the South Carolina Disaster Recovery Office and the South Carolina Governor's office, are actively investigating potential mitigation measures in areas that include Nichols.

6.1.1 South Carolina Disaster Recovery Office

The South Carolina Disaster Recovery Office (SCDRO) has received over $157 million in HUD-MID funding to prepare a flood mitigation plan focused on Low to Moderate Income (LMI) areas within the Pee Dee Region of South Carolina in response to the flood damage resulting from the 2015 and 2016 hurricanes. As part of this effort, the SCDRO has engaged AECOM, an engineering firm, to develop a high level hydrologic and hydraulic models of the Lumber and Little Pee Dee River basins for the purposes of evaluating potential mitigation projects impacting LMI areas. This effort is similar, but on a much larger scale, to the Town of Nichols Flood Reduction project.

The SCDRO requested project ideas from communities within the Pee Dee region of South Carolina for consideration. While the timeframe for submittal was not conducive for a comprehensive project identification

(less than a week from project kick-off to submittal deadline), Woolpert did present several potential projects on April 11, 2019 on behalf of the Town. Submitted projects included the following.

1) Evaluation of bridge openings individually and in combination to determine backwater impacts
    a. US 76 at Little Pee Dee River
    b. US 76 at Lumber River
    c. SC 917 at Lumber River
    d. US 501 at Lumber River
2) Construction of Levees/floodwalls
3) Relocation of all or portions of the Town to an area of higher elevation

Each potential project was also evaluated within this project scope and will be discussed in further detail in Section 8 of this report. The SCDRO only requested project concepts; AECOM will provide additional detail sufficient for their analysis. The SCDRO anticipated having the project evaluation complete by early Fall 2019.

The SCDRO released the *South Carolina CDBG-MIT Action Plan* in December 2019 that explains the source of the money, who is eligible, and how each project's eligibility will be determined. Public meetings were held to review this Action Plan and further explain the process through which eligible communities (including Nichols) can receive a portion of the funding. The SCDRO has allocated $10 million for planning efforts to help communities carry concept plans through design. The remaining $140 million (allowing $7 million for administration) will be allocated to housing, infrastructures, and mitigation fund matching. Nichols, located in a HUD-designated Most Impacted and Distressed (MID) county, is eligible for planning and implementation funding. Training sessions are expected in the spring of 2020 to provide more information about the application process, which is projected to begin in May 2020. Nichols should continue to refine and evaluate potential projects as more information becomes available.

6.1.2 South Carolina Governor's Flood Waters Commission

In response to the intense flooding experienced in South Carolina, the Governor created a Flood Waters Commission (FWC). This commission is tasked with evaluating flooding problems and potential solutions across the State, but with a focus on the Pee Dee and Charleston regions. The Infrastructure Committee of the FWC, led by the South Carolina Department of Transportation (SCDOT) Secretary Christy Hall is conducting a pilot effort to improve drainage systems within impacted areas. This effort supports a deeper cooperation between SCDOT and local governments.

In general, the Infrastructure Committee has established a series of meetings between the SCDOT and local governments to identify and prioritize drainage systems that need maintenance. The SCDOT will then work with the community to address the highest priority systems. Understanding that many communities lack the financial resources, equipment, and/or personnel to perform the required maintenance, the Infrastructure Committee has offered to assist communities in locating addition funding sources to address the short-fall.

On April 9, 2019 Woolpert submitted a "Work Plan" to the SCDOT identifying drainage canals and culverts within the Town of Nichols corporate limits needing maintenance, included as Appendix A to this report. Transportation Secretary Hall indicated that the FWC intended to meet in Nichols in June 2019 and was organizing a "clean up" day to address at least one of the areas on the submitted work plan. This clean-up day occurred on June 15, 2019. SCDOT crews came out and cleared and cleaned large drainage ditches, the FWC organized volunteer groups who picked up trash and debris and did light cleaning of stormwater systems around the Town, and the Governor held a briefing from in front of Town Hall. This activity provided a great opportunity to bring Nichols back into the spotlight and remind people of the work still needing to be done in the Town to recover from the damage. Nichols should, to the extent practicable, continue to work with the FWC to ensure that Nichols receives its fair share of efforts and available monies.

6.2 Potential Flood Mitigation Activities

In addition to the efforts by the SCDRO and the SC FWC, Woolpert is investigating and evaluating a wide range of potential mitigation activities that may be applicable in Nichols. Section 500 of FEMA's NFIP Community Rating System Coordinator's Manual provides valuable information and guidance for flood damage reduction activities in existing communities. In particular, section 510 provides steps to produce a community-wide strategy to reduce the impacts of flooding on the community. Step 7 of this planning process is to review the (six) global categories of mitigation measures that can be taken:

1) Preventive measures,
2) Property protection,
3) Structural projects,
4) Natural resource protection,
5) Emergency services, and
6) Public education and awareness

Each category offers specific advantages and risks to the community. Creating multiple layers of defense by employing tactics from each of the categories helps ensure a higher and redundant level of protection.

The following sections of this report discuss each mitigation category and identify related projects or activities that may be applicable to Nichols. These discussions also incorporate the concepts identified in discussions with other communities as noted in the mitigation matrix. The list of projects in this report are not intended to be comprehensive or sufficiently detailed for implementation, but rather a quick assessment of projects worth further investigation and description.

6.2.1 Preventive Measures:

Preventive measures aim to prevent the exacerbation of existing flooding problems. This is primarily achieved through the protection and control of flood-prone areas and floodplains by preventing development or impacts to these areas.

Future Flood Mapping

As development continues within a watershed there will be increases in flood waters and flood elevations. With nearly the entirety of the watersheds upstream of Nichols being out of the Town's control, managing growth and development is not possible. However; understanding the increasing risk allows a community to be prepared not only for today's level of risk, but also for tomorrow's level of risk.

Project: Building on the hydrologic and hydraulic modeling being prepared as a part of this project, create future floodplain mapping assuming the anticipated full buildout of the watershed with today's stormwater controls in-place. This mapping would be used to communicate and manage risk within the Town of Nichols and would also be an effective tool in communicating the need for more stringent development and stormwater management controls to other communities in the watershed.

Floodplain Regulations

Higher regulatory standards than those required by the National Flood Insurance Program (NFIP) are an effective tool for preserving natural functions of the floodplain and protecting property and infrastructure. As a preventative measure, communities can implement more protective regulatory standards such as increased floodway widths, minimize or eliminate development in the floodplain, and preserve open space to accommodate rising flood waters.

Project: Review the Town's current ordinance and floodplain development policies for increasing regulatory standards. Consider both the regulatory 100-year storms and larger storm events.

Town Planning

As a result of flooding, especially repetitive flooding, many communities have created new community comprehensive plans - a new vision for the layout and function of the community with consideration given to its level of risk. These plans may impact only small portions of the community or, in some cases, may require relocation of all or large parts of the community.

Project: Clemson University is already engaged in a planning effort on behalf of the Town. This effort is focused on developing the Town around its wealth of natural resources, including its proximity to two of the States "black water" rivers. As this planning process continues, significant consideration should be given to minimizing the Town's risk to the flood hazard while optimizing the use of the surrounding natural resources.

Drainage System Maintenance

Drainage systems are designed to convey some flow rate of water, based on the regulations at the time of the design and the location of the system. If not properly maintained, these systems can have a significant impact on nuisance flooding from smaller, more frequent events. While local drainage systems have less impact on flooding from larger, less frequent the storm events, they still provide benefits and facilitate quicker dissipation of flood waters.

Project: The Governor's Flood Waters Commission has implemented a cooperative effort with the SCDOT to assist communities with addressing prioritized drainage system maintenance needs. A workplan with prioritized list of drainage maintenance needs for the Town was submitted to the SCDOT for consideration on April 9, 2019, and the clean-up day was held on June 15, 2019. The Town can keep working with the FWC to held with drainage maintenance.

For areas outside of SCDOT responsibility, the community can work together to clean and maintain existing ditches and infrastructure as well as prevent debris from entering inlets, pipes, and ditches through good housekeeping practices on the individual level and by the Town. The Town could consider hiring a contractor once or twice a year to perform routine maintenance on a certain number of drainage features.

Bridge and Culvert Maintenance

Similar to drainage system maintenance, proper maintenance of bridges and culverts is essential to effective operation of the overall drainage network. There are several bridges located on the Lumber and Little Pee Dee Rivers near and downstream of the Town. Modeling efforts through this project show the impacts of these bridges on the Town of Nichols, assuming free flowing conditions. Debris build-up under bridges, damage to bridges, and other conditions may increase the impact on the Town.

Project: Although these structures are outside of the Town limits, many bridges and culverts are owned and maintained by the SCDOT. Maintaining and growing a relationship with the SCDOT may help with the maintenance of downstream bridges and culverts, particularly those that may attribute to the flooding in Nichols.

6.2.2 Natural Resource Protection:

As Nichols experienced during the 2016 and 2018 flood events, flood waters move through the low areas and into higher areas with no regard to structures or features in its way. By identifying, preserving, and protecting these areas and allowing them to serve their natural function, this provides the floodwaters with somewhere to go without adversely impacting structures.

Floodplain protections

Floodplains provide a natural and beneficial functions beyond simply providing flood conveyance and storage. Among other benefits, floodplains enhance water quality and provide habitat for wildlife. Providing further protection to floodplains can provide direct benefit to the Town by adding a healthy buffer between the river and the built environment.

Project: Adopt more stringent controls on floodplain development and look for areas of floodplain near and upstream of Nichols to place under some form of enduring protection such as a conservation easement. These areas can also be used as parks and recreational areas, which can add to the tourist attraction for Nichols and capitalize on the natural resources the area provides. Parks should have minimal clear areas and disturbance and be largely preserved with greenways and access areas surrounded by natural vegetation. This is an effort being currently considered by Lumberton, NC and Fair Bluff, NC, and is being proposed for Nichols by Clemson.

Wetlands protections

Wetlands within the watershed are critical to both water quality and attenuating runoff. While wetlands are currently regulated by the US Army Corps of Engineers (USACE), local jurisdictions can further regulate wetland areas. Protecting existing wetlands and constructing new wetlands in the watershed upstream of Nichols can have an impact on flooding.

Project: Although Nichols cannot regulate areas outside of its jurisdiction, the Town may have an influence on other jurisdictions pertaining to wetlands regulation. The Town should encourage the State and other upstream jurisdictions to consider additional protections on this critical line of defense.

6.2.3 Emergency Services:

In general, emergency services are more relevant to flood disaster response than pre-disaster protection but are equally important to protecting residents. However, certain emergency services such as early warning systems can help property owners better prepare for an impending flood and can help save lives.

Early warning

Early warning systems provide residents and business owners an opportunity to prepare themselves and their property for an impending flood. Early warning systems have a greater impact in areas prone to flash flooding as opposed to a slow rising flood as Nichols has recently experienced. Even so, the state is interested in potentially funding early warning systems in Low to Moderate Income areas (LMIAs).

Project: Continue to encourage the state in its pursuit of early warning systems and apply for funding when available. In order to qualify for assistance from the state, Nichols will need to demonstrate that it is a LMIA. Identify methods that will work well in Nichols with its residents and be sure residents without cell phones or other technologies still have access to early warnings. Investigate options such as an electronic sign, notices on church signs and at major government facilities within the town (i.e. Post Office, Library).

Real-time modeling

The South Carolina Disaster Recovery Office (SCDRO), through an engineering contractor, AECOM, is developing a "real-time" or near real-time model of the Lumber River watershed, as discussed in Section 6.1. This model will provide predicted flood levels along the Little Pee Dee and Lumber Rivers based on anticipated and actual rainfall. This information will be extremely valuable in preparing for an impending event.

Project: Continue to encourage the State to further develop and refine the hydrologic and hydraulic model of the Lumber River watershed and to facilitate sharing of results with local officials in a timely manner. Participate in

meetings and data gathering efforts for this model and share thoughts that may help smaller communities prepare for these events.

Flood response planning

Given the nature of flooding in the Town of Nichols, it is prudent that the Town have a written flood response plan. There are grant funding opportunities to develop such plans. This plan is typically created and managed by the County Emergency Response division and should include all municipalities within the County.

Project: Evaluate the existing flood response plans for the area and evaluate the need for modifications or amendments that are specific to Nichols. If appropriate, seek grant funding to develop and maintain a flood response plan for varying levels of anticipated flood events.

Buddy-System

Nichols being a small, quaint town is what draws many people to the Town to visit and live. In such small towns, there is often a strong sense of community that can be capitalized for emergency planning and resident safety. With a small number of residents, many of which may not have constant access to technology or transportation, Nichols could implement a "buddy system" to ensure every resident is recognized during emergency events. The responsibility of each buddy could be as minimal as knocking on a door to ensure the resident is aware of the impending danger to assisting with preparations and evacuations. This could be a volunteer effort organized by the Town or by the local churches.

6.2.4 Structural Projects:

There are a variety of potential structural projects that may reduce the risk of flooding to the Town of Nichols. Several have been preliminarily identified and provided to the South Carolina Disaster Recovery Office as will be discussed in the following subsections. These structures often aim to control or direct floodwaters and require maintenance and management by Town staff.

Reservoirs / Impoundments

Properly operated and maintained in-stream dams can control flooding. Currently, there is only one such dam on the Little Pee Dee River, Red Bluff Lake, and none on the Lumber River. There are a number of significant permitting barriers to constructing a new dam on either river. Further, while dams can control flooding, they come with their own associated risk. While this solution certainly has merits for flooding and should be considered, it is essentially impractical given the cost (initial and lifetime) and environmental issues associated with placing a dam in-stream for flood protection.

Smaller, off-line impoundments can help alleviate flooding for areas where localized flooding is the primary concern. Unfortunately, with the location of Nichols, flooding in the Town is a result of the rivers coming out of their banks rather than localized flooding concerns. The installation of an off-line impoundment would not counteract the impacts from the rivers, as will be discussed further in Section 8.

Project: Develop strong relationships with upstream communities and encourage regional impoundments that would benefit Nichols.

Diversions

Diverting water from the Lumber or Little Pee Dee Rivers, either to a new basin or diverting the main channel away from the Town, can reduce flooding in Nichols. Similar to dams, however, there are significant cost and permitting barriers to be overcome, and often these diversions can shift the flooding rather that alleviate it. Again, a suitable route should be considered, but this option, like dams, is likely to be impractical.

Project: Consider potential diversion routes primarily on the Lumber River and also on the Little Pee Dee River.

Channel modifications

Channel modifications are intended to add capacity to the channel. There may be opportunities to increase carrying capacity of both the Little Pee Dee and Lumber Rivers near and downstream of the Town. It is important to understand hydrology and groundwater; digging a deeper river will not increase the carrying capacity of the river, it will only provide a deeper river. Increasing the carrying capacity of a river requires widening the river and increasing the floodplains. This alternative should be considered with careful thought given to potential downstream impacts. Similar to other options that impact the rivers themselves, there may be significant permitting barriers to this option.

Project: Consider increasing channel capacity through geometry configuration changes on the Little Pee Dee and Lumber Rivers in the vicinity of Nichols and downstream.

Drainage improvements

Improvements to the Town's internal drainage system can have a significant impact on smaller, more frequent flood events. Drainage improvements typically have less impact on the extents of the flooding associated larger more frequent events, but they can move floodwaters away faster, thereby reducing the time of flood inundation. When considered as another "line of defense" drainage improvements are a viable flood protection measure.

Project: The South Carolina Disaster Recovery Office (SCDRO) requested that communities within the Pee Dee Region submit a list of projects for inclusion in their modeling effort and potential funding consideration, as discussed in Section 6.1. The Town submitted potential flood mitigation projects to evaluate bridge/ culvert openings to the SCDRO on April 11, 2019. The list of project locations included the following.

- US 76 at Little Pee Dee River
- US 76 at Lumber River
- SC 917 at Lumber River
- US 501 at Lumber River

The second phase of the Governor's Flood Waters Task Force initiative was to follow up the drainage maintenance project with improving capacity of local drainage where needed, which was done on June 15, 2019. In addition to assisting with the SCDOT efforts, the Town should identify and prioritize areas for improvement that includes all of the drainage system features within the Town. The Town recently purchased an excavator which should be used to keep the drainage ditches clean of debris and sediment at least twice a year.

Levees / Floodwalls

Levees and floodwalls provide a given level of protection depending on the height of the levee or wall. Long-term operation and maintenance is also required for these flood protection measures. Likewise, levees and floodwalls do not remove all risk, however they can be very effective against the design flood.

Project: Construct a levee or floodwall around the Town limits. The Town is bordered to the northwest by a sudden increase in elevation of approximately 25 feet, providing a natural barrier to begin and end the structure. Initial modeling efforts showed floodwaters coming over from the Lumber River and the up from the Little Pee Dee River, so the Town would need protection from all other directions. Cost will be the driving factor in whether to use a wall or earthen levee. This project was submitted to the SCDRO for inclusion in their modeling effort and funding consideration, and alternatives will be discussed further in Section 8.

Should construction of a "ring levee or wall" be cost prohibitive, there are also opportunities to use strategically placed levees or floodwalls in conjunction with other mitigation measures to reduce flooding. Likewise, a wall or levee constructed to a lower height could still offer some protection and, again, act as one line of defense along with several other measures.

6.2.5 Public Education and Awareness:

Because of the recent flood events, residents of Nichols have become acutely aware of the flood risk associated with living near the Lumber River. And, many now have knowledge of floodproofing techniques including home elevation and floodproofing. The nuances of flood insurance coverage and the National Flood Insurance Program (NFIP) requirements have been an on-going issue with many residents as well. Educating the public on its risk of flooding, measures to protect property, and the requirements of the NFIP provides another line of defense against flood damages and enhances recovery efforts.

Project: Continually provide information and assistance regarding flood insurance, the NFIP, and floodproofing techniques. This information should be available to all residents through hand-outs as well as information on who they can call to learn more. Understanding that many residents are only there after hours while trying to rebuild their homes, these materials should be available during these times, either at Town Hall or other community locations.

To assist with this effort, Nichols could host a community-wide event, as suggested by efforts in Fair Bluff, NC. This event could serve to bring the community together, provide residents with an update on the efforts being undertaken by the Town to address the flooding concerns, and provide important educational resources.

7 Hydraulic Modeling

Hydraulic models are a critical tool to show the hydrologic response of a watershed and evaluate potential system improvements. A 2-dimensional hydraulic model was created for the Town of Nichols to determine at-risk structures during storm events of varying magnitudes. These models enabled Woolpert to assess different mitigation options including relocating structures, creation of an off-line storage area, widening bridge openings over the Lumber River, building a levee, and raising buildings.

Nichols receives flow from two large drainage systems: the Lumber River (1,750 sq. miles) and the Little Pee Dee River (780 sq. miles). The first step was to determine the boundaries of the model that would accurately represent the hydraulics in Nichols and create a model that could be effectively used to evaluate potential solutions. The downstream boundary condition was set at the USGS stream gauge on the Little Pee Dee River at US-501 Galivants Ferry (2,790 sq. miles) where there are 77 years of historical flow data. The upstream boundary conditions were set to incorporate the flows from both the Lumber and the Little Pee Dee River. An additional flow boundary was included along the Little Pee Dee just above Galivants Ferry at the confluence with Rooty Branch. The overall model limits are shown in Figure 10 as the black hatched area.

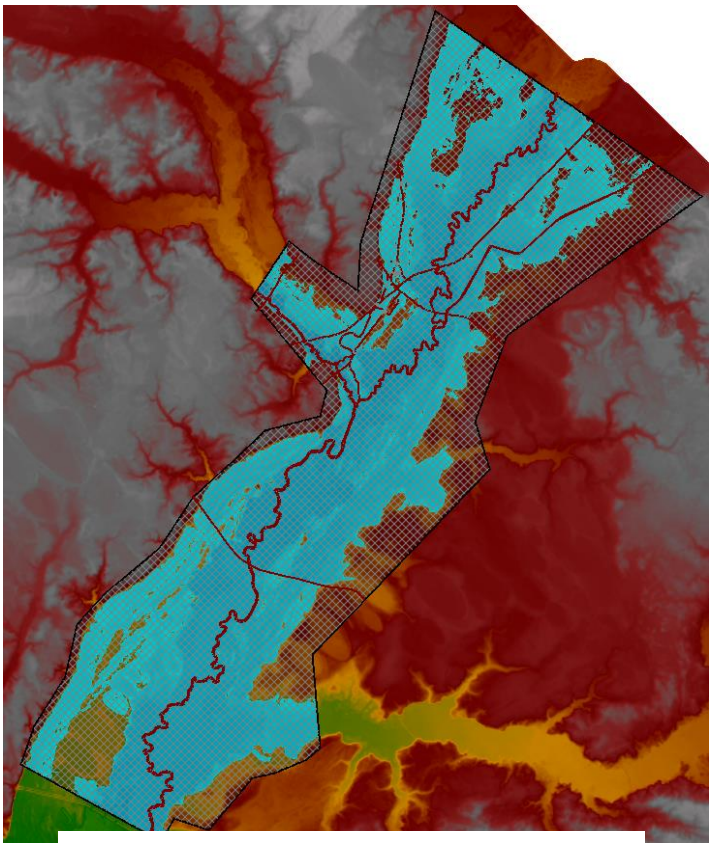

Figure 10: 2-D Model Boundaries

A HEC-RAS 2-dimensional model was created using LiDAR data from Marion, Horry, and Dillon Counties to determine the flow path of the water. 2D models have the ability to evaluate overland flow using grid cells at designated levels of detail. With HEC-RAS, the

grid cells can vary in size to show more or less detail throughout the model and break-lines are used to define cell edges at high or low points along the ground surface that represent roadways and/or ditches. The HEC-RAS model 2D grid cells near the town is shown in Figure 11. The smaller grid cell sizes provide more detail in areas of interest: near structures within the Town and along the banks of the rivers. Areas with minimal elevation change, no development, and consistent land use were represented with larger grid cell sizes. This creates a model that provides the correct amount of detail in the areas of interest but with manageable run times to effectively evaluate the causes of flooding and potential solutions.

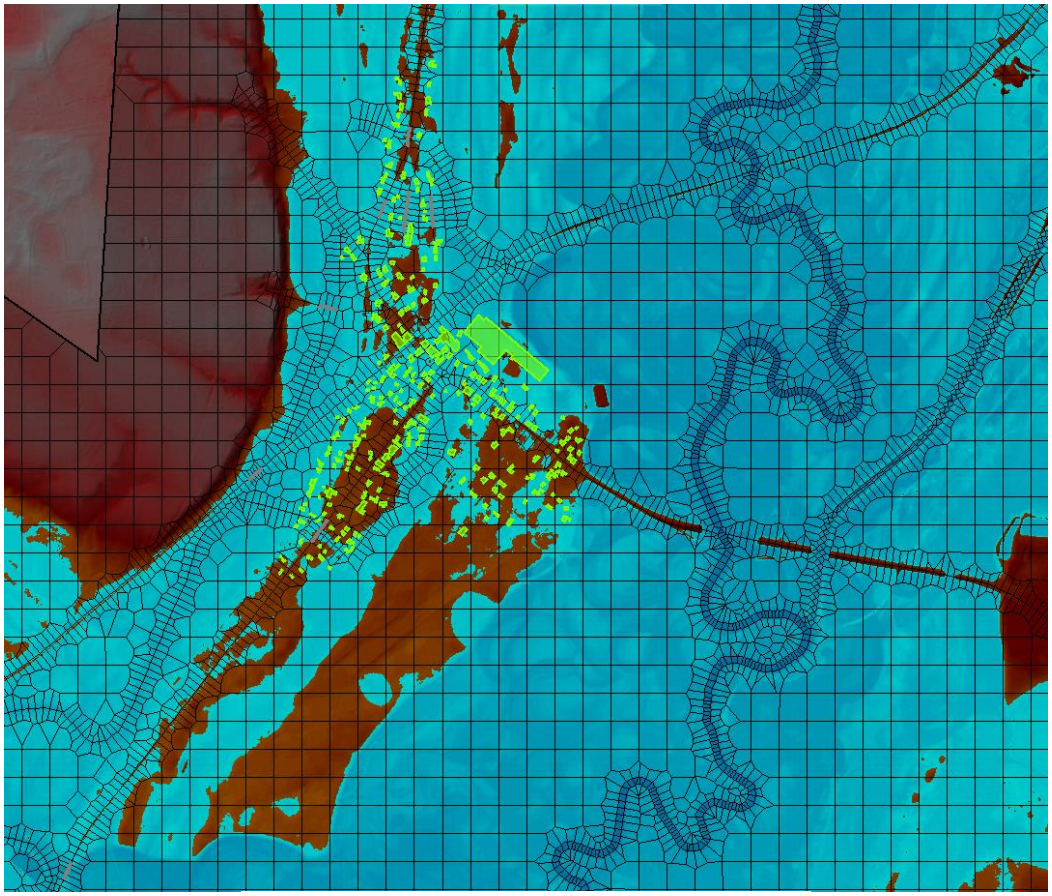

Figure 11: HECRAS 2-D Model Grid Cell Size

7.1 Boundary Conditions and Model Validation

The drainage area of the Lumber River is approximately twice as large as the drainage area of the Little Pee Dee RIver where the two rivers join just downstream of Nichols. To evaluate how the timing of each of these streams has a combined impact on the flooding within Nichols, an unsteady flow analysis was done. USGS stream flow data for Hurricane Florence (Sept 2018) from the US-501 / Galivants Ferry (2135000) and the Nichols (2134900) gauges were used to develop unit hydrographs in order to represent the shape and timing of flow for each of the streams. Using these unit hydrographs, upstream boundary conditions were derived so the modeled results would closely match the peak flows and timing at each of the gauge locations. Figure 12 shows the three boundary condition hydrographs, the two USGS gauge flow hydrographs and the two modeled hydrographs at the location of the USGS gauges. Once the boundary conditions were validated with the stream gauge flows, these unit hydrographs were scaled for different design frequency storm events.

Originally Woolpert had planned on using images, high water marks, survey data, and various resident accounts of water depth to develop similar hydrographs for Hurricane Matthew (October 2016), but it was difficult to pinpoint exact times and locations of much of this information. In addition, the Nichols gauge was installed in May of 2017 after Hurricane Matthew. Due to the many assumptions that would be needed to validate the model using Hurricane Matthew information, the model validation was done using USGS gauge data during Hurricane Florence.

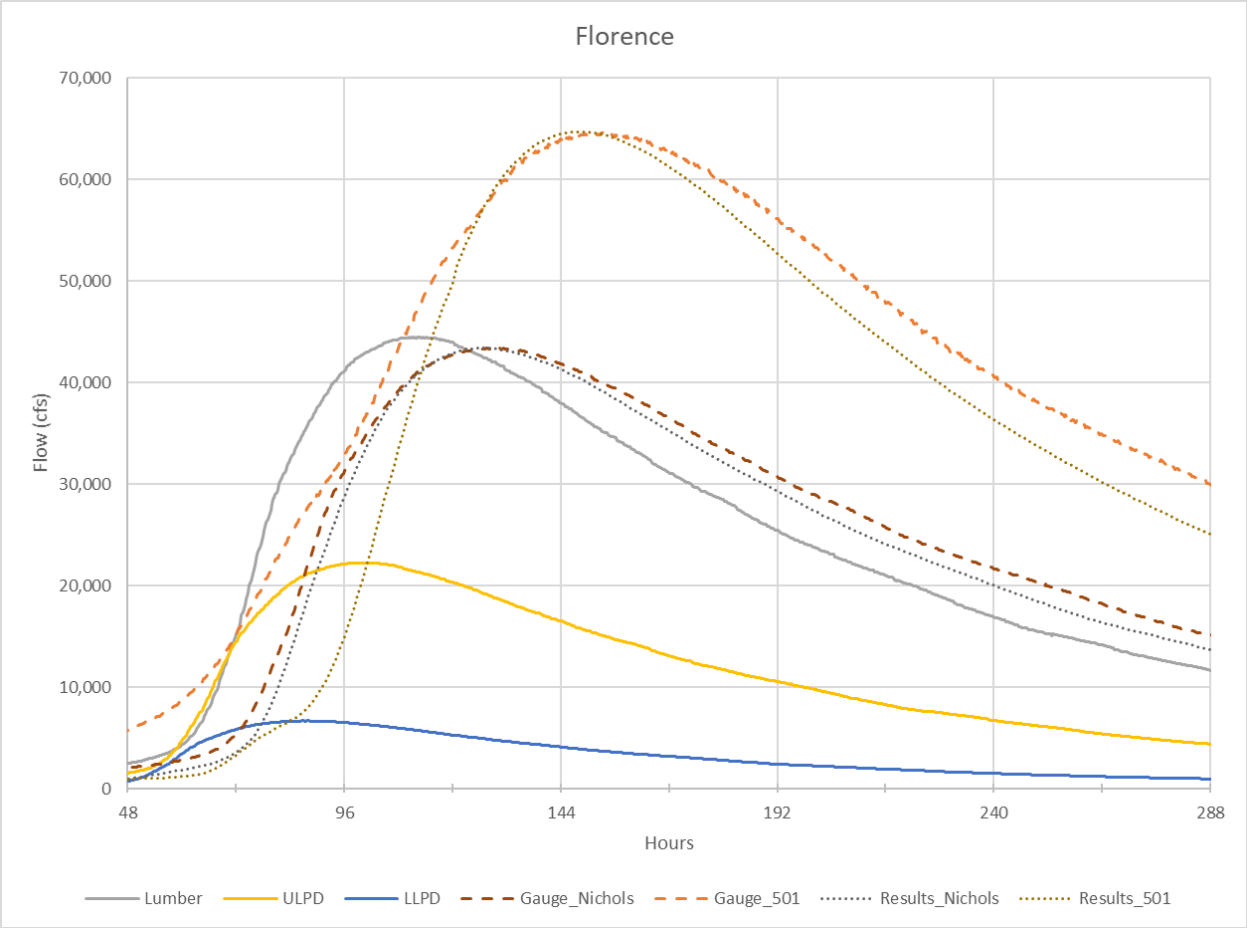

Figure 12: Model Validation using Hurricane Florence

The current effective FEMA FIS for Marion County only reports discharges for the Lumber River, while the HEC-RAS model for Little Pee Dee River provided by FEMA is based on hydrologic data from a Marion County Report. Discharges for all return frequencies were also taken from the USGS StreamStats website which uses USGS regression equations. The FEMA discharges for the 100- and 500-year return frequencies appeared to be slightly low based on Woolpert's evaluation of the USGS stream gauge at Galivants Ferry and in relationship to the observed flows during Hurricanes Matthew (59,300 cfs) and Florence (64,700 cfs), while the USGS regression flows were lower but closer than the FEMA flows. Therefore, the USGS StreamStats data was used in lieu of the FEMA flow analysis data when evaluating the various return frequency events. A summary of the Discharges is provided in Table 8 below.

Table 8. Summary of Discharges

Source / Location	Drainage Area (Sq. Miles)	Return Frequency (Years)					
		2	10	25	50	100	500
FEMA FIS (Oct 2011) - Flows taken from March 1978 US CORPS Study							
Lumber River							
At mouth	1,760		16,100	25,000	---	29,800	42,000
FEMA Marion County Study							
Little Pee Dee River							
Just downstream of the confluence with Lumber River	2,522		---	---	---	31,994	---
Approx 0.7 miles downstream of SC-917	2,577		---	---	---	32,466	---
Approx 0.3 miles upstream of US-501	2,777		---	---	---	34,146	---
USGS StreamStats							
Lumber River							
above confluence w/ Little Pee Dee River	1,750	7,620	16,900	21,900	26,200	30,600	40,700
Little Pee Dee River							
above confluence w/ Lumber River	784	3,050	6,280	8,260	9,860	11,700	16,300
at confluence w/ Lumber River	2,530	9,750	21,400	27,700	33,100	38,600	51,100
at US-501	2,800	10,400	22,900	29,600	35,300	41,200	54,500

7.2 Model Results

Woolpert used the validated model to determine the flooding extents for the 2-, 10-, 25-, 50-, 100-, and 500-year storm events (Figure 13). The model also revealed how the floodwater moved and where the areas of concern were located. During larger storm events, Nichols is impacted by floodwaters from both the Lumber River and the Little Pee Dee River. Floodwaters from the Little Pee Dee River flows north and west of US-76 impacting the western side of the town, while the Lumber River flooding primarily impacts areas to the east and north of US-76. During the larger return frequency events and during Hurricane Florence, the Lumber River floodwaters move through culverts under SC-9, north of the Town, and combine with the backwater from the Little Pee Dee River. **Error! Reference source not found.**13 shows the flooding extents associated with each storm event. The smaller (10-year) storm events will cause some minor flooding within the town, particularly through the downtown area and along Bay Street. The larger storm events (100-year and 500-year) impact most of the Town, with isolated areas that remain above the floodwaters. These modeling results agree with the observations within Nichols during Hurricane Florence, which produced flows greater than a 500-year storm event.

Using the model results, structures were evaluated to determine the number that would be impacted during each storm event. Table 9 below shows the number of structures impacted by the flooding during the various return frequency events. Finished floor elevations were not collected for every structure in Nichols, so these numbers indicate that the floodwaters would reach the footprint of the building, but they do not indicate that finished floor flooding would actually occur. Figure 14 shows the structural flooding associated with each storm event.

Table 9. Number of Structures Impacted for Each Storm Event

Storm Event	Number of Structures Impacted
2-year	1
10-year	31
25-year	108
50-year	159
100-year	205
500-year	264

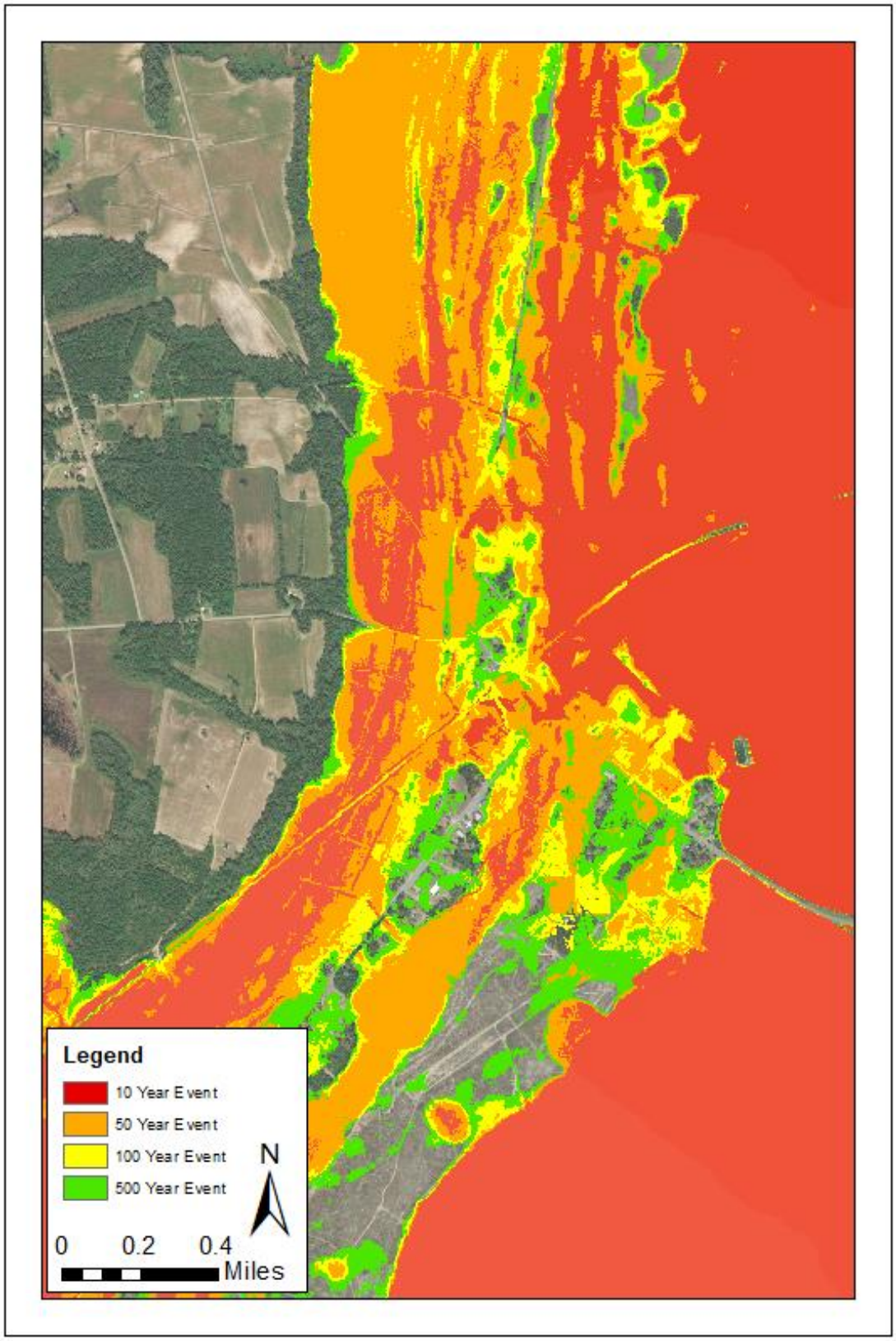

Figure 13: Flooding Extents for the 10-, 25-, 100-, and 500-year Storm Events

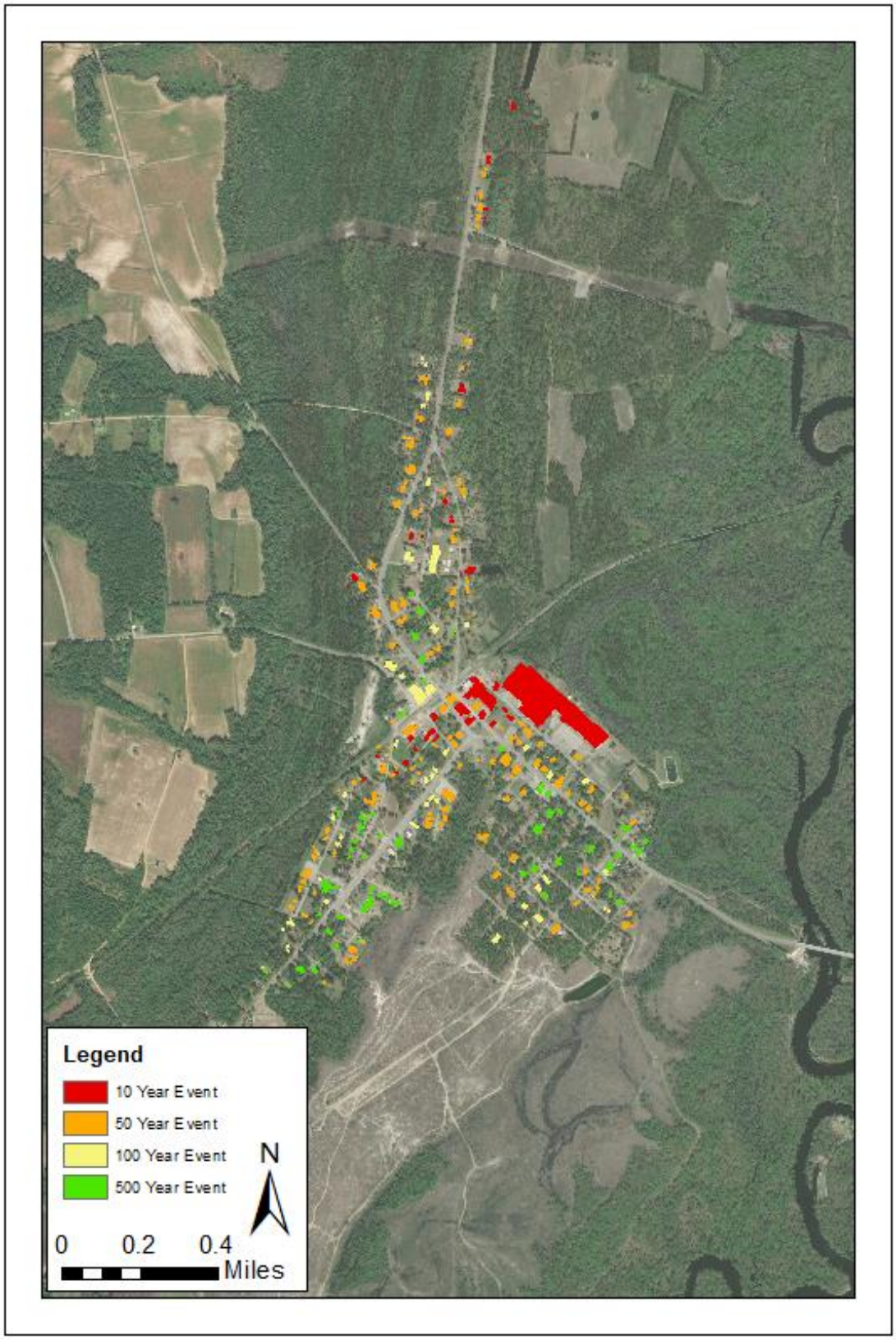

Figure 14: At-Risk Structures During the 10-, 25-, 100-, and 500-Year Storm Events

Nichols is faced with the challenge of controlling floodwaters from two large rivers to protect the Town's structures, infrastructure, and residents. It is likely that the solution to the flooding problems in Nichols will be a combination of a number of alternatives. The 2D model allowed Woolpert to investigate a number of structural alternatives and measure the flood reduction achieved by each alternative. The outputs from the modeling scenarios provided Woolpert with insight on which structures would be affected in different storm events, and it allowed for a more technical view of the possible solutions. There are also non-structural alternatives that Woolpert considered to protect the Town, using the existing conditions model results as a guideline. The following sections discuss each of the potential alternatives investigated by Woolpert and the anticipated flood reduction and reduction in the number of impacted structures.

8 Flood Alleviation Alternatives

The following sections evaluate the potential flood alleviation alternatives for the Town of Nichols.

8.1 Lumber River Bridge Opening: US-76

The Lumber River flows under US-76, east of the Town, through three bridge openings. The model representation of this bridge opening is shown in Figure 15, looking downstream at the bridge. This is a high-level model so details of the bridge (bridge deck width, piers, etc.) are not included in the bridge cross-section; the bridge line represents the top of the bridge, and the ground line shows the ground elevation extracted from the LiDAR data.

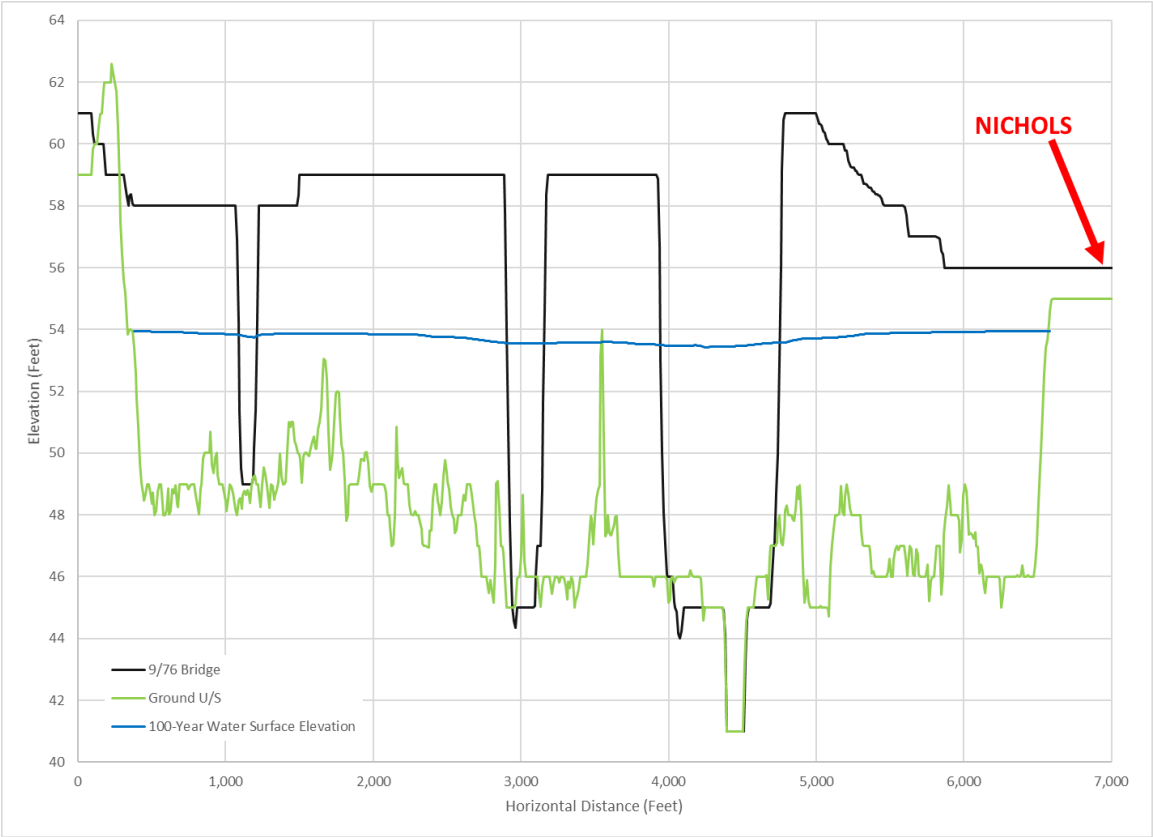

Figure 15: Lumber River Cross-Section (Looking Downstream) at US-76

The water surface elevation raises by nearly fourteen (14) feet above normal water surface elevations during the 100-year storm event and by approximately seventeen (17) feet during Hurricane Florence. The calibrated model revealed that the US-76 bridge is a point of constriction along the river during storm events, as shown in Figure 16. The figure shows the water surface elevations for the 10-year and 100-year storm events, with and without the influence of the bridges along US-76. The two bridges shown on the figure are the railroad crossing (upstream, at 4,000 feet along the channel) and the US-76 bridges (10,000 feet along channel). The differences seen on Figure 16 show the backwater impacts of the bridge openings on the water surface elevations. Backwater effects of US-76 extend upstream past the railroad opening, which has a negligible impact.

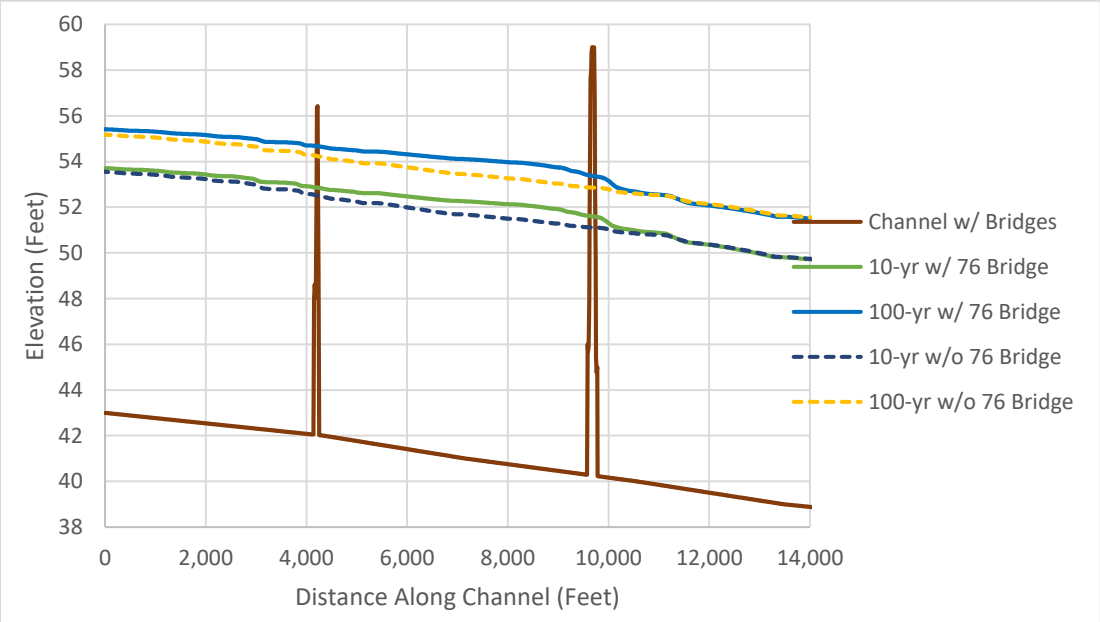

Figure 16: River and Water Surface Elevation Profile at the US-76 Bridge Openings

Woolpert investigated the impacts of increasing the bridge opening to allow the water to flow for freely and decrease the backwater effects created by the bridge. Two options were evaluated: (1) creating a larger span bridge by opening up the area between the two current two smaller bridges, and (2) creating a mile-long single span bridge. The impacts to water surface elevations are summarized in Table 10 below.

Table 10. Water Surface Elevations with Various Bridge Scenarios

Location	Ground Surface Elevation (ft)	Existing US-76 Bridge Openings	Larger US-76 Bridge Opening	Mile Long Span Bridge
		100 Year Storm Event Water Surface Elevation (ft)		
Post Office	53.2	54.1	54.0	53.6
Exxon Parking Lot	52.7	53.8	53.7	53.3
Dollar General Parking Lot	50.8	53.6	53.5	52.7
Town Hall	53.6	53.1	53.0	52.3
Bridge Deck	41.0	53.4	53.3	52.9

The 100-year storm event produces about one (1) foot of water in many areas of the Town; and widening the US-76 bridge opening lowers this depth of flooding by about one (1) inch. Creating a one-mile long span bridge along US-76 drops water levels in the Town by up to 0.8 feet (10 inches) in some areas of the Town. Figure 17 shows the reduction in flooding, with the contours showing the decrease in water surface elevations. This figure also shows the areas of the Town that would no longer flood during a 100-year storm event, including 44 structures that are at-risk under existing conditions (see Table 11). This alternative would not substantially reduce the areas that flood, but it would reduce the depth of flooding in many areas. For example, the elementary school floods under existing conditions during the 100-year storm event (show in red below). If the US-76 bridge opening were increased to a mile long span bridge, this area would no longer flood in the 100-year storm event (shown in blue) and water surface elevations around this area would be approximately 0.5 ft less (shown by the contour). It is important to remember that both Hurricanes Matthew and Florence were greater than the 100-year storm event.

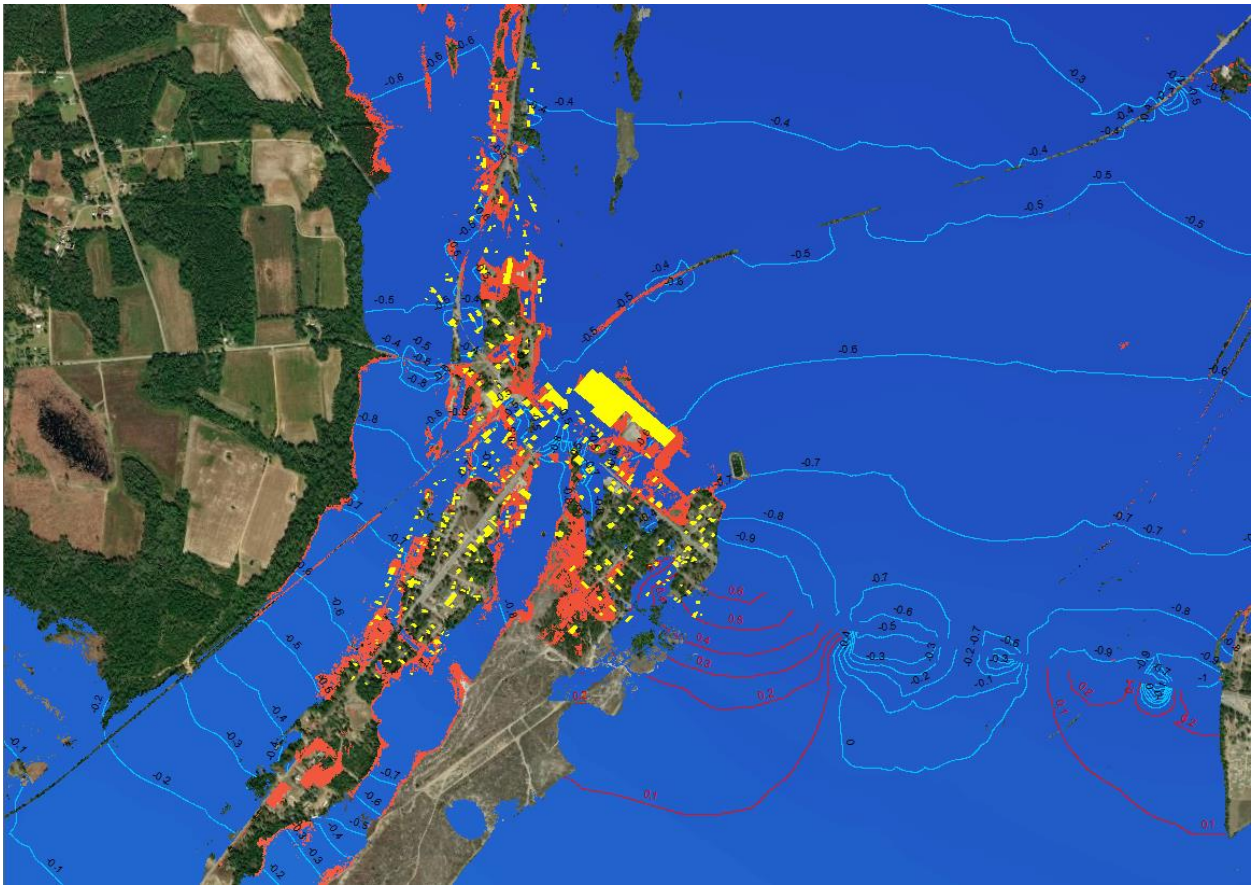

Figure 17: Change in Water Surface Elevation with One-Mile Bridge Opening at US-76

SCDOT owns and maintains US-76, and both of these bridges are two-lane highways that were constructed between 2005-2007 to replace the older bridges in these areas. According to the Federal Highway Administration, unit costs for bridge replacements in 2018 in South Carolina ranged from $122 to $144 per square foot. For a 40-foot-wide, two-lane bridge, this equates to an average cost of $5,320 per linear foot of bridge replacement cost. This cost does not include environmental assessment, engineering, permitting, or land acquisition costs. Marion County replaced an 85 linear foot span bridge along Senator Gasque Road across Smith Swamp in 2018 for a total cost of $1.4 million, or $16,471 per linear foot. Using these numbers as guidance, it can be estimated that the cost to replace the existing two span bridges with a mile-long bridge across the Lumber River would be approximately $10,000 per linear foot. Therefore, a mile-long bridge would cost approximately $52.8 million to design and construct. Increasing the conveyance capacity by connecting the two existing bridges would cost approximately $12 million.

This bridge opening is being included in the larger modeling effort being conducted by the SCDRO, as discussed in Section 6.1 of this report. It is possible that this bridge opening could be addressed through this effort.

Table 11. At-Risk Structures – Mile Long Bridge Opening at US-76

	Number of Structures Impacted	
Storm Event	**Existing Conditions**	**Mile Long Span Bridge**
10-year	31	22
50-year	159	115
100-year	205	161
500-year	264	241

8.2 Lumber River Bridge Opening: SC-917

The Lumber River flows under SC-917 approximately seven (7) miles downstream of Nichols, downstream of the confluence with the Little Pee Dee River. There are three bridge openings along SC-917 through which the Lumber River flows under the road. This roadway was elevated in 2011 and 2012, and residents in Nichols are concerned that the modifications to the roadway caused or contributed to the flooding in Nichols in 2016 and 2018. Figure 18 shows the water surface elevation profile, which illustrates the elevation of the water along the length of the river. While this bridge is a point of constriction for the river (shown by the "hump" in the water surface elevation directly upstream of the bridge), the backwater effects do not impact Nichols due to the Town's distance upstream. To verify this assertion, Woolpert used to 2D model and "removed" the bridge opening at SC-917 from the model to allow the Lumber River to flow freely downstream; this did not have any impacts on the water surface elevations of the flooding during either Hurricane Matthew or Hurricane Florence.

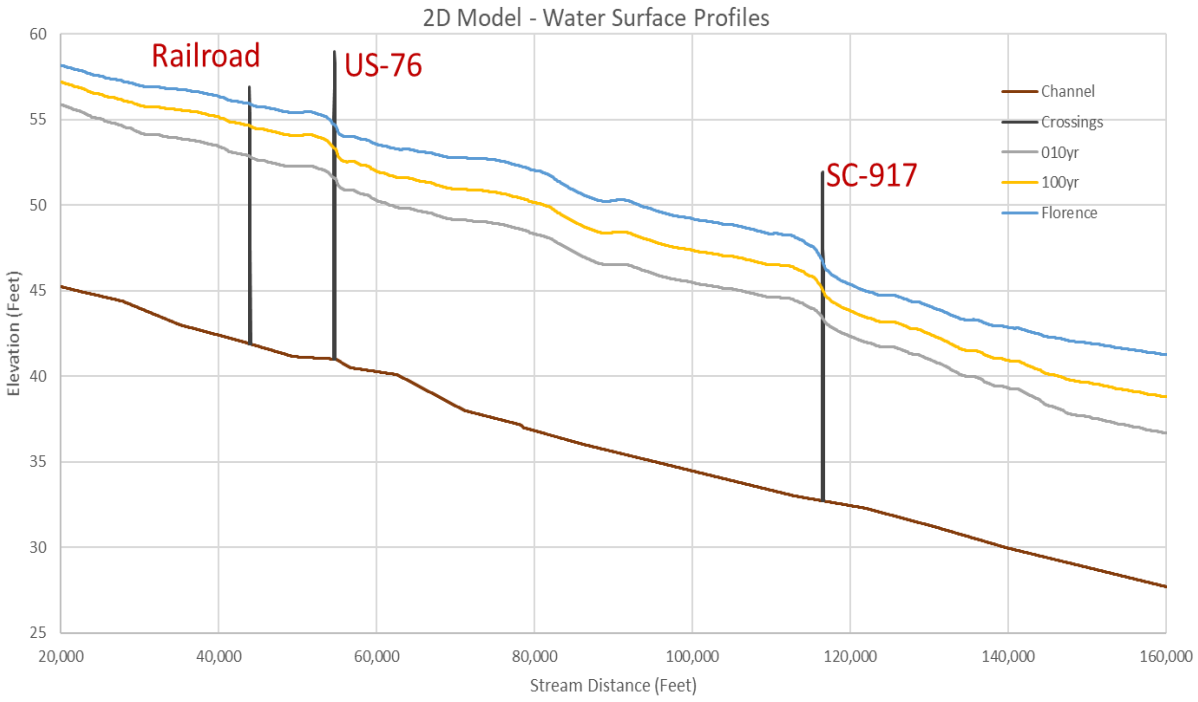

Figure 18: Water Surface Elevation Profile along the Lumber River

8.3 Off-Line Storage

There is a large tract of land behind Nichols' Town Hall that is an old airport that could be purchased and converted into an area for off-line storage with the intention of flood relief from the Lumber River. Unfortunately, the volume of water moving through this area would rapidly overwhelm even a very large storage area. If this open area were maximized the Town could create a 150-acre storage area. The existing elevations in this area range from 50 feet to 54 feet, and a discharge channel is at elevation 46 feet. Using the excavated material to create a berm, a six (6) foot deep available storage area could be constructed on this tract of land, which could hold approximately 40 million cubic feet of water, or nearly 300 million gallons. When compared to the flow rates in the Lumber River during large storm events, even a storage area this large would fill up in minutes. During Hurricane Florence, the peak discharge of the Lumber River was recorded as 45,290 cubic feet per second. This flow rate of water would fill the storage area in under 15 minutes.

Figure 19: Off-Line Storage

8.4 Levees

With floodwaters coming from the east (Lumber River) and the south and west (Little Pee Dee River), a levee around the Town is a conservative option to provide flood protection for the entire Town. As noted in Section 6.2.4, the Town is bordered to the northwest by a sudden increase in elevation of approximately 25 feet, providing a natural topographic barrier to begin and end a levee. Multiple options for levees were investigated to determine the most effective length and height to alleviate flooding in Nichols.

FEMA provides resources for the construction of a levee and details the requirements for a levee that is intended to be recognized by the National Flood Insurance Program (MFIP). As stated on FEMA's website:

> *In order for a levee system to be accredited, a community must provide data and documentation demonstrating that the levee system is in compliance with the requirements of the National Flood Insurance Program (NFIP) regulations cited in the Code of Federal Regulations (CFR) at Title 44, Chapter 1, Section 65.10 (44 CFR 65.10). Once FEMA determines compliance with 44 CFR 65.10 has been demonstrated, the levee system can be shown as accredited on the effective FIRM panel(s).*

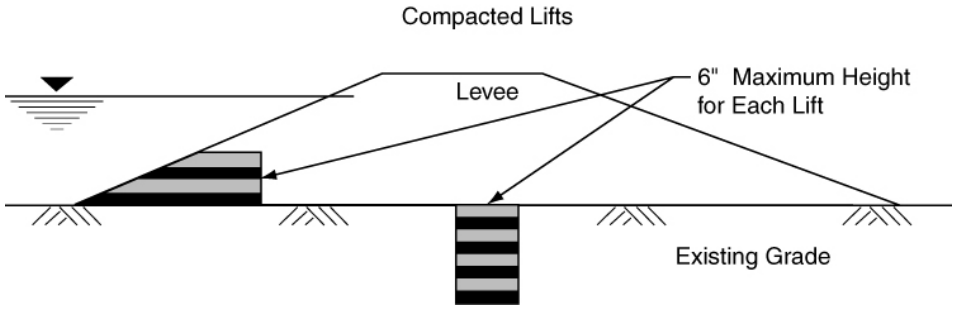

Figure 20: Levee Cross-Section Example (Source: FEMA 259)

The benefit of this accreditation is a reduction in the cost of flood insurance for the Town's residents. Following the process for designing a FEMA-accredited levee will also demonstrate that the levee is meeting an accepted set of minimum design requirements for a levee system. The certification is robust and comprehensive, but a summary of the design requirements are as follows:

1. Levee height must allow for three (3) feet of freeboard above the 100-year base flood elevation (Four feet of freeboard required where the levee is within 100 feet of a structure)
2. Design must show embankment stability and that loading conditions during the base flood will not jeopardize stability
3. Conduct extensive soil analysis related to soils and potential settling
4. Any openings must be able to be closed structurally
5. A Maintenance Plan must be submitted to FEMA for approval

While a levee provides a high level of protection, there are many important considerations related construction costs, maintenance, space requirements, and failure potential. The following sections will discuss potential levees and the associated protection level for the Town, as well as estimated costs and maintenance requirements.

8.4.1 Full-Length Levee

The full levee option to provide the maximum amount of protection for the Town is about 13,000 feet in length and spans from the higher elevation agricultural fields near Kemper Road and Blackmon Road, east towards the Lumber River, crossing SC-9, south around the Town, and southwest to continue blocking the floodwaters from the Lumber River. Figure 21 shows the resulting limits of flooding during the 100-year storm event and the structures that may still be at risk. Notably, the majority of the Town, including the downtown area, is protected with the construction of a full levee. Construction of the full-length levee would increase flood elevations north of the levee, impacting seven homes along SC-9. Acquisition of these homes would need to be included as part of the project.

To comply with FEMA requirements, this level would need to be constructed at an elevation of 57 feet, resulting in a levee approximately six (6) feet tall. Allowing for side slopes of 4 horizontal to one vertical for levee strength and stability, and a top width of ten (10) feet for access and maintenance, this would result in an average levee width of 58 feet. Nichols would need to acquire easements or purchase land for the construction of this levee and perform the required analysis and design calculations.

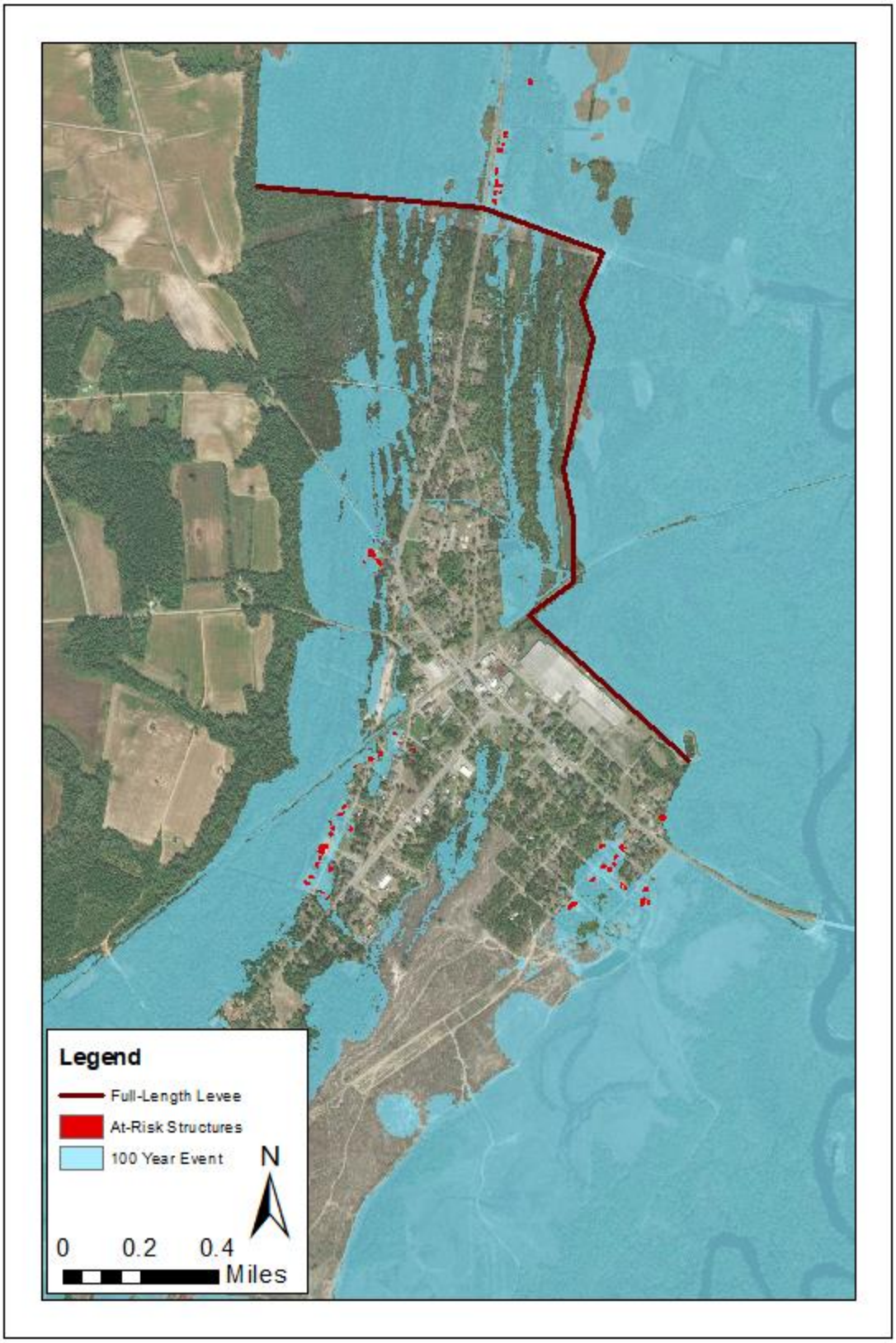

Figure 21: Full Levee and At-Risk Structures

8.4.2 Modified Levee with Backflow Preventer

Considering the potential cost complications with constructing a full levee around the entire Town of Nichols, Woolpert investigated options to construct smaller levees that may provide a comparable or acceptable level of protection. Unfortunately, due to the topography of the area and the flow from two rivers and two directions, any levee option that would provide the Town with a level of protection against larger storm events would be at least 10,000 feet in length. One option is a modified levee combined with a backflow preventer on SC-9. This option would be the same configuration of the full levee, with the northern portion, west of SC-9, removed, as shown in Figure 22. The backflow preventer would prevent floodwaters from the Lumber River crossing the roadway and adding to the backwater from the Little Pee Dee river. This combination would contain a 50-year storm event, but anything greater than that would overtop SC-9 and allow flooding within the Town. This modified levee would not comply with FEMA requirements and would thus not be eligible for FEMA funding.

Raising SC-9 could allow SC-9 to act as part of the levee system and provide an added level of protection. SC-9 is a state highway but it is not currently included on the list for repairs in the SCDOT Ten Year Plan. The cost of raising the road is expected to be greater than the cost of the extra 3,000 feet of levee between SC-9 and the higher elevation agricultural fields to the west. If the Town or SCDOT intend to repair or modify (such as widen) SC-9 in the future, the Town should consider also raising the road elevation at that time.

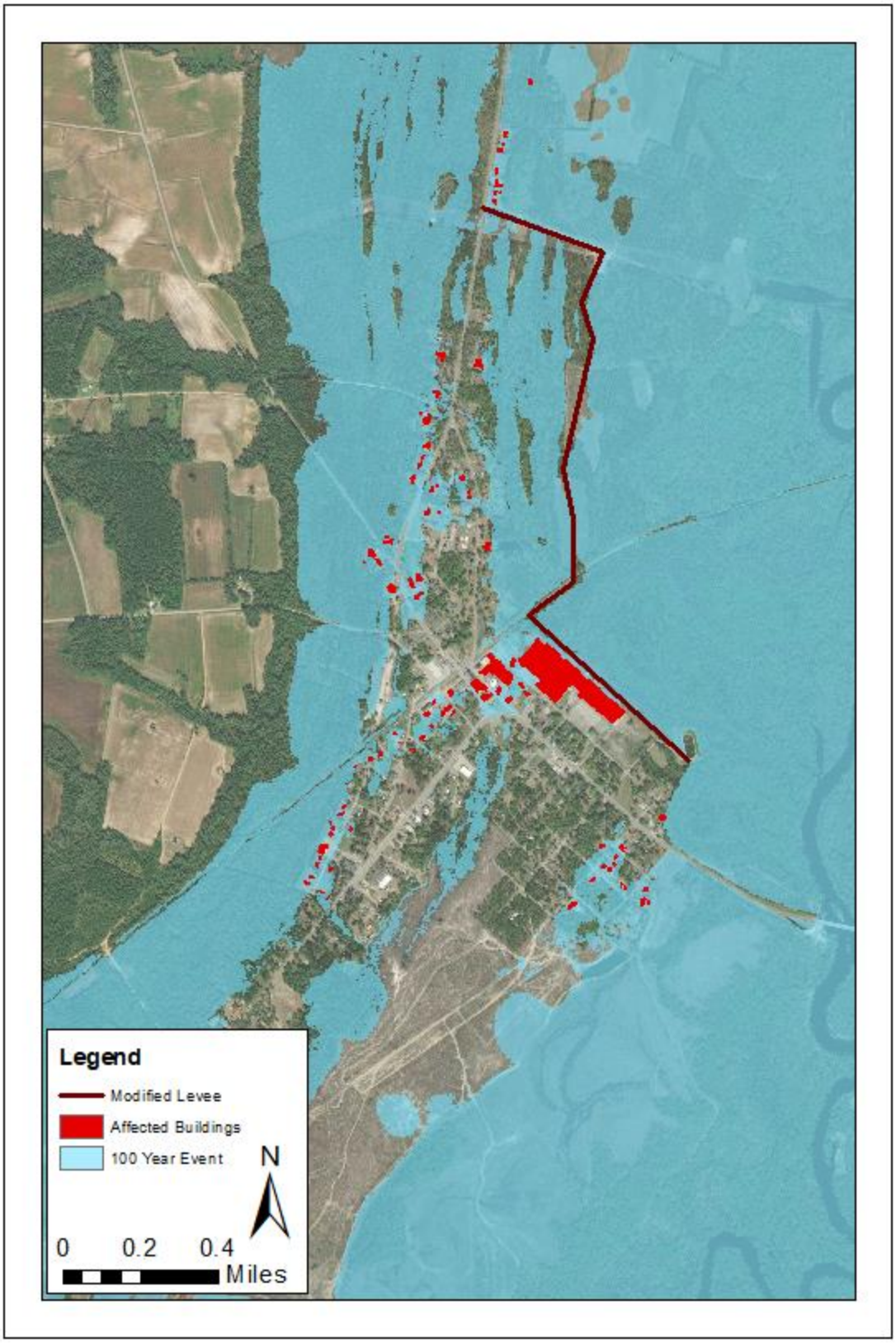

Figure 22: Modified Levee and At-Risk Structures

8.4.3 Small Scale Levee

An evaluation of how the water from the Lumber and Little Pee Dee Rivers moved around and through Nichols during large storm events showed that the water leaving the banks of the Lumber River first entered the Town by flowing through downtown and behind Town Hall, along the lower topography. The previous levee investigations showed that controlling the Hurricane-sized storms would take a levee of substantial size. However, building a smaller, more cost-effective levee would enable the Town to protect its lower-lying areas, including downtown, during smaller storm events.

Construction of a levee with a top elevation of 53.0 would provide protection for the downtown area for up to a 10-year storm event, or a storm that has a 10% chance of occurring each year. This levee would be about 3,000 feet long, span from N Main St, east and south to the railroad, and then behind the empty warehouse. As shown in Figure 23, this smaller levee would divert Lumber River floodwaters away from the downtown areas.

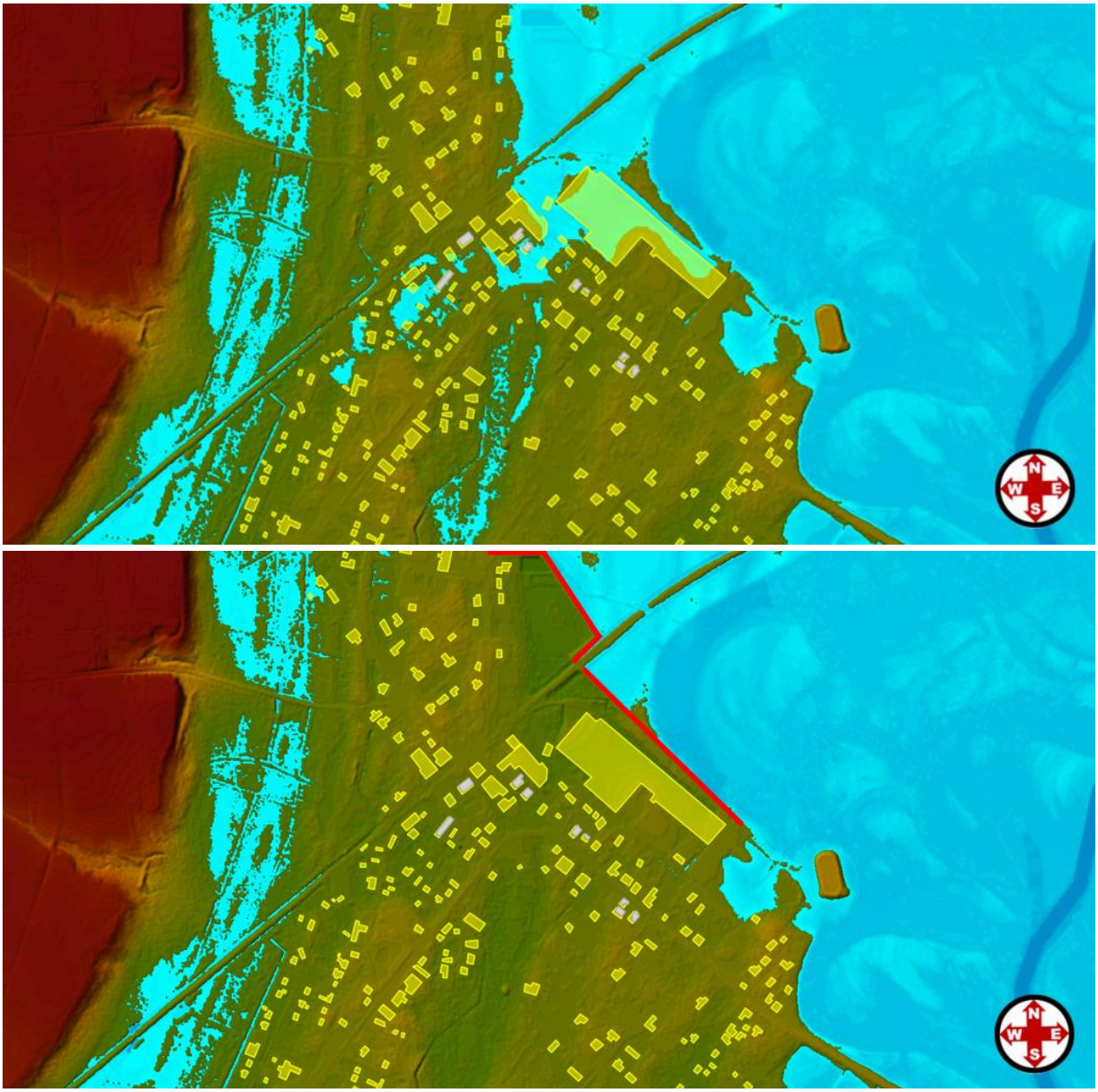

Figure 23: Small Levee at Elevation 53

This smaller levee could be increased to an elevation of 54.0 to protect the downtown area for storms up to the 25-year storm event, or those that have a 4% chance of occurring each year. The railroad at this location has a top elevation of 53.0, so manual measures such as sandbags would need to be put in place prior to a large storm event. The figures below show the impacts of this small scale levee during the 25-year storm event. This levee, like the others, would require land acquisitions or easements, and permissions from the railroad. Because this levee would offer the levels of protection below those required by FEMA, this levee would not be eligible for FEMA funding, nor would it offer any flood insurance benefits to the residents. However, it is a cost-effective option to provide protection for sensitive areas of the Town during storm events.

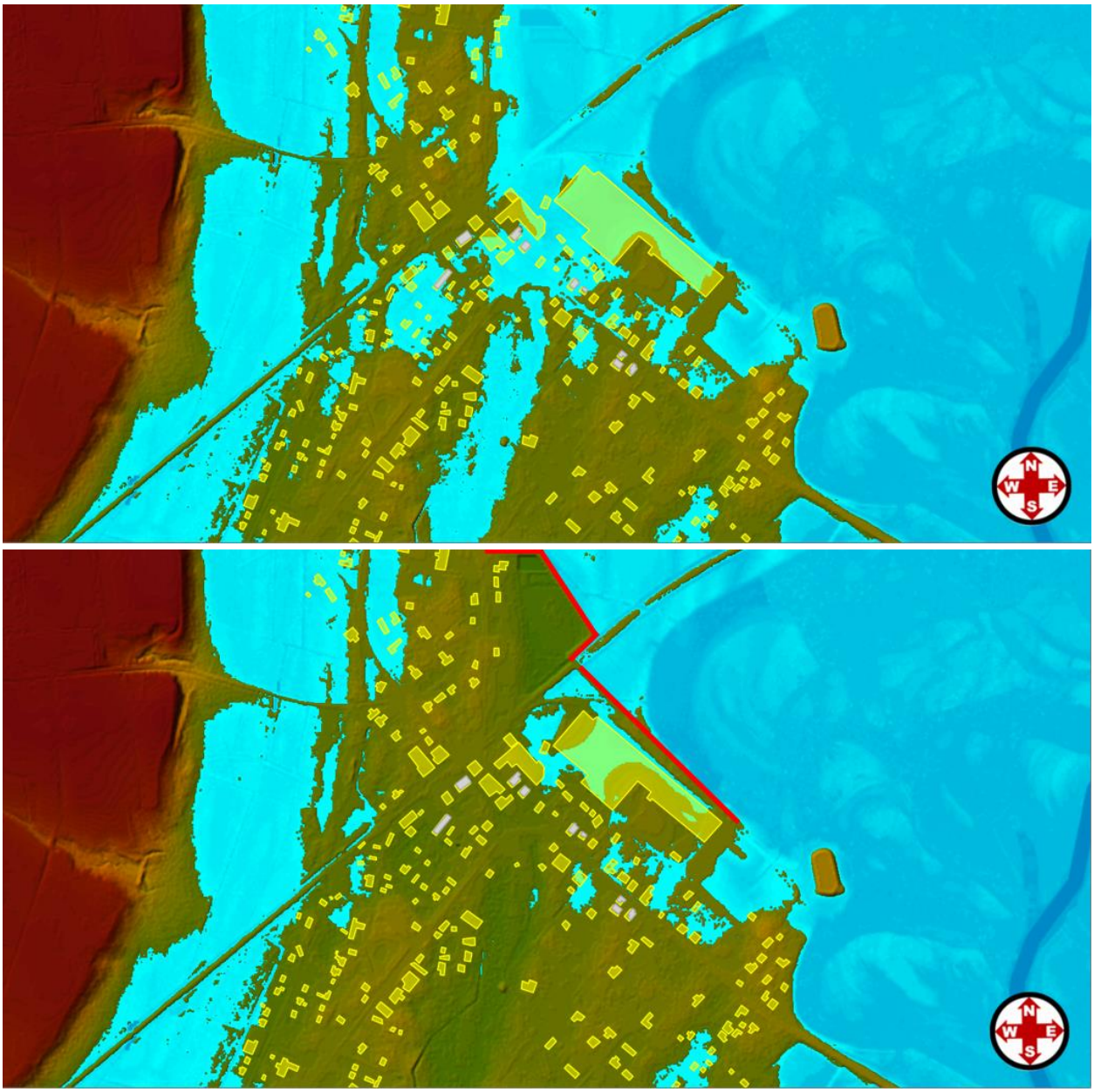

Figure 24: Small Levee at Elevation 54

8.4.4 Levee Cost Estimation

The cost of a levee is dependent upon a number of factors, including the size of the levee as well as the proximity to the source of fill material for an earthen embankment levee. A 6-foot earthen embankment levee around the Town of Nichols would need to be of substantial width to provide the strength necessary to hold back the water. FEMA recommends that side slopes be no greater than 4 horizontal to 1 vertical. Providing a 10-foot wide top for access and maintenance, this would result in a levee for Nichols that averages 58 feet wide bottom.

The US Army Corps of Engineers completed the Upper Mississippi River Comprehensive Plan (2008) to include two large levee projects. Based on these two projects, the average cost per linear foot, per foot of levee height, was $235. Using this estimate and an average height of six (6) feet, the full levee for Nichols would cost approximately $18.3 million. Developing a more detailed cost estimate using anticipated quantities of material produces an estimated levee construction cost of approximately $8 million, which does not include the associated costs for the engineering, environmental analysis, permitting, land acquisition, and construction administration and oversight. Maintaining a conservative position and understanding recent economics, it is anticipated that the full levee around Nichols would cost at least $20 million from beginning to completion. With the required assessments and permitting, it could take many years before the Town could even begin construction.

8.4.5 Levee Maintenance

Maintenance of the levees is critical to ensuring that they remain functional when they are needed. Maintenance will need to be performed on a regular basis to address issues such as erosion, tree growth, woody vegetation, and animal activity. It is important that problems are addressed before major storms to prevent a catastrophic failure. Ideally, an earthen levee will be covered in grass; the short root system does not go deep enough to damage the integrity of the structure, and it helps to prevent erosion. If a levee is properly maintained, planting and cutting grass may be the only expenses, however a thorough inspection should be completed after large storm events to determine if the structure is damaged. It is easy for levee maintenance to be neglected during dry periods, as they are often “out of sight, out of mind.” The longer a levee is left unmaintained, the more extensive and costly the repairs and corrections will be, and the higher likelihood of a failure or breach. These annual maintenance costs should be accounted for when considering the total cost of a levee.

8.4.6 Temporary Levees

Prefabricated levee systems could be considered for Nichols as well. Woolpert investigated a product called Muscle Wall that is made of low-density polyethylene plastic and then wrapped with a plastic sheeting liner and can withstand the force of rushing water. These systems are typically deployed as needed and can be installed more quickly than sandbags, take up less room, and provide a higher level of protection.

Muscle Wall has an 8-foot tall wall that comes in 4-foot wide sections, and the total product cost for 13,000 feet is about $10 million. It should be noted that installation costs, to include clearing and grubbing and any necessary permitting, has not been included in this estimate. If the varying ground elevations will require a levee height of more than 8 feet in some places, the ground will need to be raised to achieve the necessary elevations for protection. These systems require an even surface for installation to achieve the best results.

For Nichols, deploying these walls would involve the storage of, and then subsequent moving and installation of over 3,000 wall units. This may involve clearing vegetation and debris and would likely take multiple days to install. These systems cannot be left in place as they would damage the environment and be a physical barrier for wildlife and vegetation. The use of these systems offers a flexible and more short-term solution than a permanent earthen embankment, and

Figure 25: 8ft Muscle Wall (Source: www.musclewall.com)

Nichols could investigate their targeted use to protect critical facilities such as Town Hall, the fire station, and the post office.

8.5 Elevate Structures

One option to prevent structural flooding is to elevate structures above the base flood elevation, often also allowing for some amount of freeboard between the base flood elevation and the bottom of the finished floor elevation. This is typically a common method used to protect homes that have been flooded, as it is cost effective and allows the residents to keep their homes and their properties. To raise a structure, the home or building is separated from the foundation, lifted using hydraulic jacks, and then a new foundation is constructed beneath the elevated structure. This process is easier with homes that are on a crawlspace or open foundation, but the process can be modified to raise structures that are currently slab on grade as well.

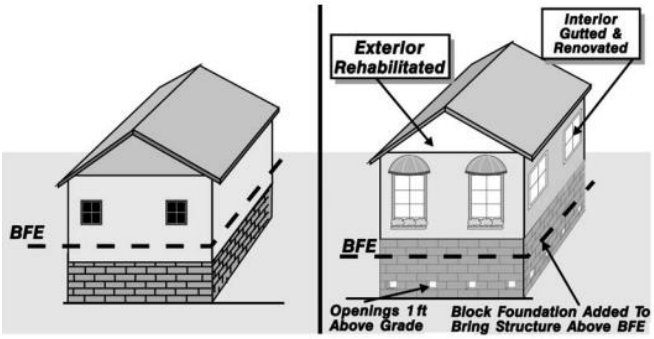

Figure 26: Structure Elevation (Source: FEMA NFIP Unit 8)

FEMA provides information related to the benefits and expectations associated with raising a structure. If a home only needs to be raised a couple of feet, often the impacts on the appearance are minimal and minor modifications are required for access (i.e. stairs). An alternative is to raise the structure the height of a house story and use the space under the home for storage or parking. An important consideration is the service equipment, including water, sewer, gas, and other utilities, must also be elevated to reach the home. HVAC and other such equipment that could be damaged by floodwaters must be elevated to the desired flood protection elevation (FPE). Elevating a structure does not protect the property from being flooded, but it allows the floodwaters to flood around and under the home or building without damage to critical services or finished floors.

With help from Town staff, multiple homeowners in Nichols have applied for grants to raise their houses. Most of these requests are for $75,450 per structure, with a few being for $150,450. Overall, it can be estimated that to lift a home it would cost roughly $75,000 per structure. This price is dependent on the age and structural integrity of the structure, the existing foundation, and the amount of elevation desired. Currently, there are 205 structures within the Town of Nichols that are within the 100-year floodplain; however, this study does not determine the associated finished floor elevations. To elevate every at-risk structure in Nichols would cost approximately $15.4 million, which could be largely accomplished through a number of grants.

Clemson University is helping the Town study alternative solutions from a socio-economic perspective. One option they have discussed is elevating the buildings downtown above the base flood elevation and using the lower areas as parking or outdoor seating. This would protect these structures while keeping them located along the major highways, accessible to travelers and protecting their primary source of income. The Clemson University report will include additional details and supporting information for this potential alternative.

8.6 Relocation

An alternative to elevating structures is to relocate the entire structure to a less flood-prone area. Alternatively, the residents could be relocated to new buildings or homes in the less flood-prone area and the current structure would be demolished and the area preserved as floodplain. As has been discussed in previous sections of the report, there is an area to the west of the Town that is at least 15 feet higher than the current Town. This area is largely agricultural with a few existing homes and did not experience any flooding in Hurricane Matthew or Florence. A portion of this area could be used to relocate the Town or portions of the Town, ensuring the residents would not flood again.

The economy in Nichols relies heavily on traffic through the town and people travel to and from the beach along US-76 and SC-9. Relocating the Town to this higher area would remove the businesses from an area where travelers would be able to easily reach, so relocation is not an option for the entire Town. However, selective relocation may be a desirable option for some homeowners. As seen in Figure 14, there are many homes along Bay Street and Maple Street, as well as multiple homes scattered throughout Town, that experience flooding in the smaller storms such as the 10-year and 25-year storms. The Town could create a neighborhood in this area of higher elevation (shown on Figure 27) and offer incentives or assistance to relocate certain families to these new homes that are outside of the area of flooding concern. This may provide an opportunity for some families, who cannot afford to elevate their homes, remain in Nichols near family and friends, with this area being less than a mile from the downtown area and the post office.

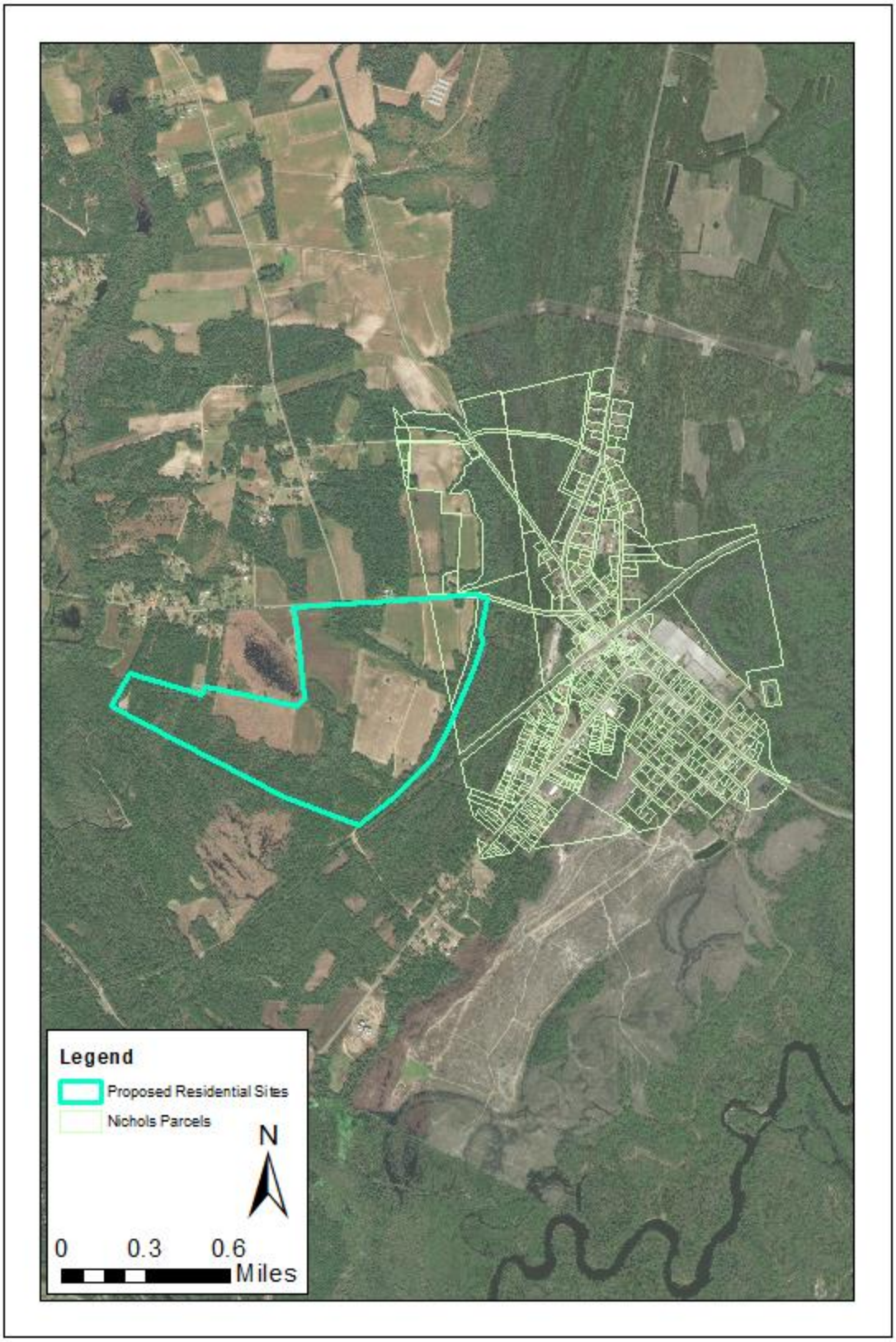

Figure 27: Potential Relocation Area

9 Benefit Cost Analysis

A benefit cost analysis (BCA) provides an evaluation of a mitigation project's total benefits related to its lifecycle costs, producing a benefit-cost ratio (BCR). FEMA requires a BCA for any mitigation project prior to funding, showing that the BCR for the proposed project is 1.0 or greater, or it is "cost-effective." This analysis provides FEMA with an objective view of projects to then award funding efficiently. To aid in the BCA, FEMA developed a BCA Toolkit, a computer software that develops a BCA for a wide range of hazards and potential mitigation projects. Woolpert used this toolkit to develop a BCR for the potential projects presented in this report to ensure that Nichols was eligible for funding with a BCR calculated using FEMA approved methodologies and tools.

Table 12 shows the BCR calculated for each potential project included in this report.

Table 12. Benefit-Cost Ratios for Various Scenarios

Project	Approximate* BCR
Increase Lumber River US-76 Bridge Opening	0.14
Increase Lumber River SC-917 Bridge Opening	0
Detention Pond	0
Full Levee	0.37
Modified Levee with Backflow Preventers	0.5
Small Levee	0.3
Raising Structures	0.41
Relocation/ Acquisition	0.1

*All BCR values are estimates based on available cost data and estimated benefits

10 Prioritization

Project prioritization is a key component for a community to objectively evaluate available projects, which were presented in Section 8. Each project is individually evaluated based on a weighted set of criteria deemed important to the Town. Although several of the projects identified in Section 8 were deemed to be ineffective at alleviating flooding, those projects are included in the prioritization. Each project was evaluated on the following set of prioritization criteria:

1. **Flood Reduction Potential**: The potential for the project to reduce the flooding in Nichols
2. **Number of People Helped**: The relative number of people helped in relation to the entire Town
3. **Time to Implementation**: Accounts for potential permitting, acquisitions, design, and construction time
4. **Cost**: The total cost of the project, from start to finish, not accounting for the source of the funding
5. **Available Funding**: Accounts for potential grants or assistance from other entities (i.e. SCDOT)

Each project was given a score of one (1) to three (3) for each criteria, with one indicating the project does not achieve the desired result for that criteria, and three indicating the project has a high probability of success to meet the desired result for that criteria. To account for the importance of alleviating flooding for the entire Town of Nichols, Flood Reduction Potential and Number of People Helped were given a weight of two (2), so that each score was multiplied by two for these two criteria, and the remaining three criteria had weights of one. Table 13 shows the project prioritization for the Town of Nichols.

Raising structures was determined to be the highest-ranking project based on the prioritization, as it is a cost-effective solution to alleviate structural flooding with a short time to completion and potential grant assistance. The full levee and modified levee were ranked third and fourth, as both of these projects have a high probability of

success to alleviate flooding for a large number of people, but the cost and time to completion raise concerns for their feasibility for the Town. Increasing the bridge openings along the Lumber River and adding a detention pond were ranked the lowest; as discussed in Section 8, these would not alleviate flooding within the Town and should thus not be further pursued as potential solutions.

Table 13. Project Prioritization

	Prioritization Criteria											
	Flood Reduction Potential		Number of People Helped		Time to Implementation		Cost		Available Funding Source		**Total Score**	***Rank***
Project	Score	*Weight*	Score	*Weight*	Score	*Weight*	Score	*Weight*	Score	*Weight*		
Increase Lumber River US-76 Bridge Opening	2	*2*	2	*2*	2	*1*	2	*1*	3	*1*	**15**	***3***
Increase Lumber River SC-917 Bridge Opening	1	*2*	1	*2*	2	*1*	2	*1*	3	*1*	**11**	***7***
Detention Pond	1	*2*	1	*2*	2	*1*	2	*1*	1	*1*	**9**	***8***
Full Levee	3	*2*	3	*2*	1	*1*	1	*1*	1	*1*	**15**	***4***
Modified Levee with Backflow Preventers	2	*2*	3	*2*	1	*1*	1	*1*	1	*1*	**13**	***6***
Small Levee	2	*2*	3	*2*	1	*1*	2	*1*	1	*1*	**14**	***5***
Raising Structures	3	*2*	1	*2*	3	*1*	3	*1*	3	*1*	**17**	***1***
Relocation	3	*2*	2	*2*	2	*1*	2	*1*	2	*1*	**16**	***2***

11 Recommendations

This report has presented a number of potential projects to alleviate the flooding in the Town of Nichols during large storm events, such as Hurricanes Matthew and Florence. After evaluating and prioritizing the potential projects, it was determined that elevating at-risk structures and relocating structures and/or residents are the most cost-effective solutions, but these solutions only address flooding concerns for a portion of the residents. Building a levee around the Town would provide a higher level of protection for nearly the entire Town, but the cost and time to implement pose serious concerns for the feasibility of a levee. Replacing the two existing bridges along US-76 with a mile-long single span bridge would provide flood relief to a smaller number of people as the levee, but it would cost less, and the burden of the cost could be carried by SCDOT.

Woolpert recommends that the Town take a tiered approach to alleviating the flooding in the Town. The Town should continue to investigate grant options for elevating at-risk structures for residents who want to stay in their current homes. Meanwhile, the Town can investigate the acquisition of property at higher elevations that could be developed as a residential area for those residents who would prefer to relocate to an area with a much lower risk of flooding. The Town can reach out to SCDOT to discuss the concerns related to the US-76 bridge openings and potential ways to increase the conveyance capacity of the road crossing.

While the Town is implementing and investigating alternatives that will alleviate flooding for at-risk structures, they can continue to pursue an option for a levee. As noted in Section 7.4, construction of a levee will require a significant investment of resources, time, and money. It is unlikely that the Town will be able to finance a levee without a large contribution from an outside source.

Flood mitigation for the Town of Nichols will be a process rather than a one-time event. Below is a table of activities the Town can use to keep the mitigation process moving forward.

Mitigation Activity	**Time Frame**	**Responsible Party**	**Comments**
Utilize available HMGP funding for home elevation and business floodproofing	Immediate	Town of Nichols	Securing a firm to assist with elevation projects has been problematic; group elevations to provide incentive for out-of-town contractors.
Prioritize existing structures (not already slated for elevation) for elevation and floodproofing	Immediate	Town of Nichols	Differentiate between residential and commercial properties
Evaluate current flood damage prevention ordinance	Immediate	Town of Nichols	Ordinance requirements were reviewed and adjusted during the initial recovery effort. Revisit at least annually
Seek CBDG program opportunities to rebuild local businesses and infrastructure	Immediate	Town of Nichols	The state program is administered by the South Carolina Department of Commerce, Division of Grants Administration.
Pursue SCDRO grant application for mitigation activities	March - June 2020**	Town of Nichols Woolpert	SCDRO will provide additional information on eligible projects
Continue discussions with Clemson University (CU) regarding Town rebranding efforts	Summer 2020	Town of Nichols Clemson University	Request that CU continue the planning effort to identify opportunities and a path forward

Contact the Town of Fair Bluff, NC regarding their greenway / recreational area mitigation project and potential Town relocation.	Summer 2020	Town of Nichols	Students at UNCH Chapel Hill created a recovery plan that included a greenway to protect the floodplain and provide recreational opportunities and investigated moving the Town further from the River.
Continue to improve and maintain local drainage	On-going	Town of Nichols Marion County SCDOT	Local drainage will require on-going maintenance that the Town will need to account for financially
Continue to follow up with the SCDRO regarding projects submitted for review and inclusion in their funding plan	On-going	Town of Nichols Woolpert	Monitor SCDRO communications for additional information
Continue to seek support from the Governor's Flood Waters Task Force	On-going	Town of Nichols Flood Waters Task Force	
River Debris Cleanup	On-going	SCDOT Marion County Town of Nichols	
Levee Construction	Long-term	Town of Nichols	Some of the levee systems evaluated during this exercise do not meet FEMA funding criteria. Alternative funding sources are needed in order to construct a levee.
Relocate portions of the Town to a higher elevation	Long-term	Town of Nichols	This solution contains multiple challenges including; moving residents out of Town limits, purchase and development of an appropriate site, creating space that fits the Town's overall objectives.
Prepare future floodplain mapping	Long-term	Town of Nichols SCDNR – Flood Mitigation Program SCDRO FEMA	Woolpert's existing model could be modified to provide this type of mapping. There is also a possibility the models prepared for the SCDRO could also include future modeling. Ideally this activity would be driven by a state or regional authority
Seek funding for installation of early warning systems	Long-term	Town of Nichols SCDRO	One issue during the two major events was that the Town became cut-off, an island. Understanding impact of rising water levels on access is critical to evacuating residents

** The definition of eligible activities has not yet been established by SCDRO*

*** Delayed indefinitely at the time of this report due to the Coronovirus pandemic.*