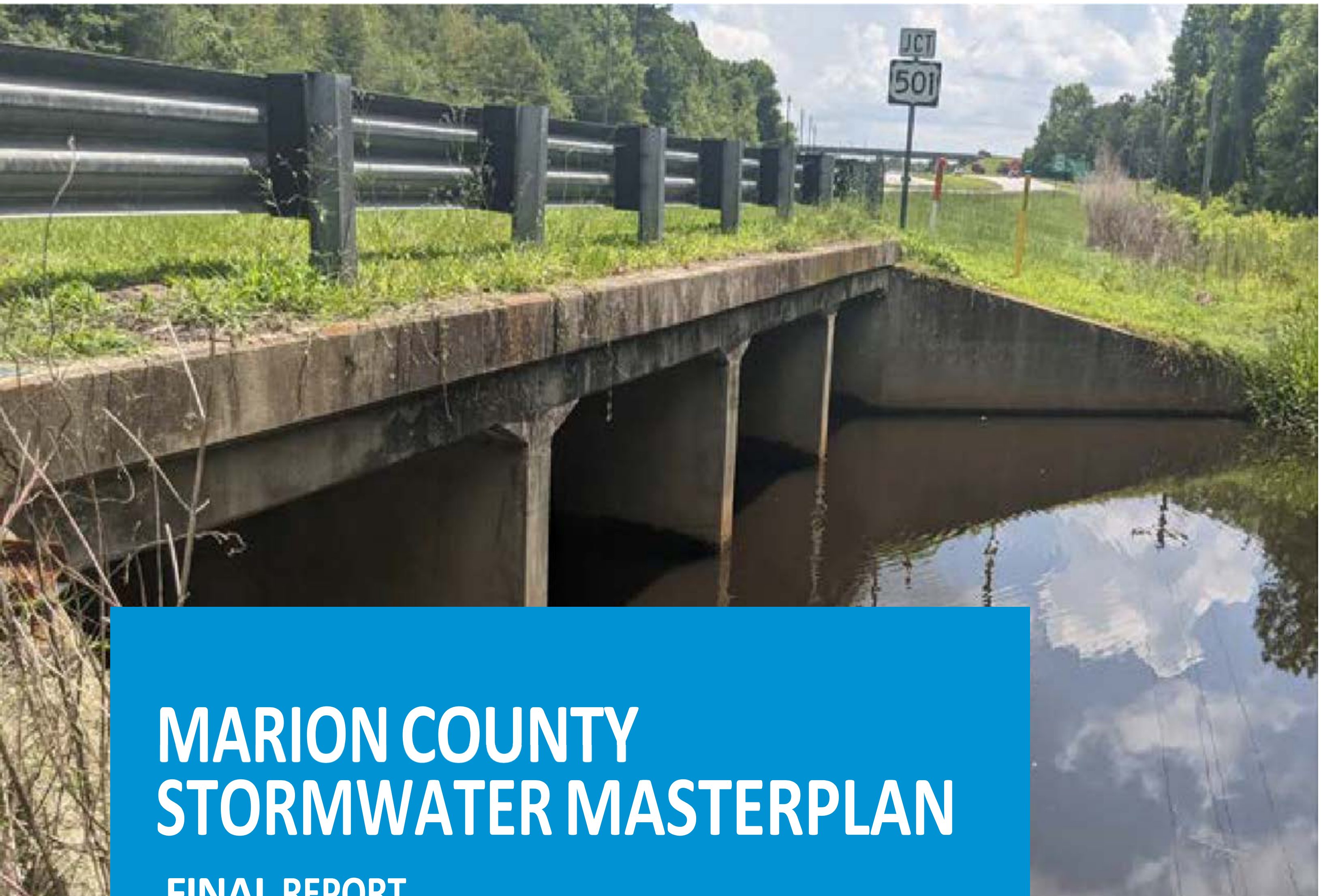
DECEMBER 2022



MARION COUNTY STORMWATER MASTERPLAN

FINAL REPORT

STATE PROJECT # D30-N001-MJ

SUBMITTED BY
MICHAEL BAKER INTERNATIONAL
700 HUGER STREET, COLUMBIA, SC 29201
DUNS 080232628

Michael Baker
INTERNATIONAL

Marion County
Stormwater Masterplan

Final Report for the Marion County Stormwater Masterplan, D30-N001-MJ

Submitted: December 14, 2022

Prepared by:
Michael Baker International, Inc.

Under contract with
South Carolina Office of Resilience

List of Tables

List of Figures

List of Appendices

Executive Summary

This report outlines the details of the stormwater masterplan that was developed for Marion County, South Carolina. The final plan was developed in four phases.

- Phase I: Existing Conditions Analysis
- Phase II: Alternatives Analysis
- Phase III: Project Recommendations and Low-to-Moderate Income (LMI) Assessment
- Phase IV: Final Stormwater Masterplan Development

During Phase I, Michael Baker International (Michael Baker) conducted extensive research of available information related to stormwater issues within the County limits, including information on historic flooding. Data gathered includes, but is not limited to:

- Historic flood data from the Federal Insurance & Mitigation Administration (FIMA) Redacted Claims
- The FEMA Flood Insurance Study (FIS) report for Marion County
- FEMA hydraulic models
- Other previous studies and models
- Historical USGS stage and flow data
- Highwater Mark (HWM) data from the USGS
- Precipitation frequency estimates and historical rainfall data
- GIS data
- SCDOT As-Builts and information on future projects
- Information received from workshops with officials from Marion County, the Town of Nichols, the Town of Sellers, and the City of Mullins
- Information gathered from site visits and field reconnaissance

Using the information gathered, Michael Baker created hydraulic and hydrologic models of flood prone areas in Marion County. These models were used to assess existing flooding conditions and determine a level of service performance of the analyzed systems.

During Phase II, a list of potential projects was developed and analyzed. Apparent causes of flooding that were identified in the Existing Conditions Report were:

- Inadequate maintenance of existing drainage features
    - Debris accumulation
    - Sediment build-up
    - Overgrown vegetation
- Undersized stormwater conveyance
- Collapsed/deteriorated stormwater conveyance
- Inadequate floodplain storage

Potential flood reduction and/or elimination projects were developed to address these apparent causes.

Michael Baker conducted extensive analyses of numerous projects to provide options to improve the level of service of the existing systems within the County. These projects vary in size from small scale infrastructure projects to larger scale stormwater management facilities as well as complex natural system restorations. As directed in the scope of services, the various alternatives that were analyzed include:

- Some designs that may fully meet design standards
- Some designs that may improve the level of service of the infrastructure, but may not fully meet all design standards
- Potential buyouts
- Low-impact development and/or retrofit projects
- Potential stream and/or wetland restoration

During the existing conditions analysis, a thorough review of all available hydraulic and hydrologic models along with discussions with local authorities highlighted potential problem areas within Marion, Nichols, Sellers and Mullins. An extensive analysis was performed on various alternatives, identifying viable projects that meet the criteria of eliminating flooding, improving level of service, or improving existing conditions through infrastructure improvement, stormwater management, natural condition restoration or buyouts. These potential projects were then vetted for viability and impacts.

During Phase III, the list of potential projects was prioritized in order to help determine which alternatives are best recommended for implementation. Project prioritization was determined based on a ranking system that considers both the benefit-cost analysis (BCA) as well as the project’s impacts on LMI communities.

Information developed in all phases of the masterplan has continued to evolve with more information and analysis throughout the course of the planning process. The final stormwater masterplan presents the final summary of data gathered as well as the final list of recommended projects along with all the supporting information related to the projects and their potential execution.

1. Summary of Known Historic Flooding Issues within the County

Extensive research on all available reports, studies, and plans within the County were reviewed to get a better understanding of the existing flood prone areas. Historic events were used to calibrate and validate the hydrologic and hydraulic model parameters. Information from all publicly available datasets along with any additional information that the County may be able to provide were reviewed and assessed as part of the initial data gap analysis.

Several available sources were reviewed by the Michael Baker team including but not limited to the following:

- Historic flood data from the Federal Insurance & Mitigation Administration (FIMA) Redacted Claims. This dataset is derived from the Federal Emergency Management Agency (FEMA) National Flood Insurance Program (NFIP) system of record (OpenFEMA Dataset: FIMA NFIP Redacted Claims). The information is redacted to protect policyholder identifiable information, and the data is spatially lumped into a 2-D grid of size approximately 6.7 miles by 6.7 miles. There have been 262 claims made in the County since 1983, with 145 of these claims occurring in the last five years.
- The FEMA Flood Insurance Study (FIS) report for Marion County.
- The FEMA Flood Risk Study Engineering Library (FRiSEL) website was also reviewed to determine what engineering models and studies were available.
- Historical USGS stage and flow data is available from gage stations on the Pee Dee River, Little Pee Dee River, Lumber River and Lynches River. Gaging stations with 20 years of record were useful in calibrating hydrologic models. The Current/Historical Observations data file was assessed to make sure there are daily or sub-daily (15-minute) data available in electronic form and used accordingly.
- Highwater Mark (HWM) data is available from the USGS Flood Event Viewer website. This web interface allows for a search of HWM data collected from a prepopulated search list of major storm and flood events throughout North America. The HWMs were analyzed and used as calibration or boundary condition information for hydraulic models as appropriate.
- NOAA Atlas 14 Volume 2 provides precipitation frequency estimates for the Ohio River Basin and surrounding states which includes South Carolina. However, Volume 2 is based on data through 2000. This means that the information we are using is over 20 years old which may be underestimating or overestimating the amount of heavy precipitation and flooding that we should be prepared to handle. Before using these values blindly, the project team compared rainfall data at long-term stations in the County or just downstream to determine if an adjustment factor was necessary.

1.1. Previous Watershed Studies

1.1.1. Federal Insurance & Mitigation Administration (FIMA) Redacted Claims

The FIMA redacted claims dataset provides information on location of the structure subject to flooding, date of loss, amount paid on the claim, etc. However, it makes sure that the personally identifiable information of the policy holder is protected by anonymizing the data to census tract, reported ZIP code, and one decimal point digit of latitude and longitude. Due to the anonymization process, the data may appear to be lumped or clustered at a certain location. The dataset is derived from the National Flood Insurance Program (NFIP) system of record. Redacted claims data for Marion County was obtained from 'OpenFEMA Dataset: FIMA NFIP Redacted Claims - v1'.

1.1.2. Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) report for Marion County

The current (Effective) Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) for Marion County is dated October 18, 2011. This countywide FIS investigates the existence and severity of flood hazards in the geographic area of Marion County, South Carolina, including: the Cities of Marion and Mullins; and the Towns of Nichols and Sellers; and the unincorporated areas of Marion County.

This FIS was prepared to include all jurisdictions within Marion County into a single countywide FIS. The FIS includes data previously printed in each jurisdiction's FIS reports as well as a Limited Detailed analysis performed for the current FIS. Hydraulic modeling and supporting data for each of the previously published FIS reports and the current limited detailed study was acquired from FEMA.

1.1.3. FEMA Flood Risk Study Engineering Library available engineering models

The FEMA Flood Risk Study Engineering Library website was checked to see what Effective FEMA models in Marion County were available for download. A hydrologic and hydraulic analyses of three streams studied by limited detail methods in Marion County were available. A total of 65.1 miles of stream and 9 hydraulic structures were studied. The available models that were downloaded from the website are summarized in Table 1.

Table 1: *FEMA Flood Risk Study Engineering Library available engineering models*

Flooding Source	Community Name	Data	Date
Little Pee Dee River	Countywide FIS	Limited Detailed HEC-RAS models	Dec-09
Sellers Branch	Countywide FIS	Limited Detailed HEC-RAS models	Dec-09
White Oak Creek	Countywide FIS	Limited Detailed HEC-RAS models	Dec-09

1.2. Data request for FEMA models not available for download

Effective FEMA models that were deemed critical to the proposed stormwater masterplan, but not available for download from the FEMA Flood Risk Study Engineering Library website, were requested from the FEMA Engineering Library. No electronic modeling files were available, but scans of the model input, output, and supporting reports were received. A list of the information received is summarized in Table 2.

Table 2: *FEMA models obtained from the FEMA Engineering Library*

Flooding Source	Community Number	Community Name	Data	Date
Catfish Canal	450141	Marion County (Unincorporated Areas)	HEC-2	Aug-87
Catfish Canal	450142	City of Marion	HEC-2	Aug-85
Smith Swamp	450141	Marion County (Unincorporated Areas)	HEC-2	Jul-87
Smith Swamp	450142	City of Marion	HEC-2	Aug-85
Maidendown Swamp Tributary	450141	Marion County (Unincorporated Areas)	HEC-2	Jul-87
White Oak Creek	450141	Marion County (Unincorporated Areas)	HEC-2	Aug-87
White Oak Creek	450143	City of Mullins	HEC-2	Aug-87
Lumber River	450144	Town of Nichols	Report	Mar-78

1.3. Other Studies

The Town of Nichols provided two (2) additional studies.

The first of which is entitled “Nichols Community Planning Project Next Steps 2019”, that was prepared by a Masters Degree level class (CRP 800 Direct Studies) in the fall of 2019 at Clemson University and is dated December 10, 2019. The report explores two (2) general next-step planning suggestions; 1) re-inventing the Main Street area with flood resistant streetscaping and reorganizing existing built and open spaces, and 2) combining non-engineered ecological resilience measures with annexation to augment floodplain protection as well as economic opportunities.

> The redevelopment of Main Street in Nichols is explored in a number of ways that include the partial preservation of brick storefronts and streetscape modifications. The existing structures that do not meet preservation standards structurally or that are uninhabitable due to mold will be demolished. It is noted that based on FEMA requirements new development must be constructed a minimum of three (3)-feet above grade. The use of shipping containers is mentioned as a potentially inexpensive method to raise the elevation of potentially relocated/preserved or newly constructed businesses. These shipping containers or other new construction could be utilized behind the preserved brick facades of the historical buildings to maintain the visual image of the Nichols Main Street area. These large shipping containers are often discarded and could be obtained from the new inland port in Dillon or from the active

railroad that runs perpendicular to Main Street. Whatever form of new development occurs in it will likely need to be elevated on pylons or steel beams to meet FEMA requirements. Streetscape and open space modifications are introduced as a reduction of impervious area, re-introduction of native flood-resistant tree species (Bald Cypress, River Birch, and Black Tupelo), use of permeable pavements, and the repurposing of existing open space to improve amenities and pedestrian accessibility. Two (2) specific parcels of open space located near US Highway 76 on Main Street are proposed to be utilized as public green space. The public space is described as a community meeting place with a small amphitheater, benches, pervious paths leading to a playground, as well as a pavilion to provide dedicated space for a local farmers market and outdoor events that is elevated to prevent potential future flood damage.

Annexation and associated regulatory recommendations are explored in-depth within this study. The annexation of two (2) specific areas that are contiguous to the Town of Nichols is investigated in regards to ecotourism and increased tax base as well as relocation of essential public facilities. Annexation area A is an approximately [redacted] tract of land that lies [redacted] of the Town, [redacted], and is comprised of [redacted]. Dealing with one (1) owner would simplify annexation in that an agreement would only need to be reached with one (1) party. Approximately 51% of this area is located within the regulatory Floodway, and an additional 42% is within the AE floodzone. For this reason, any proposed development in this area would need to be closely regulated to lessen the risk of future property damage or loss of life in the event of flooding. This area could represent a significant opportunity to provide recreational amenities to facilitate ecotourism while allowing development connecting Nichols directly to the Lumber River. As stated in the report, "Nichols' greatest asset is also its greatest threat, so any attempt to connect the Town to the river should be done in a careful way." Annexation area B is approximately [redacted] and is situated to the [redacted] of the Town of Nichols and is of an upland description at elevations greater than the Town and the river. The entirety of this approximately [redacted] is outside of the 500-year floodplain and could represent an opportune area for essential public facilities/services as well as prime residential development. This area is comprised of approximately [redacted]. Three options and associated South Carolina codes are discussed as possible methods for annexation. It is likely that zoning ordinances would need to be adjusted or specifically created for each of these annexation areas as well as specific developmental regulations. Flood resilient design standards are discussed at length and would be highly recommended for any future development within the current footprint of Nichols or within future annexation areas. Establishment of a required minimum freeboard on new development/structures is an example of flood resilient design regulations. Conservation subdivisions (40% or more of area maintained in a conservation easement) are recommended within the 800+-acre annexation area and would help mitigate flooding impacts of development while adding to Nichols' housing stock and tax base.

Potential funding sources associated with grants that can be used for the acquisition and development of land for recreation and conservation purposes were also listed within this study. Those listed are the Land and Water Conservation Fund, Park and Recreation Development Fund, Recreational Trails Program, and Undiscovered SC Grant.

The second study shared by the Town of Nichols is entitled "Flood Reduction Study - Problems and Opportunities Report" and was prepared for the Town of Nichols by Woolpert, dated April 2020.

Within this study Woolpert discusses the general background of the Town of Nichols and its geographic location, near the confluence of two (2) major river systems, the Little Pee Dee River and the Lumber River, in a relatively flat part of the State. The Town is essentially at the mercy of these rivers during flooding events as they have little to no say in upstream developments within the 1,750 square mile Lumber River watershed.

Woolpert generally describes the flooding events of Hurricane Matthew in 2016 and Hurricane Florence in 2018 as being extreme events that created flow rates and water surface elevations (WSELs) well above the established 100-year flood elevations shown on FEMA FIRMs. Flow rates of 59,300 cfs and 64,700 cfs were observed by the USGS river gaging station located at Galivants Ferry which are double any flow observed at this station since 1940. WSELs of approximately 56.5 feet were observed within the Town of Nichols during these flood events. These depths are more than 2-ft greater than the calculated FEMA FIS WSELs of 54.0 feet to 52.0 feet from the downstream end to the upstream end of the Town of Nichols. The FEMA FIRM panel, 45067C01823 effective October 18, 2011, shows that large areas of the Town are within the 100-year floodplain, Zone AE.

Woolpert provides an account of the existing conditions (circa 2019) of the Town of Nichols as well as a fairly in-depth economic analysis of pre-storms to current day essentially highlighting the effect that Hurricane Matthew and Florence has had on the Town. Active business licenses and a breakdown by category, active water utility accounts, a door to door income survey from 2014, and Marion County fiscal year income limits from 2014 and 2019 were used to assess economic change for Nichols. The Town was understandably devastated as a result of the back to back flooding of these two large hurricanes and has suffered economically. However, based on pre-storms business license numbers it appears that there is room for growth and a potential engine for that growth is mentioned in the form of ecotourism. Community research was conducted by attempting to reach out to other municipalities that have struggled with past flooding to garner ideas of how to move forward and build back. Lumberton, Fair Bluff, and Princeville were contacted in North Carolina, Andrews, South Carolina, Thompson, Texas, and Norfolk, Nebraska were all contacted in some form. Funding ideas as well as potential community building events and design ideas were discussed. Fair Bluff, NC is located approximately eight (8)-miles upstream along the Lumber River and though the population is about double Nichols, it may be the best model for how to plan future growth.

Woolpert conducted a dam analysis that assessed the threat level associated with 158 regulated dams in SC and NC gathered from SCDHEC and NCDEQ. Eighteen (18) of these dams were deemed as a "medium" threat based on impoundment volume and distance from Nichols. Most of these medium level threat dams were based on volume of impoundment and were greater than 50-miles aways. Overall, the Town of Nichols is at a very low risk level from dam failure.

Finally, Woolpert developed modeling and coordinated with other parties, mainly Clemson and AECOM, to compile current flood mitigation and planning efforts as well as provide recommendations for potential additional flood mitigation efforts. South Carolina Disaster Recovery Office (SCDRO), now South Carolina Office of Resilience (SCOR), and the South Carolina Governor's Flood Waters Commission are noted as two (2) state agencies that are actively investigating potential mitigation measures in areas that include the Town of Nichols. Potential flood mitigation activities can be in the form of five (5) global categories: preventive measures, natural resource and property protection, emergency services, public education and awareness, and structural projects. Preventive measures include actions such as development of future flood plain mapping based on flow rates that result from "full build-out" of the watershed, more stringent floodplain regulations, Town master-planning and planned development, and drainage system/bridge/culvert infrastructure maintenance. Natural resource and property protections can be employed in the form of local level regulatory floodplain and wetland protections, as well as more specific/flood-prevention focused development standards. Emergency services can be provided in a number of ways such as early warning systems (sirens etc.), real-time (or near real-time) modeling that can provide predicted flood levels based on actual or anticipated rainfall, flood response planning that essentially provides a detailed written plan to inhabitants, even something as simple as the buddy-system can provide a small community such as Nichols with a means to account for residents that may not have access to technology or transportation during a time of crisis, such as flooding. Public awareness and education can enhance preparation and recovery efforts by providing information about measures of protection, risks, and requirements of the NFIP. Structural projects include actual constructed structural systems that can mitigate or control flooding such as reservoirs and impoundments, flow or channel diversions, channel modifications, drainage infrastructure improvements including closed drainage systems and bridge/culvert openings, as well as levees and floodwalls.

Woolpert developed a 2-dimensional (2-D) hydraulic model utilizing USACE's HEC-RAS design software. The downstream boundary condition is set to the USGS stream gage on the Little Pee Dee River at US-501 in Galivants Ferry. The drainage area is approximately 2,790 square miles and there the gage has approximately 77-years of historical flow data. The upstream boundary conditions incorporate flows from both the Little Pee Dee and Lumber Rivers. An additional flow boundary was included a short distance upstream of Galivants Ferry to include the confluence with Rooty Branch. LiDAR data from Marion, Horry, and Dillon Counties is used to compile the terrain for this 2-D model. Due to the large difference in the Little Pee Dee and Lumber Rivers contributing drainage areas (the Lumber is nearly double the area at the confluence) an unsteady flow analysis was conducted to determine how the timing of each conveyance's peak flows impact flooding within Nichols. USGS stream flows associated with Hurricane Florence in September 2018 at both the Nichols gage (2134900) and the US-501/Galivants Ferry gage (2135000) were used to create unit hydrographs and the upstream boundary conditions were adjusted so that the results produced by the model closely matched the peak flows and timing exhibited at the gage locations. Upon validation of the boundary conditions by the stream gage flows the calculated unit hydrographs were scaled for appropriate design frequency storms. To provide conservative flows for various return periods it was determined that USGS StreamStats flow data would be used in lieu of FEMA flows (particularly for the 100- and 500-year events) as they were found to be higher and more closely relating to the flows observed during Hurricanes Matthew and Florence. Using this validated model Woolpert determined the flooding extents of the standard storm events, 2-, 10-, 25-, 50-, 100-, and 500-year. Using this 2-D model allowed Woolpert to assess how floodwater moved and areas of concern. High flow events impacted Nichols via floodwaters from both the Lumber River and the Little Pee Dee. The Lumber River flooding primarily impacts the areas north and east of US-76 while the Little Pee Dee River floodwaters inundated areas north and west of US-76, the western side of the Town of Nichols. During these large events, floodwater from the Lumber River moves west through the culverts under SC-9 on the north side of Town, and meet the backwater associated with the Little Pee Dee River, effectively surrounding Nichols with floodwater. The 10-year storm is observed to cause some minor flooding, particularly through the downtown area/Bay Street, and the 100-year and 500-year storms impacted the majority of the Town.

Using the 2-D model, Woolpert investigated a number of structural alternatives and measured the observed flood reduction. The alternatives that were investigated were increasing the Lumber River US-76 bridge opening, Lumber River SC-917 bridge opening, creating off-line storage, and a few different levee options. Though not investigated hydraulically, elevating structures and relocation were assessed as options for the Town. All of these flood mitigation projects were evaluated via a benefit cost analysis (BCA) and finally ranked via five (5) prioritization criteria: 1) Flood Reduction Potential, 2) Number of People Helped, 3) Time to Implementation, 4) Cost, and 5) Available Funding. Each project was given a one (1) to three (3) value for each criteria and the totals added to result higher scores meaning a more favorable project. Using this ranking system the top five (5) prioritized projects were 1) raising structures, 2) relocation, 3) increasing the Lumber River US-76 bridge opening, 4) full levee, and 5) small levee.

Woolpert ultimately recommended a multi-tiered approach that involves short-term and long-term planning, organization, and coordination. In the immediate future grant funding for elevating the most at-risk structures and acquiring (via annexation or other means) adjacent high-ground property for the relocation of residents and businesses who are interested in that should be investigated.

1.4. Precipitation Data

Atlas 14 Point Precipitation Frequency Estimates were obtained from the National Oceanic and Atmospheric Administration (NOAA) Precipitation Frequency Data Server (PFDS) website. Table 3 below shows the values used for design storms in the XP-SWMM models.

Table 3: *Point precipitation frequency estimates*

Point precipitation frequency estimates (inches) NOAA Atlas 14 Volume 2 Version 3							
Location	Duration	Average recurrence interval (years)					
		2	10	25	50	100	500
Nichols	24-hr	3.75	5.71	7.02	8.14	9.36	12.7
Mullins	24-hr	3.72	5.65	6.93	8.02	9.21	12.4

For calibration models, actual precipitation amounts for historic storms were obtained from both the National Weather Service and the PRISM Climate Group, Oregon State University. After review of both datasets, the following estimates were used in the calibration runs of the XP-SWMM models.

Table 4: *Precipitation amounts for historic storms*

Precipitation amounts for historic storms			
Event	Duration Considered	City	
		Nichols	Mullins
Matthew	10/07/2016-10/09/2016	14.31	15.22
Florence	9/15/2018-9/17/2018	14.15	15.05

In considering future conditions and anticipated changes in rainfall intensities, several sources were researched. The U.S. Global Change Research Program (USGCRP) is a federal program mandated by Congress to coordinate federal research and investments in understanding the forces shaping the global environment. As a key part of the Fourth National Climate Assessment (NCA4), the USGCRP oversaw the production of a stand-alone report.

Per the NCA4 Report, projections of changes in the 20-year return period amount for daily precipitation show large percentage increases for both the middle and late 21st century (Figure 1). A lower scenario shows increases of around 10% for mid-century and up to 14% for the late century projections. A higher scenario shows even larger increases for both mid- and late-century projections, with increases of around 20% by the late 21st century. The increases in extreme precipitation tend to increase with return level, such that increases for the 100-year return level are about 30% by the end of the century under a higher scenario. Based on the potential future changes in 20- and 100-year rainfalls, changes in 2-, 10-, 25-, 50-, and 500-year rainfalls were estimated by assuming a linear trend. Table 5 outlines the future design rainfall depths which were used to run future condition XPSWMM simulations for Nichols and Mullins.

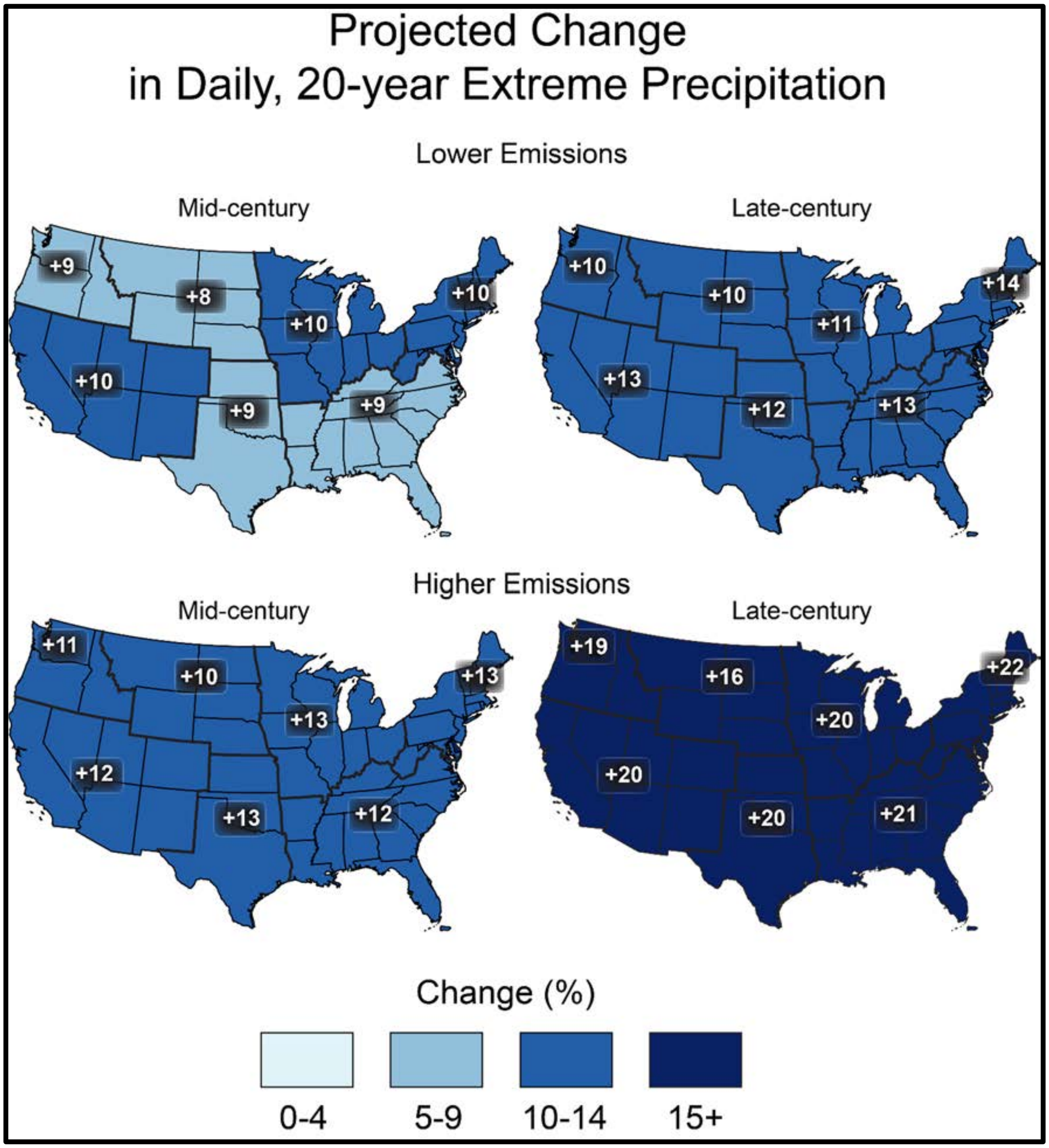


Figure 1: *Projected change in extreme precipitation*

(Source: USGCRP, 2017: Climate Science Special Report: Fourth National Climate Assessment, Volume I [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 470 pp)

https://science2017.globalchange.gov/chapter/7/

Table 5: *Potential future changes in extreme rainfall by the end of 21st century*

Future extreme precipitation (inches)							
Location	Duration	Average recurrence interval (years)					
		2	10	25	50	100	500
Nichols	24-hr	4.03	6.14	8.60	10.38	12.17	16.76
Mullins	24-hr	4.00	6.07	8.49	10.23	11.97	16.37

1.5. Streamflow and Stage Data

The use of USGS stream gage data is extremely valuable in reviewing historical events. They can also be helpful in predicting future events using a statistical analysis. The more years a given gage has recorded data, the better it is at predicting future recurrence intervals. Figure 2 below shows the USGS stream gage locations as it relates to Marion County.

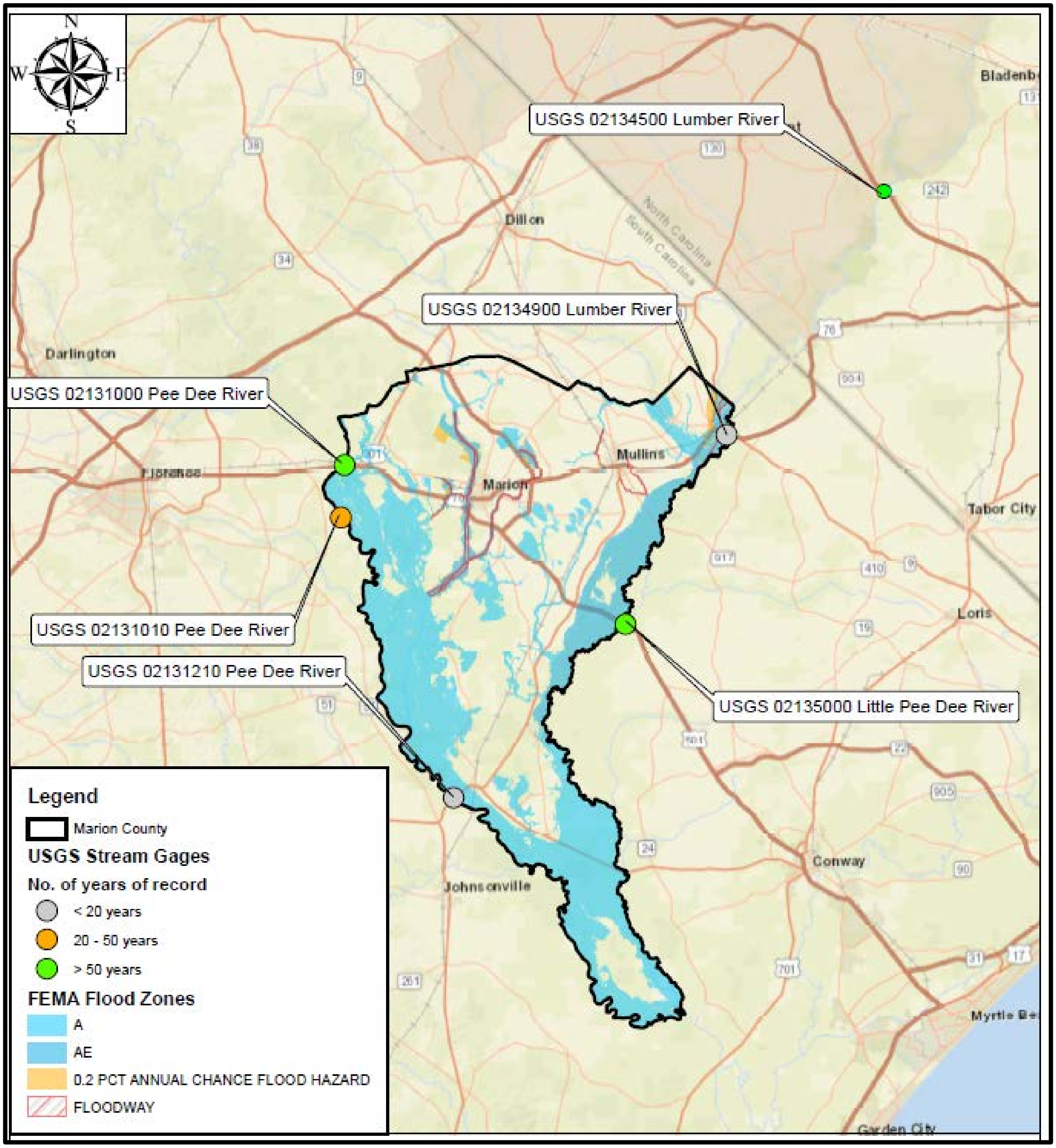


Figure 2: *Relevant USGS streamgage locations*

There is a short term gaging station with only four years of record on the Lumber River at Nichols, SC. The drainage area to this location is 1,670 square miles. As shown in Figure 3 below, this stream gage recorded a maximum discharge of 41,500 cfs during the September 2018 flood (Hurricane Florence).

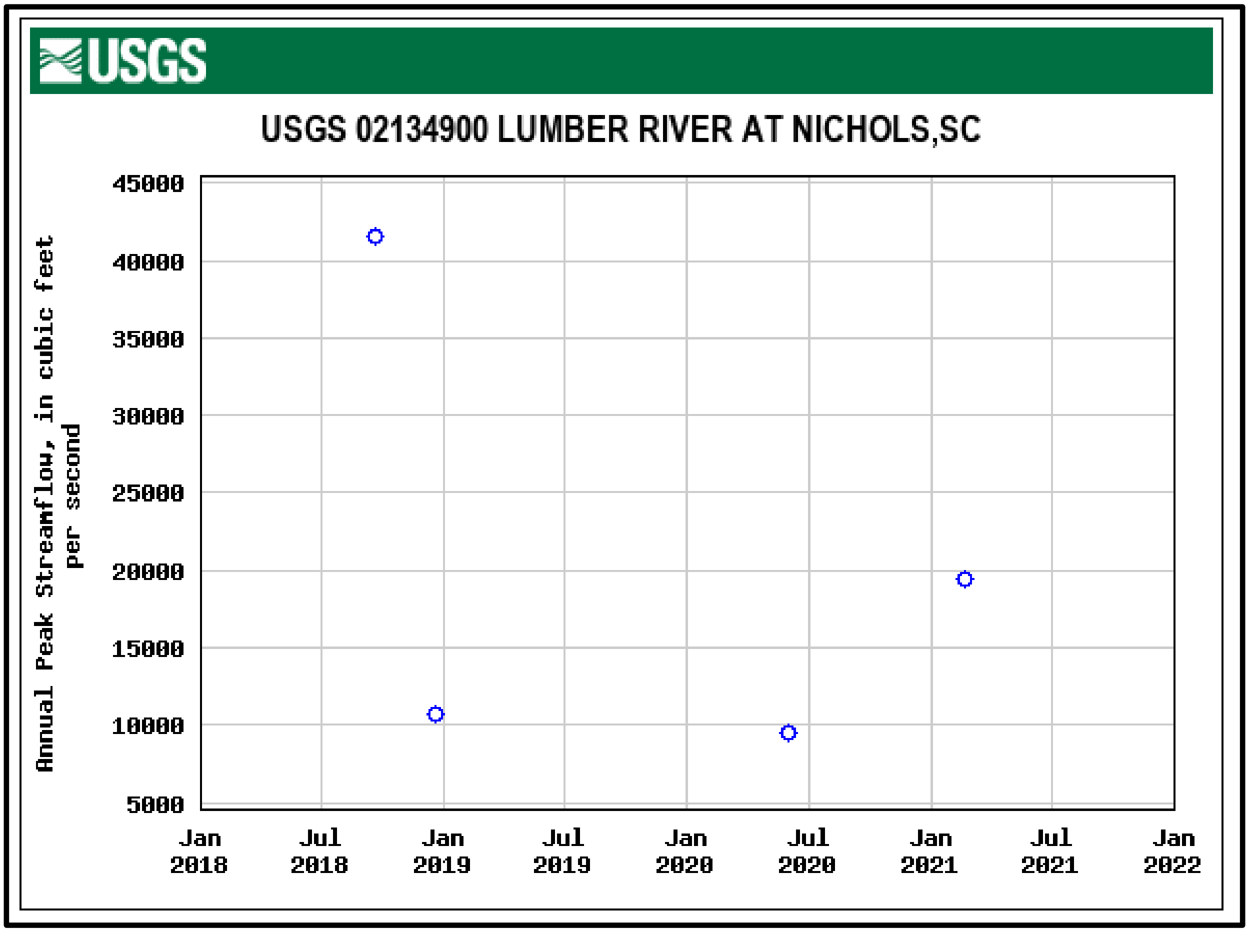


Figure 3: *Annual peak streamflow for USGS 02134900 Lumber River at Nichols, SC*

The closest gage upstream of Nichols along the Lumber River with a long flood record is USGS 02134500 at Boardman, NC where the drainage area is 1,228 square miles. There are 99 years of annual peak flow data at this station dating back to 1901. Figure 4 shows the October 2015 and September 2018 (Hurricane Florence) floods are both above 35,000 cfs. Hurricane Florence produced a peak flowrate of 35,400 cfs at Boardman (drainage area = 1,228 square miles) compared to 41,500 cfs at Nichols (drainage area = 1,670 square miles). This is a 17.2 percent increase (41,500/35,400 = 1.172) in observed flowrates between the two gage stations for this historical event.

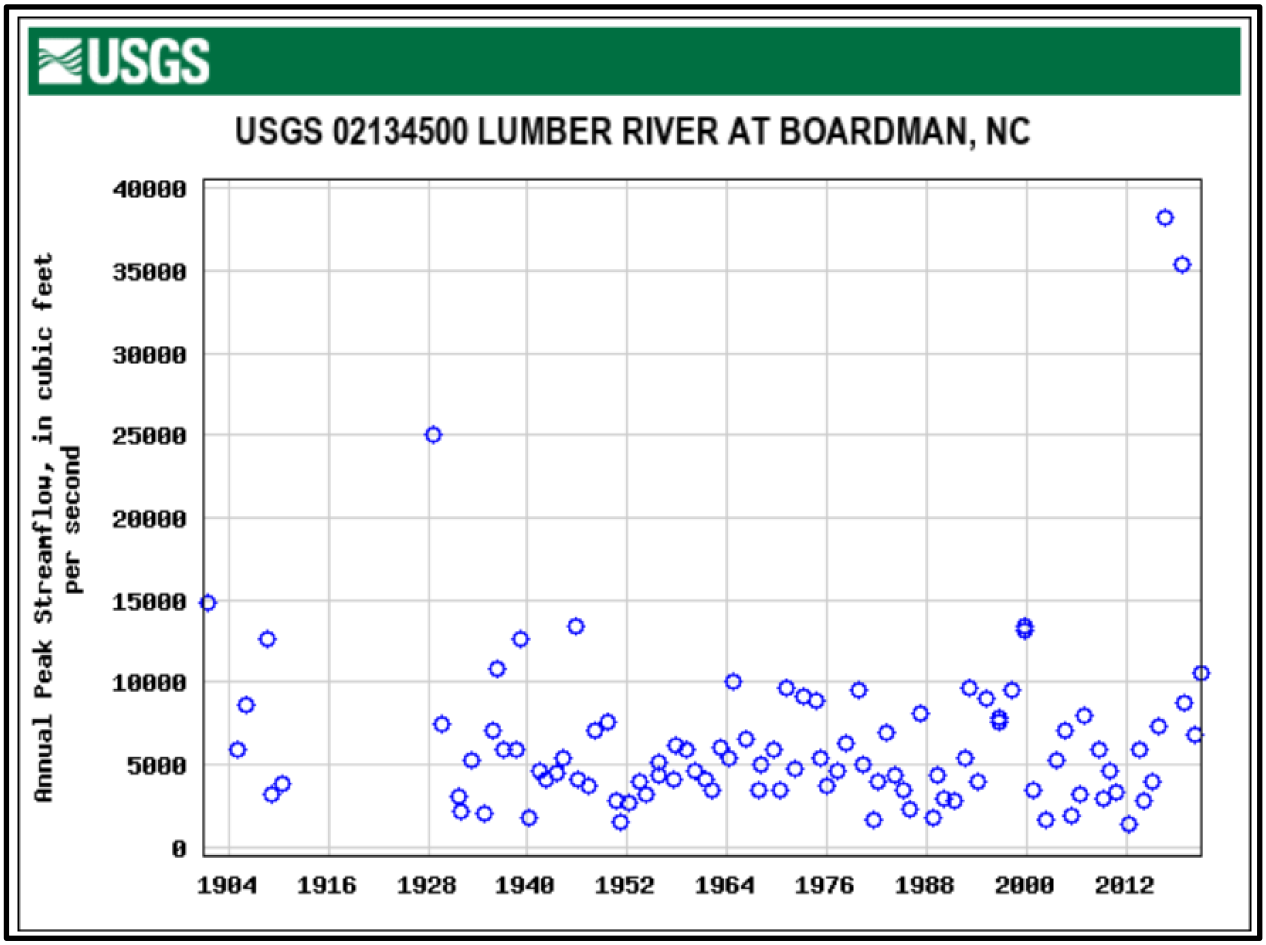


Figure 4: *Annual peak streamflow for USGS 02134500 Lumber River at Boardman, NC*

A Bulletin 17C flood frequency analysis using PeakFQ was conducted for the Lumber River at Boardman (02134500). The output table can be found in Table 6. This table provides the probability a given flowrate may occur within a given year. The station skew (0.526) was used for the analysis because the regional skew is -0.019. The station and regional skew were not weighted because they differ more than 0.5 and are considerably different.

Table 6: *PeakFQ Output for Lumber River at USGS 02134500 in Boardman, NC*

ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	<- EMA ESTIMATE -> WITH REG SKEW	WITHOUT REG SKEW	<- FOR EMA ESTIMATE WITH REG SKEW -> LOG VARIANCE OF EST.	<-CONFIDENCE LIMITS-> 5.0% LOWER	95.0% UPPER
0.9950	1139.	1139.	0.0056	848.8	1504.0
0.9900	1257.	1257.	0.0040	978.2	1583.0
0.9500	1697.	1697.	0.0014	1443.0	1933.0
0.9000	2030.	2030.	0.0009	1782.0	2256.0
0.8000	2569.	2569.	0.0007	2311.0	2843.0
0.6667	3263.	3263.	0.0007	2940.0	3621.0
0.5000	4279.	4279.	0.0008	3829.0	4776.0
0.4292	4817.	4817.	0.0009	4301.0	5398.0
0.2000	7734.	7734.	0.0012	6824.0	8939.0
0.1000	10910.	10910.	0.0019	9391.0	13300.0
0.0400	16160.	16160.	0.0039	13280.0	22060.0
0.0200	21140.	21140.	0.0062	16680.0	32150.0
0.0100	27200.	27200.	0.0093	20520.0	46650.0
0.0050	34550.	34550.	0.0132	24850.0	67440.0
0.0020	46690.	46690.	0.0198	31460.0	109200.0

The flood frequency graphs based on this analysis can be seen in Figure 5. The skew is positive (concave upward) which indicates the regional skew is not applicable for this site. Given that there are 99 years of data for this particular location, one can conclude that the station skew is accurately defined.

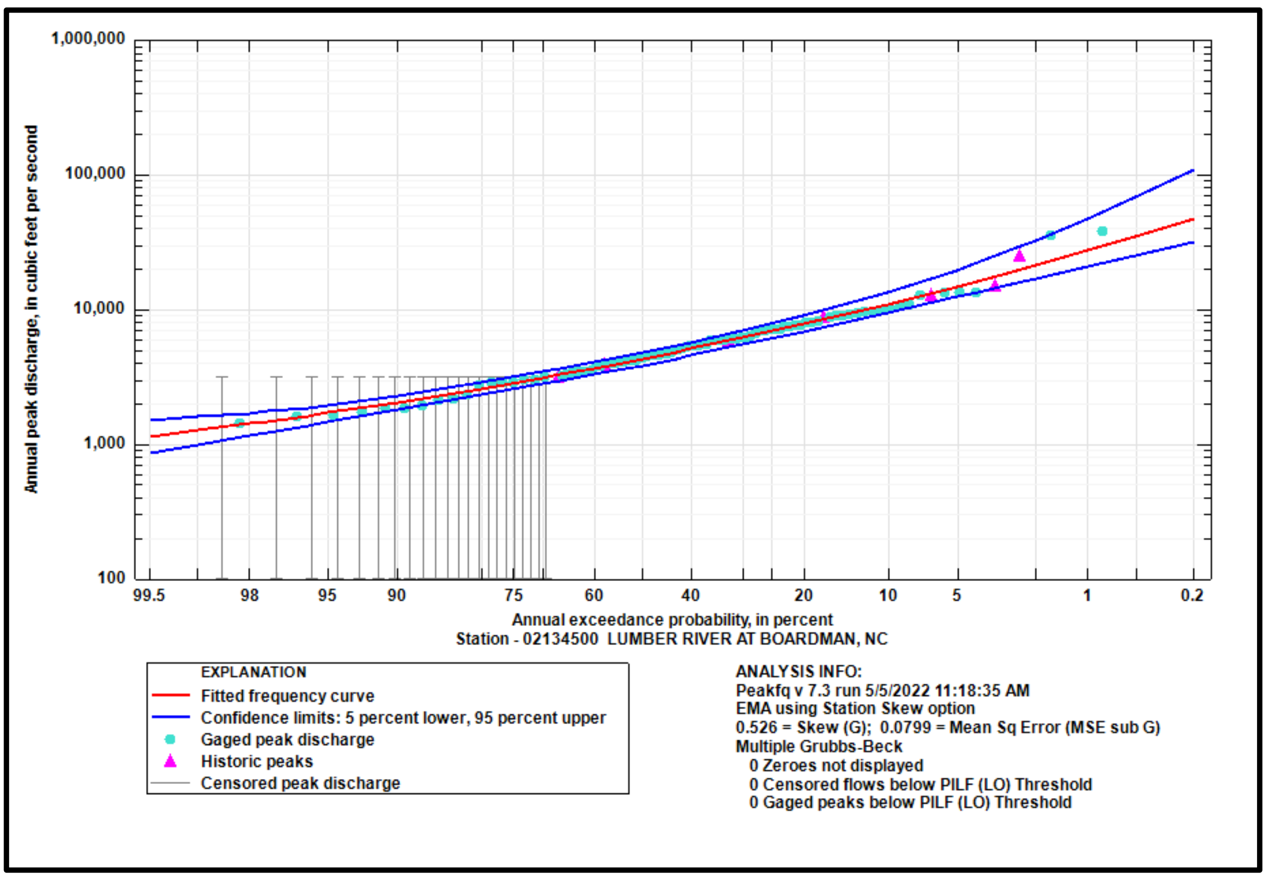


Figure 5: *Flood frequency graph based on PeakFQ Output from USGS 02134500*

The most recent USGS regional flood report for South Carolina for large rural watersheds is USGS Scientific Investigations Report 2009-5158 (dated 2009 with flood data through 2006). Table 7 below illustrates the regional regression equations for streams contained in one hydrologic region. Region 4 is the Coastal Plain Region and the Lumber River is mostly contained within this Region. This table is provided to give the exponent on the drainage area which will be used for transferring the Boardman, NC flows downstream to Nichols, SC since the gage at Nichols does not have the historical data the upstream gage provides.

Table 7: *Regional regression equations for Region 4*

[*DA*, the drainage area in square miles]

Percent chance exceedance	Hydrologic region (shown in figures 5 and 7)				
	1	2	3	4	5
50	$158(DA)^{0.649}$	$110(DA)^{0.779}$	$25.7(DA)^{0.758}$	$60.3(DA)^{0.649}$	$91.2(DA)^{0.649}$
20	$295(DA)^{0.627}$	$209(DA)^{0.749}$	$44.7(DA)^{0.744}$	$123(DA)^{0.627}$	$200(DA)^{0.627}$
10	$398(DA)^{0.617}$	$288(DA)^{0.736}$	$58.9(DA)^{0.740}$	$174(DA)^{0.617}$	$295(DA)^{0.617}$
4	$537(DA)^{0.606}$	$398(DA)^{0.724}$	$77.6(DA)^{0.736}$	$245(DA)^{0.606}$	$447(DA)^{0.606}$
2	$661(DA)^{0.600}$	$479(DA)^{0.718}$	$91.2(DA)^{0.735}$	$309(DA)^{0.600}$	$575(DA)^{0.600}$
1	$776(DA)^{0.594}$	$575(DA)^{0.713}$	$105(DA)^{0.733}$	$380(DA)^{0.594}$	$724(DA)^{0.594}$
0.5	$891(DA)^{0.589}$	$661(DA)^{0.709}$	$120(DA)^{0.733}$	$447(DA)^{0.589}$	$891(DA)^{0.589}$
0.2	$1{,}072(DA)^{0.583}$	$794(DA)^{0.704}$	$138(DA)^{0.732}$	$550(DA)^{0.583}$	$1{,}148(DA)^{0.583}$

The discharges at Boardman (station 02134500) can be transferred to Nichols, SC (station 02134900) by using a ratio of drainage areas raised to the power provided in Table 7 for a given recurrence period. For example, the 1-percent chance discharge for the Lumber River at Nichols can be calculated as such 27,200*[(1670/1228)^0.594] = 32,600 cfs. This value is reasonably consistent with the regression estimate of 31,200 cfs (380 * 1670^0.594) using the equations provided in Table 7. The annual exceedance probability flowrates using this approach are summarized for Nichols in Table 8 below.

Table 8: *Adjusted flowrates for the Lumber River at Nichols*

Flowrates (cfs)						
Location	Average recurrence interval (years)					
	2	10	25	50	100	500
Nichols	5,250	13,200	19,500	25,450	32,650	55,900

1.6. Highwater Marks (HWM)

Documenting the peak height of high water during flood events is important for stormwater planning. After storm events, visual indicators of peak water levels can be observed, surveyed, and documented for historical reference. The USGS has documented high water marks within Marion County for Hurricane Florence (2018) and Hurricane Matthew (2016). These values can be used to validate models created to replicate these events.

Table 9: *Documented HWM for Hurrican Florence (2018)*

Event: Florence September 2018					
STN Site No.	**Elevation**	**Height Above Ground**	**Type**	**Waterbody**	**Description**
SCMAR27286	23.43	0.78	Mud	Little Pee Dee River	[redacted] Bay Rd, Gresham, SC - HWM found on [redacted]
SCMAR27288	23.28	0.53	Seed line	Great Pee Dee River	[redacted] Hwy 378, Gresham, SC - HWM found on house foundation
SCMAR27261		2.42	Seed line	Great Pee Dee River	Side of [redacted] and other structures on Bear Pond Road, Gresham, SC
SCMAR27261	37.74	2.42	Seed line	Great Pee Dee River	Structure on Bear Pond Rd, Gresham, SC
SCMAR27192	32.03	1.64	Seed line	Little Pee Dee River	Side of house [redacted] Hwy 908, Brittons Neck, SC
SCMAR27259	36.83	3.85	Seed line	Great Pee Dee River	Power pole at intersection of Warren Ct & Hwy 9, Gresham, SC
SCMAR27257	36.40	4.35	Seed line	Great Pee Dee River	Seed line on [redacted] house on Treadway Rd, [redacted] Gresham, SC
SCMAR27255	36.21	4.38	Mud	Great Pee Dee River	Mud line on pwer line guide wire guard on east side of Murray Rd, Marion, SC
SCMAR27250		3.54	Stain line	Great Pee Dee River	Mud line on yellow & black culver sign on left upstream side of small box culvert on Hwy 9, Marion, SC
SCMAR27248	46.27	1.33	Mud	Great Pee Dee River	Mud line on house on Wahee Rd, Marion, SC
SCMAR27239	45.54	3.60	Seed line	Great Pee Dee River	Seed line on yellow casing of power pole guide wire at Cheva Ct [redacted] Pee Dee, SC
SCMAR27236	52.21	1.78	Seed line	Great Pee Dee River	Seed line on fiber optic pole, Jack's Hill Rd, [redacted] downstream side of bridge, Pee Dee, SC
SCMAR27233	52.19	3.45	Seed line	Great Pee Dee River	Seed line on house on Mossy Point Rd, Pee Dee, SC
SCMAR27237	51.59	6.10	Seed line	Little Pee Dee River	Seed line on house on Grice Ferry Ct, Marion, SC
SCMAR27234	51.82	4.95	Seed line	Lumber River	Seed line on house at [redacted] Grice Ferry Rd, Marion, SC
SCMAR27228	52.27	5.96	Mud	Little Pee Dee River	[redacted] house at [redacted] Wildlife Action Rd, Mullins, SC
SCMAR27226	52.56	6.79	Seed line	Little Pee Dee River	Side of house at [redacted] Wildlife Action Rd, Mullins, SC
SCMAR27222	53.01	5.00	Seed line	Little Pee Dee River	Side of house at [redacted] Wildlife Action Rd, Mullins, SC

SCMAR18635	56.05	2.28	Seed line	Lumber River	Seed line on [redacted], [redacted] Old Stage Rd, Nichols, SC
SCMAR27097	55.87	2.38	Seed line	Lumber River	Seed line on house [redacted] Juniper St, Nichols, SC
SCMAR18627	54.60	2.89	Seed line	Lumber River	Seed line [redacted] [redacted] Waccamaw St, Nichols, SC
SCMAR27101	56.52	2.35	Seed line	Lumber River	Seed line on [redacted] [redacted] [redacted] house [redacted]/Hwy 76, Nichols, SC
SCMAR18629		2.46	Seed line	Lumber River	Seed line on [redacted] building, Nichols, SC
SCMAR27028	56.47	2.28	Seed line	Lumber River	Seed line of [redacted], Nichols, SC
SCMAR18623	56.64	2.69	Seed line	Lumber River	Seed line on [redacted] [redacted], [redacted] N Main St, Nichols, SC
SCMAR18625	56.82	3.17	Seed line	Lumber River	Seed line [redacted] [redacted], [redacted] N. Main St, Nichols, SC
SCMAR27079	57.00	2.95	Seed line	Lumber River	Seed line on [redacted] [redacted] Highway 9, Nichols, SC
SCMAR27071	57.47	1.38	Seed line	Lumber River	Seed line on power pole at [redacted] Hwy 9, Nichols, SC
SCMAR29467	50.10	3.00	Seed line	Little Pee Dee River	DOT bridge, SC 917 at Little Pee Dee River, 200ft us of road, 2000 ft from river
SCMAR29467	49.80	4.00	Mud	Little Pee Dee River	DOT bridge, SC 917 at Little Pee Dee River, 0.8 miles from bridge
SCMAR29468	47.80	2.50	Seed line	Little Pee Dee River	DOT bridge, SC 917 at Little Pee Dee River, 1.0 mile from bridge

Table 10: *Documented HWM for Hurrican Matthew (2016)*

Event: Matthew October 2016					
STN Site No.	**Elevation**	**Height Above Ground**	**Type**	**Waterbody**	**Description**
SCMAR19035	21.40	5.65	Seed line	Giles Bay Creek	Seed line on tree on S-86, Gresham, SC
SCMAR19034	21.50	5.45	Seed line	Giles Bay Creek	Seed line on tree on S-86, Gresham, SC
SCMAR18871	21.10	5.23	Seed line	Giles Bay Creek	Seed line on tree on S-86, Gresham, SC
SCMAR19020	58.50	6.30	Seed line	Little Reedy Creek	Seed line on tree on S-32, Rains, SC
SCMAR19021	58.40	6.43	Seed line	Little Reedy Creek	Seed line on tree on S-32, Rains, SC
SCMAR18848	58.50	7.27	Seed line	Little Reedy Creek	Seed line on tree on S-32, Rains, SC
SCMAR19023	60.50	8.48	Seed line	Little Reedy Creek	Seed line on tree on S-32, Rains, SC
SCMAR19025	60.70	8.33	Seed line	Little Reedy Creek	Seed line on tree on S-32, Rains, SC
SCMAR18816	48.30	0.95	Seed line	Little Pee Dee River	Structure #2640091700200, RT bank bridge abutment, SC 917 over Little Pee Dee River, Mullins, SC

SCMAR18990	52.00	8.30	Seed line	Little Pee Dee River	Tree near SC 917 over Little Pee Dee River, Mullins, SC
SCMAR18835	70.70	5.58	Seed line	Maindendown Swamp	Tree near SC 41, Mullins, SC
SCMAR18846	55.00	1.35	Seed line	Little Pee Dee River	Seed line on house at [redacted] Sunny Point Ct, Mullins, SC
SCMAR18635	55.50	1.83	Stain line	Lumber River	Stain line on [redacted] [redacted], [redacted] Old Stage Rd, Nichols, SC
SCMAR18847	55.40	6.21	Stain line	Lumber River	Stain mark on SC 9/US 76 over Boggy Branch, structure #2620007600100, Nichols, SC
SCMAR18627	55.10	3.71	Debris	Lumber River	Debris line on home at [redacted] Waccamaw St, Nichols, SC
SCMAR18847	56.00	1.89	Seed line	Lumber River	Seed line on [redacted] [redacted] house at [redacted] Nichols St, Nichols, SC
SCMAR18847	55.30	1.70	Seed line	Lumber River	Seed line on [redacted] [redacted] [redacted] house on [redacted] W. Pee Dee St, Nichols, SC
SCMAR18629	56.30	2.92	Stain line	Lumber River	[redacted] building, Nichols, SC
SCMAR18637	55.50	3.14	Seed line	Lumber River	[redacted] S. Main St, Nichols, SC
SCMAR18623	56.60	3.13	Stain line	Lumber River	[redacted] [redacted], [redacted] N. Main St, Nichols, SC
SCMAR18625	56.60	2.96	Seed line	Lumber River	Seed line on [redacted] [redacted] [redacted], [redacted] N. Main St, Nichols, SC
SCMAR18660	56.60	4.02	Stain line	Lumber River	Stain line on [redacted] [redacted] house on [redacted] N. Main, Nichols, SC

In addition to the highwater marks documented by USGS, the project team noted a water stain on the walls of the old Town Hall while performing field reconnaissance in the Town of Nichols. Documentation of this HWM was added to survey scope for the project to be used in model calibration.


Figure 6: *Old Nichols Town Hall*

1.7. Land-Use and Soils

Land use and soil type are the required variables for estimating the Curve Number (CN) of a watershed which, in turn, is necessary to compute its runoff responses based on the SCS method. Aerial imagery on ArcGIS platform was used to identify different land use types for Nichols and Mullins within Marion County. Pasture, woods, grassland, and small residential areas were identified to be the dominant land use types across Nichols and Mullins.

Meanwhile, digital soil data from the SSURGO database was used to identify the hydrologic soil groups for Marion County. This database is produced and distributed by the USDA-NRCS and contains information about soils as collected by the National Cooperative Soil Survey over the course of a century. SSURGO soil survey areas contain map data, tabular data, and information about how the maps and tables were created, all displayed with a geographic coordinate system. As per SSURGO, major soil types within and around Nichols were identified to be A and D, while C and D were the major soil groups within Mullins.

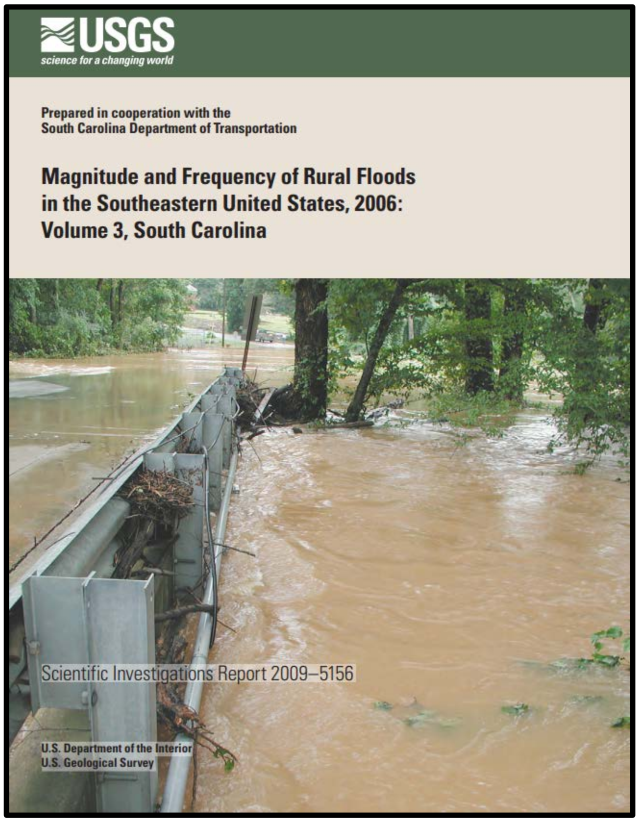
Finally, in reference to the guidelines in technical release 55 (TR-55) of USDA-NRCS, the CNs were estimated for Nichols and Mullins. CNs ranging from 30 to 100 were found for Nichols which outlined low to high runoff potentials (Appendix B). For Mullins, the range of curve numbers was 55 to 100 (Appendix B) indicating moderate to high runoff potentials.

1.8. Data Gap Analysis

In addition to the data described in previous sections of this report, several other sources of data were also collected and reviewed. Below is a brief description outlining this additional data and its relevance in developing a Stormwater Masterplan. For a complete summary of the data gathered during this task order, please see the Data Compilation and Collection Log in Appendix A.

USGS Regression Reports

For streams that do not have USGS gages present, USGS Regression reports can be used in calculating peak flow rates for different recurrence intervals. The two reports that are relevant to this study include the *Magnitude and Frequency of Rural Floods in the Southeastern United States, 2006: Volume 3, South Carolina* and the *Methods for Estimating the Magnitude and Frequency of Floods for Urban and Small, Rural Streams in Georgia, South Carolina, and North Carolina, 2011*. These reports summarize numerous studied streams with various parameters in order to develop a set of regression equations to predict peak flowrates for streams of similar characteristics. Selecting the correct report as well as the correct set of equations within each report typically is determined by the drainage area, the percentage of impervious area within the contributing basin, as well as the geographical location of the drainage area. These two reports as well as the equations developed from these reports can then be used to develop peak flowrates for ungagged streams within Marion County.



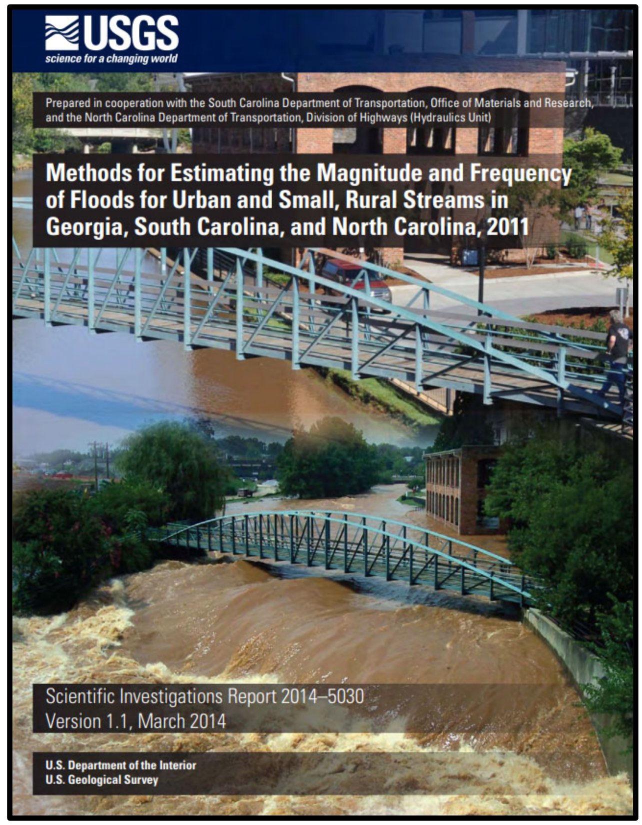


Figure 7: *USGS relevant reports for estimating magnitude and frequency of floods in Marion County*

CDC/ATSDR Social Vulnerability

The CDC/ATSDR Social Vulnerability Index (SVI) uses information from the United States Census consisting of 15 variables that help local officials identify communities that most likely would need support before, during, or after disasters. These variables are grouped into four major themes that are used in developing a census tract's SVI ranking which includes Socioeconomic Status, Household Composition, Race/Ethnicity/Language, and Housing/Transportation. Each census tract will have an overall SVI ranking as well as individual rankings for each of the four themes. Understanding where the most vulnerable communities are located will help the Michael Baker team prioritize potential future projects to help alleviate the identified flooding within these communities. Figure 8 below shows the 2018 SVI for Marion County, SC.

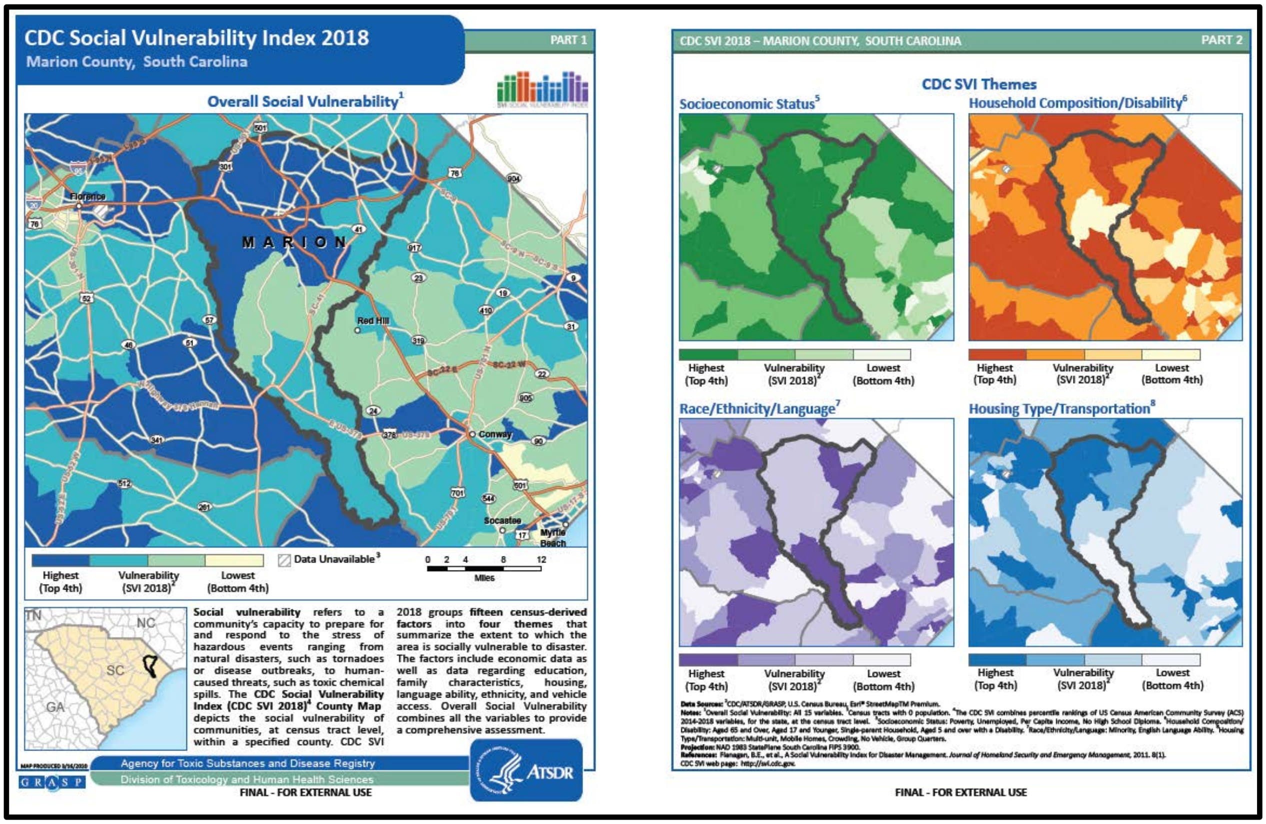


Figure 8: *CDC Social Vulnerability Index 2018 for Marion County, SC*

Low-to-Moderate Income

While identifying potential future projects, another metric that will be prioritized is the Low-to-Moderate Income (LMI) community. The Low-to-Moderate Income Population is a U.S. Census Block Group in which 51% or more of the households earn less than 80% of the Area Median Income. Flooding within this community can be catastrophic to the area and an emphasis will be placed on these communities. The project team understands the necessary requirements of a Community Development Block Grant (CDBG) and will ensure that potential projects benefit the most vulnerable communities as well as LMI communities. Figure 9 below shows the breakdown of which block groups are considered LMI in relation to the FEMA regulated floodplains within the County.

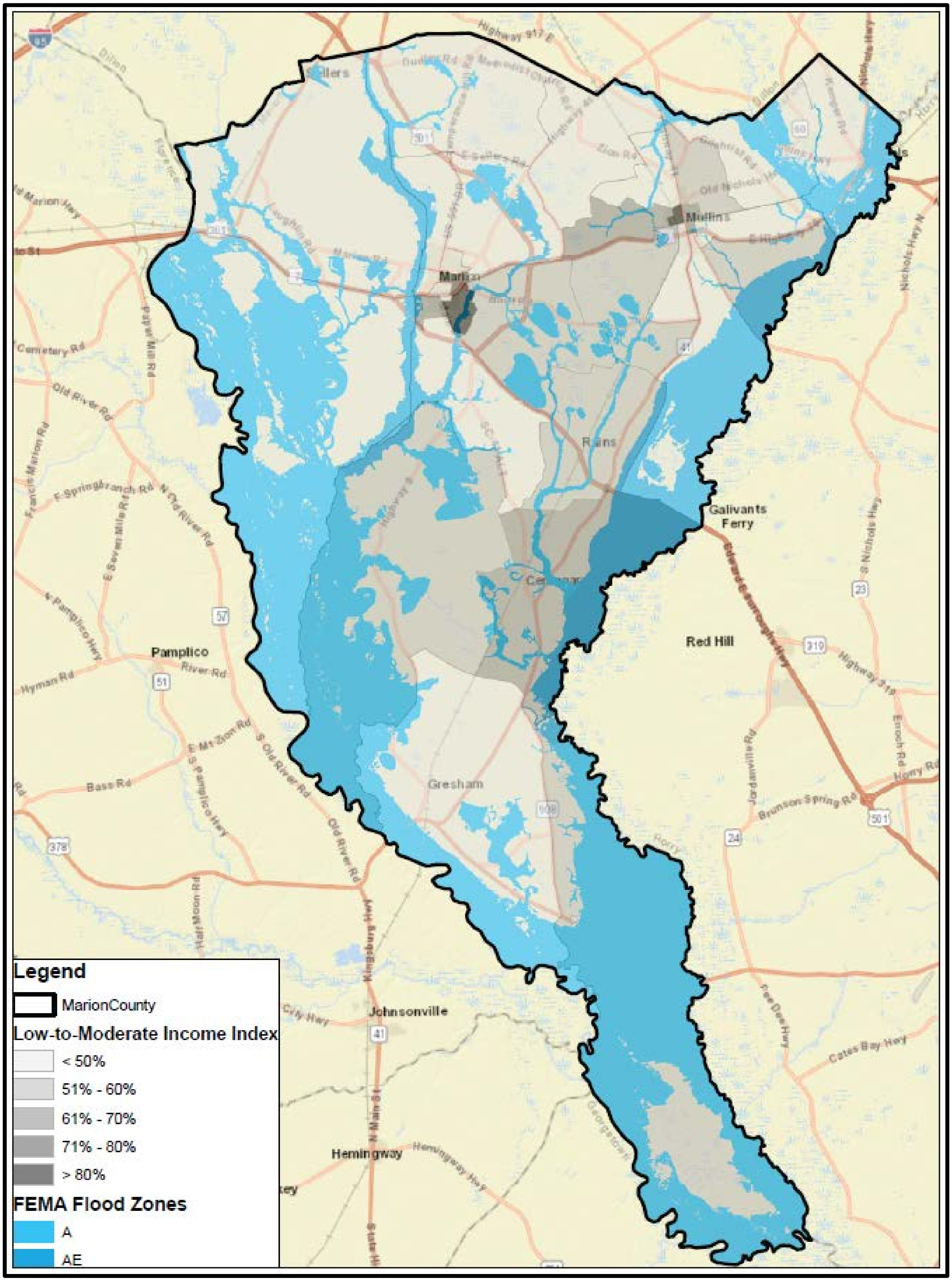


Figure 9: *LMI communities within Marion County*

SCDOT Programmed Projects

The SCDOT Programmed Project Viewer was reviewed to determine current and future programmed projects within Marion County. Figure 10 below shows the location and type of project in reference to the hydraulic modeling areas. In review of this information, it was determined that there are four projects currently in the programmed list that may potentially impact the hydraulic models. The first project is the S-41 (Senator Gasque Road) over Maidendown Swamp Bridge Replacement just west of Mullins. The anticipated construction year based on SCDOT's website is scheduled for 2023. The second project is the US 76 over Catfish Canal Bridge Replacement which has an anticipated construction year of 2026. The third project is the rehabilitation and resurfacing of SC 576 in the City of Marion. This project has an anticipated construction year of 2022. The fourth project is the S-87 Bridge Replacement over Smith Swamp with an anticipated construction year of 2023.

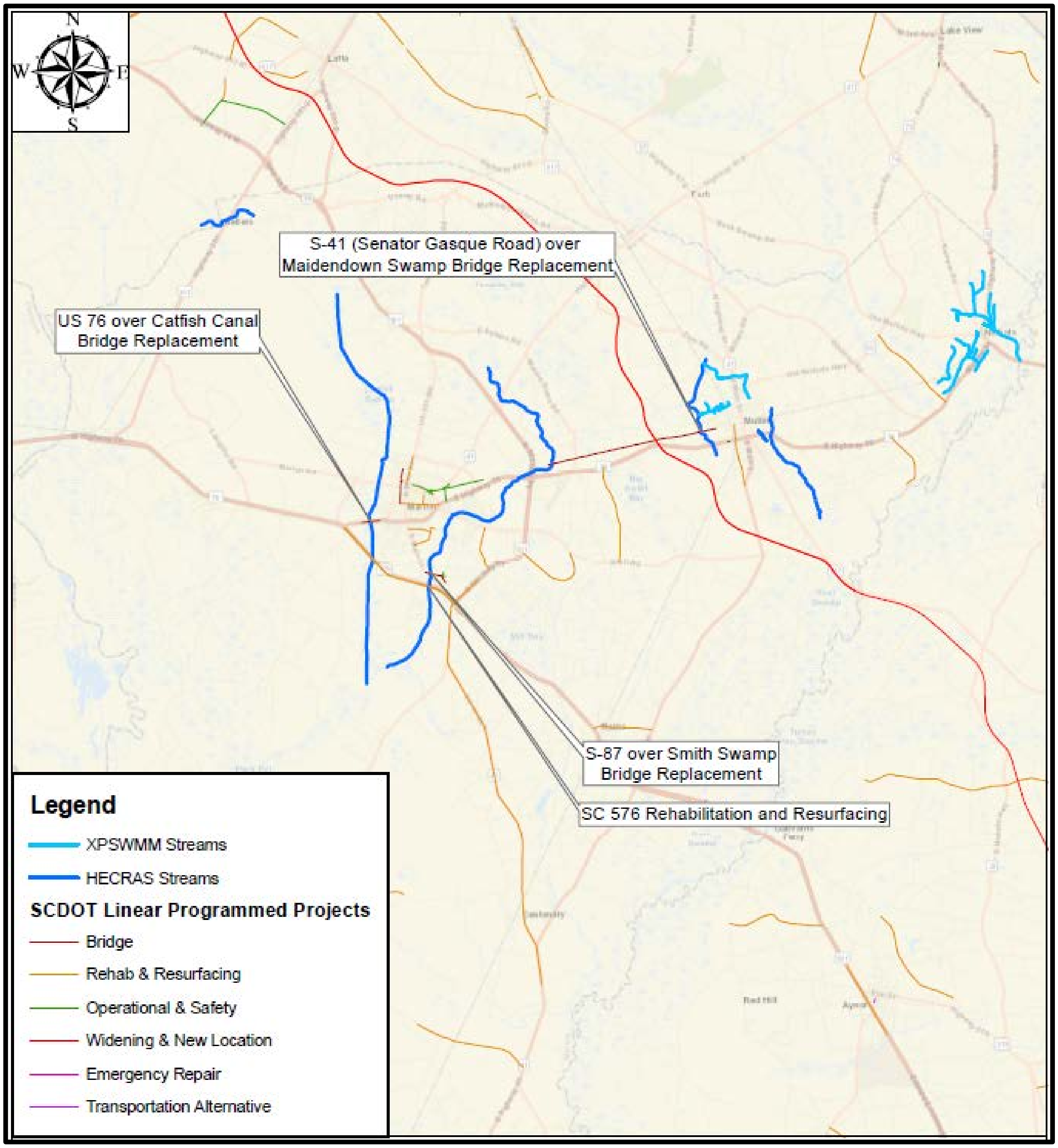


Figure 10: *SCDOT Programmed Projects*

LiDAR

LiDAR data for the project area is publicly available for download via SCDNR and comes in the form of either 10ft x 10ft Digital Elevation Model (DEM) or 2ft contours. Because a few of the modeled streams run along the Marion County border, LiDAR data was downloaded for not only Marion County but also the adjacent counties (Horry and Dillon). This elevation data is crucial for developing hydraulic models to properly assess the limits and depths of flooding.

Marion County GIS Information

Marion County's GIS Department was contacted to determine the data currently available that may be of use in the study. Although Marion County does not have a drainage database, the County was able to provide a few shapefiles that may be of use in future task orders such as parcel data and building footprint data. The parcel data was requested so the Michael Baker team could determine which parcels the County and/or municipalities currently own to determine if any of these spaces could be utilized as stormwater control.

SCDOT Bridge, Road, and Drainage Information

The Michael Baker team searched the SCDOT Plans Online database to pull as-built plans at various locations throughout Marion County to help aid in the determination of structure sizes and elevations within the modeled area. In addition to the online plans database, Michael Baker was able to obtain old bridge plans and inspection reports for all SCDOT owned bridges within the project area. This information was helpful in determining the size of the structures as well as changes in the hydraulic conditions over time based on visual observation. The Michael Baker team was able to use this information to help reduce the survey scope and cost.

1.9. Field Inventory

After assessing the data gap, several field visits were scheduled to gather general measurements of hydraulic features and structures. Maps showing the locations the Michael Baker team identified and visited can be found in Appendix D along with site photos from these visits. The locations of these field visits fall along the streams identified by the team to be studied in detail. In addition to the hydraulic structure inventory, the Michael Baker team also walked portions of the modeled area to field verify watershed boundaries, soil types, and land use types. After completing the field reconnaissance, a survey scope was developed to fill in the rest of the data gap and validate the measurements taken in the field

1.10. Existing Conditions Analyses

Based on the input from the County workshops, data gap analysis, and field inventory, a series of hydrologic and hydraulic models were created to assess the stormwater systems of identified flood prone areas of the County. Major systems (streams and floodplains) were modeled using the US Army Corps of Engineers Hydrologic Engineering Center River Analysis System (HEC-RAS). These models determine the limits of inundation from streams, outfalls, and floodplains, which in turn establish downstream boundary and backwater conditions for the more localized models. See Figure 11 below to see how these modeled areas correlate as well as the coverage of the modeling domain. Available HEC-RAS models were requested from FEMA as described in sections 1.1.3. and 1.2. of this report. A 2-D HEC-RAS model of the Lumber River was also obtained from Woolpert. All models obtained were reviewed for applicability. Models that were not available were created by Michael Baker. Additional details on these models are described in Section 1.11. below.

The localized models consist of open channels, closed piped systems, overland flow and depressional storage areas. These models were created using XPSWMM, a modeling package that simulates hydrology, hydraulics, and surface flooding using a node/link structure and a time step routing method to simulate flow through the system. XPSWMM models were created for systems in Mullins and Nichols.

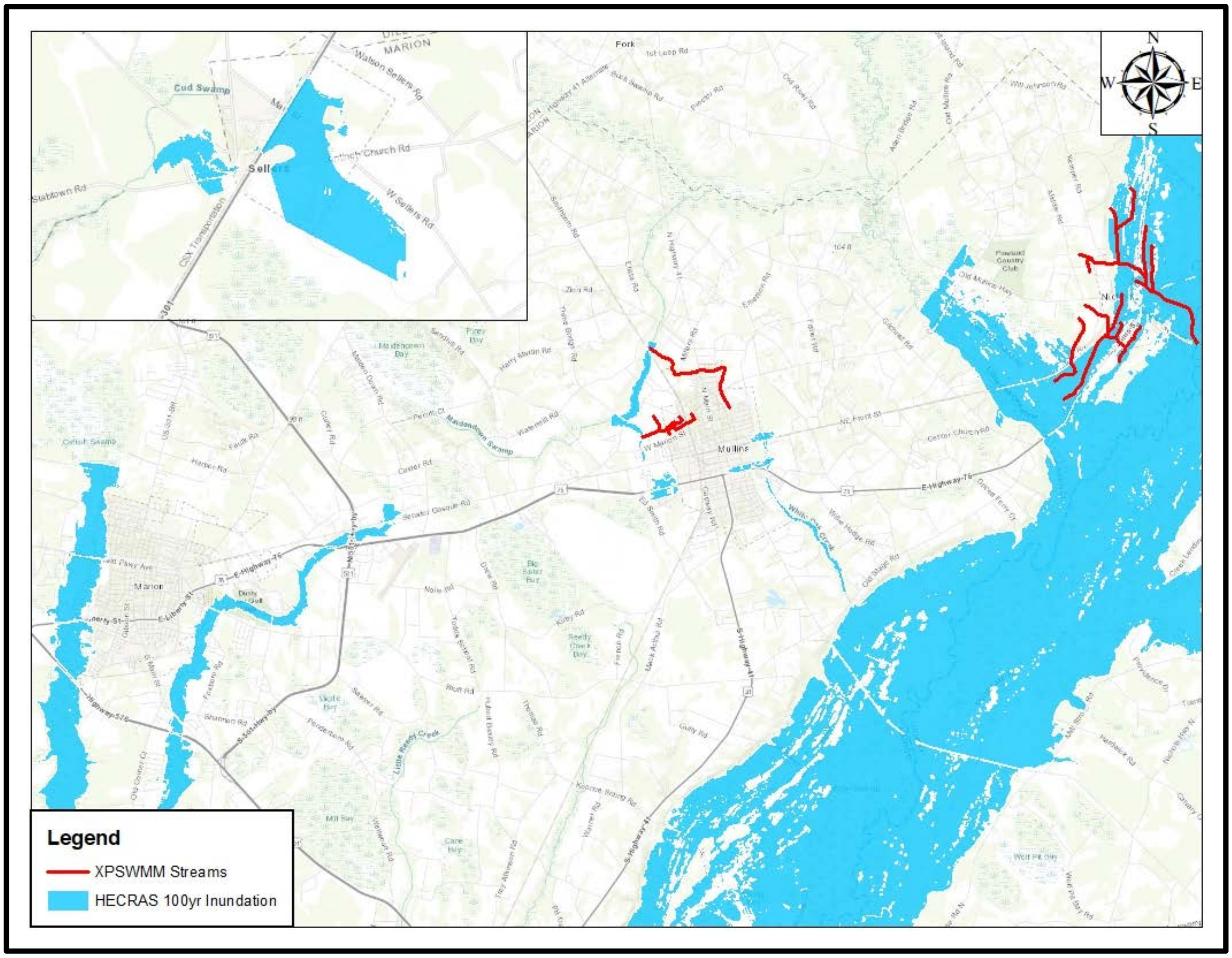


Figure 11: *Hydraulic modeling coverage*

1.11. Major System (HEC-RAS) Models

Maps associated with these HEC-RAS models can be found in Appendix C. Geometric set up of the model consisted of modeling the stream in its current condition and is referred to as the Existing Condition model. Once the geometry was established, two separate flow files were utilized to analyze the current conditions utilizing USGS Regression calculated peak discharges as well as predicted future condition flowrates. For each of these 2 scenarios, the 2-yr, 5-yr, 10-yr, 25-yr, 50-yr, 100-yr, and 500-yr events were analyzed. A summary of the flowrates used in the HEC-RAS models can be found in Table 11.

Table 11: *Peak discharges based on USGS Regression equations and future adjustment factors*

Flooding Source and Location	Drainage Area (mi²)	Flow Condition	Peak Discharges (cfs) 2yr	10yr	25yr	50yr	100yr
CATFISH CANAL							
about 3.1 miles downstream of Hwy 576	75.0	Current	993	2,490	3,360	4,120	4,940
		Future	1,068	2,677	4,116	5,253	6,422
MAIDENDOWN SWAMP							
at Zion Road	10.8	Current	282	754	1,040	1,290	1,560
		Future	304	811	1,274	1,645	2,028
MAIDENDOWN SWAMP TRIBUTARY							
just upstream of confluence with Maidendown Swamp	2.1	Current	169	364	477	565	657
		Future	182	392	585	721	855
at Senator Gasque Road	1.0	Current	91	207	276	330	387
		Future	99	223	339	421	504
SELLERS BRANCH							
just upstream of confluence with Cud Swamp	0.9	Current	75	182	248	301	358
		Future	81	196	304	384	466
SMITH SWAMP							
about 1 mile upstream of confluence with Catfish Canal	26.2	Current	502	1,300	1,780	2,190	2,650
		Future	540	1,398	2,181	2,793	3,445
about 1.2 miles upstream of Bluff Rd	14.3	Current	339	897	1,230	1,520	1,850
		Future	365	965	1,507	1,938	2,405
WHITE OAK CREEK							
at Old Stage Rd	3.6	Current	213	477	636	760	892
		Future	229	513	780	969	1,160
WHITE OAK CREEK TRIBUTARY 1-1							
just upstream of confluence with White Oak Creek	0.5	Current	269	332	354	367	378
		Future	290	357	434	468	492

The 2D HEC-RAS model obtained from Woolpert as discussed in Section 1.1.5 was reviewed to determine its condition. This review determined that the model geometry set-up was in good condition and the model had already been calibrated based on historical gage data from Hurricane Florence. The only updates made to this model involved updating the current USGS flowrates based on the methodology described in Section 1.3. In addition to updating the current condition flowrates, the Michael Baker team also created future condition hydrographs based on the methodology described in Section 1.2 to come up with future peak flows and assigning them to the unit hydrographs created by Woolpert based on the USGS gage results from historic events.

The hydraulic models for the streams summarized in Table 1 were reviewed to ensure their accuracy and currency. Because these models were published in late 2009, the hydraulic models contained geo-referencing which helped make for a simple comparison. LiDAR data for Marion County was overlayed behind the topographic data utilized in these models and showed very little discrepancies in elevation. Additionally, cross section locations were reviewed and updates were made as necessary. Finally, the structure sizes were reviewed and several errors were discovered. Based on the findings from the data gap analysis, the structure information was updated for these crossings and the models re-run with the updated hydrologic analysis described previously.

For the streams summarized in Table 2, new HEC-RAS models were created given the limitations and age of the HEC-2 models received. A brief summary of each of the streams can be found below.

Catfish Canal

Approximately 5 miles of Catfish Canal, beginning approximately 3.1 miles downstream of Highway 576, was modeled. This model contains 4 hydraulic structures crossing under US 576, West Liberty Street, Bobby Gerald Parkway, and English Park Road. Catfish Canal is located along the western border of the City of Marion.

Maidendown Swamp and Maidendown Swamp Tributary

Maidendown Swamp and Maidendown Swamp Tributary were modeled together in one HEC-RAS model. The model consists of the entirety of Maidendown Swamp Tributary which is approximately 1.5 miles in length until it flows into Maidendown Swamp just upstream of 3 Bridge Road. A flow change was added at this confluence and Maidendown Swamp was modeled for approximately another 1.3 miles in order to provide sufficient coverage to establish the downstream boundary condition for the localized XPSWMM model. The combined model contains 7 structures with 2 located on Maidendown Swamp and the other 5 located along Maidendown Swamp Tributary.

Smith Swamp

Smith Swamp was modeled from approximately 1.2 miles upstream of the confluence with Catfish Canal to 1.2 miles upstream of Bluff Road for a total distance of approximately 7 miles. This reach is located just east of the Marion City limits. There are 8 major hydraulic structures located along this section of swamp.

White Oak Creek

White Oak Creek flows along the eastern boundary of the City of Mullins. The model begins at Old Stage Road and is modeled in its entirety. This results in an approximate stream length of 2.8 miles. Along this reach, there are a total of 5 hydraulic structures.

White Oak Creek Tributary 1-1

White Oak Creek Tributary 1-1 is a small tributary just west of White Oak Creek located within the City of Mullins. The modeled portion is approximately 0.3 miles in length and contains only 1 structure.

1.12. Localized (XPSWMM) Models

The stormwater drainage networks for Nichols and Mullins, consisting of both open channels and closed pipe systems, were modeled in XPSWMM. The network layouts were developed based on topographic contours from Marion County LiDAR data (obtained from SCDNR) as well as the NHDPlus HR dataset of USGS. The modeling domain for Nichols and Mullins contained 26 and 17 subwatersheds, respectively. The subwatershed boundaries were first obtained using the StreamStats platform of USGS and then field verified. The subwatersheds along with the link-node networks for the Nichols and Mullins models are depicted in Appendix B.

The Marion County LiDAR was used to represent the topographical variation across the Nichols (42.81 to 103.83 ft NAVD88) and Mullins (70.01 to 106.89 ft NAVD88) XPSWMM models. The dataset was also used to extract node invert (i.e., channel bottom) elevation and open channel geometry, and also to compute the longitudinal channel slopes. In addition to that, information on ditch geometry (bottom width, depth, side slope) along with size (diameter, height, and width) of culverts and closed pipes for different crossings, determined from field reconnaissance were also incorporated in the models. Meanwhile, SCS CN method (see Section 1.7) was implemented in XPSWMM to simulate runoff responses of the subwatersheds.

Calibration runs for the Nichols model were performed based on the cumulative rainfall depths during Hurricane Matthew (October, 2016) and Florence (September, 2018). HWM records during those storms near the US-76 crossing for Lumber River were used as boundary conditions for those calibration runs. Table 12 outlines comparison of several of the HWMs and simulated water levels from XPSWMM for major flooding prone locations at Nichols for the calibration runs.

Table 12: *Comparison of HWMs and Nichols XPSWMM model simulated water levels for Hurricane Matthew and Florence*

Event	Latitude	Longitude	Site Description	Observed High-Water Mark (ft NAVD88)	Simulated Water Level from XPSWM Calibration Run (ft NAVD88)	Land Surface Elevation (ft NAVD88)
Matthew	34.23	-79.15	[redacted]	56.6	56.3	53.0
	34.24	-79.15	[redacted]	56.6	56.3	53.8
	34.23	-79.14	[redacted] Building	56.3	56.1	53.6
	34.24	-79.15	Residential House with [redacted] N. Main.	56.6	56.3	52.1
	34.23	-79.14	Site #14, SCDOT structure #2620007600100, Road: SC9/US76	56.0	56.0	54.0
Florence	34.23	-79.15	Parking Lot of [redacted]	56.5	56.6	53.6
	34.23	-79.15	[redacted]	56.6	56.7	53.0
	34.24	-79.15	[redacted]	56.8	56.7	53.8
	34.24	-79.15	[redacted] at Highway 9, Nichols, SC	57.0	56.7	53.1
	34.23	-79.14	[redacted] hw. 76, Nichols, SC	56.5	56.6	54.0

Following the calibration runs, existing condition runs for the Nichols XPSWMM model were performed under 2-, 10-, 25-, 50-, 100-, and 500-year 24-hour duration storms. The rainfall depths under these design events were found from NOAA Atlas 14. Water levels near the US-76 crossing for the Lumber River corresponding to these design events, were obtained from the 2D HEC-RAS model originally developed by Woolpert and used as the downstream boundary condition for the Nichols XPSWMM model. Then, the model was also run for the same design events under potential future changes in extreme rainfall. Similar changes were assumed for flow boundary conditions for the Woolpert 2D HEC-RAS model. Accordingly, simulated water levels for Lumber River at US-76 crossing were used as downstream boundary conditions in the future condition model runs. Table 13 represents the existing and future condition flooding water levels at flooding prone locations at Nichols.

Table 13: *Comparison of existing and future condition XPSWMM model simulated water levels under different design storm events for Nichols*

Longitude	Latitude	Site Description	Simulated Water Level from XPSWMM (ft NAVD88)												Land Surface Elevation (ft NAVD88)
			Existing Condition						Future Condition						
			2Y	10Y	25Y	50Y	100Y	500Y	2Y	10Y	25Y	50Y	100Y	500Y	
-79.15	34.23	Parking Lot of [redacted]	*	*	*	*	*	55.5	*	*	*	*	*	56.7	53.6
-79.15	34.24	[redacted]	*	*	*	*	54.3	55.7	*	*	*	54.4	54.9	56.8	53.8
-79.15	34.25	Residence on Highway 9, Nichols, SC	*	*	52.8	53.4	54.1	55.8	*	*	53.5	54.2	55.0	56.9	54.7
-79.15	34.24	[redacted] at Highway 9, Nichols, SC	*	*	*	*	54.3	55.7	*	*	*	54.4	55.0	56.8	53.1
-79.14	34.23	[redacted] hw. 76, Nichols, SC	*	*	*	*	*	55.5	*	*	*	*	54.4	56.7	54.0
-79.15	34.23	[redacted] Juniper St. Nichols, SC	*	*	*	*	53.5	55.5	*	*	*	53.5	54.4	56.7	53.1
-79.15	34.23	[redacted]	*	*	*	53.7	54.1	55.6	*	*	53.8	54.2	54.7	56.8	53.0
-79.14	34.23	[redacted] Building	*	*	*	*	53.6	55.5	*	*	*	53.6	54.5	56.7	53.6

-79.15	34.23	[redacted] Old Stage Road, Nichols, SC 29581	*	*	*	52.5	53.2	55.5	*	*	52.6	53.4	54.6	56.7	52.8
-79.15	34.23	[redacted] S. Main Street, Nichols, SC	*	*	*	52.8	53.5	55.5	*	*	52.7	53.5	54.5	56.7	53.1
-79.15	34.24	Residential House [redacted] N. Main	52.1	53.1	53.5	54.0	54.4	55.7	52.3	53.2	54.0	54.5	55.0	56.9	52.1
-79.14	34.23	Site #14, SCDOT structure #2620007600100, Road: SC9/US76	*	*	*	*	*	55.5	*	*	*	*	54.4	56.7	54.0

* - denotes that flooding is contained within the hydraulic feature (i.e. pipe or ditch)

Although no documented HWM's were available for Mullins, we were aware of several locations within the City limits that frequently flooded. These locations were used to help assess model accuracy. As shown in Table 14 below, the XPSWMM model for Mullins shows flooding at these locations previously identified by the City. Model simulations for existing and future conditions were performed for the 2-, 10-, 25-, 50-, 100-, and 500-year 24-hour duration storms. Potential future changes in extreme rainfall as previously described were considered for Mullins as well. The Mullins XPSWMM model has two separate systems with differing outfalls. The downstream boundary condition for these systems utilize water surface elevations extracted from the Maidendown Swamp HEC-RAS model at cross sections 11415 and 3410.

Table 14: *Comparison of existing and future condition XPSWMM model simulated water levels under different design storm events for Mullins*

Longitude	Latitude	Site Description	Simulated Water Level from XPSWMM (ft NAVD88)												Land Surface Elevation (ft NAVD88)
			Existing Condition						Future Condition						
			2Y	10Y	25Y	50Y	100Y	500Y	2Y	10Y	25Y	50Y	100Y	500Y	
-79.25	34.21	Academy St and N Mullins St	97.3	97.7	97.9	98.0	98.2	98.6	97.4	97.8	98.1	98.3	98.5	99.0	95.7
-79.26	34.22	Millers Rd Crossing	82.3	83.7	84.3	84.7	85.1	85.9	82.6	84.0	84.9	85.4	85.8	86.6	81.8
-79.25	34.22	Area behind the Mullins Housing Authority	*	96.4	96.8	97.0	97.2	97.7	*	96.5	97.1	97.4	97.6	98.1	95.6
-79.27	34.21	3 Bridges Rd Crossing	84.8	85.4	85.6	85.7	85.9	86.3	84.9	85.4	85.8	86.1	86.3	86.6	84.1
-79.26	34.21	Near Public Housing	*	*	96.6	96.7	96.7	96.8	*	96.5	96.7	96.7	96.8	97.0	96.1

* - denotes that flooding is contained within the hydraulic feature (i.e. pipe or ditch)

1.13. Upstream and Downstream Impacts

A sensitivity analysis was performed to determine what changes upstream or downstream of Marion County may impact flooding within the County itself.

1.13.1. North Carolina

Both the Lumber River and Little Pee Dee River watersheds extend into North Carolina. Figure 12 below shows the contributing watershed at the confluence of the Lumber River and Little Pee Dee River just south of Nichols.

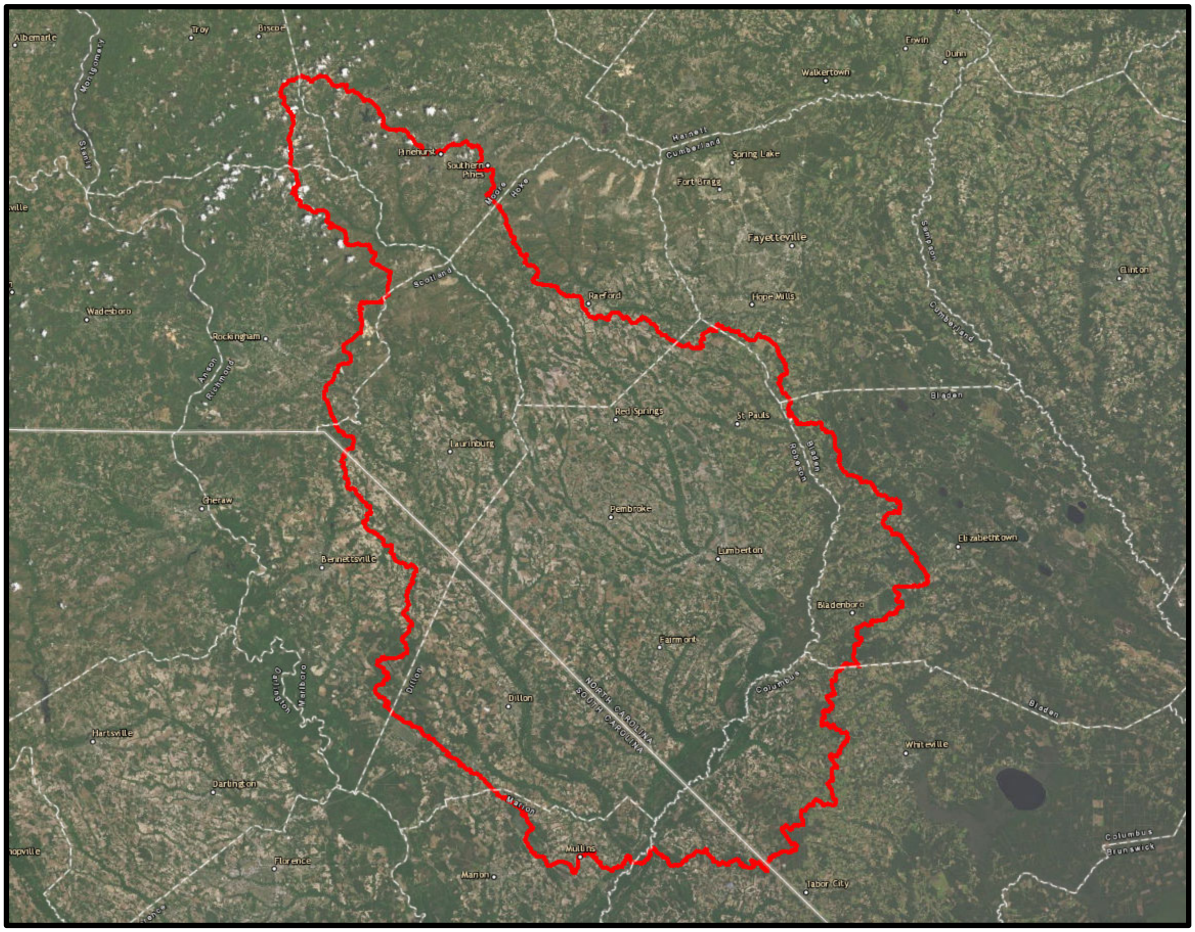


Figure 12: *Watershed to the confluence of the Lumber River and Little Pee Dee River*

The contributing watershed was analyzed to determine the potential impact that upstream development may have on flood flows downstream in Marion County. The National Land Cover Database (NLCD) provides land cover data for the entirety of the Continental United States (CONUS). Land cover data is available dating back to 2001. The most recently published land cover dataset is from 2019. A comparison between these two datasets within the contributing watershed was conducted and shows that the percentage of impervious area from 2001 was 1.85% and increased to only 2.24% in 2019. Given the size of the contributing drainage area and only slight increase in impervious area, development within the upstream watershed does not appear to be a major contributor to increased and more frequent flooding experienced in Marion County. Change in climate, as discussed in the Existing Conditions Report submitted previously, is the most likely contributor to increased flooding in recent years throughout Marion County.

1.13.2. Horry County

The watershed downstream of Marion County was analyzed to determine if the higher development rates and greater impervious areas of Horry County negatively contribute to an elevated backwater condition within Marion County. As discussed in the Existing Conditions Report, the Little Pee Dee

River limited detail HEC-RAS model was acquired from FEMA. Michael Baker had also previously developed a detailed HEC-RAS model of the Little Pee Dee River, Maple Swamp and Little Pee Dee Swamp for the US 378 eight bridges crossing project in Marion and Horry Counties. Using these two (2) models as a basis, a HEC-RAS model was created from US 76 just downstream of Nichols to US 701 in Horry County.

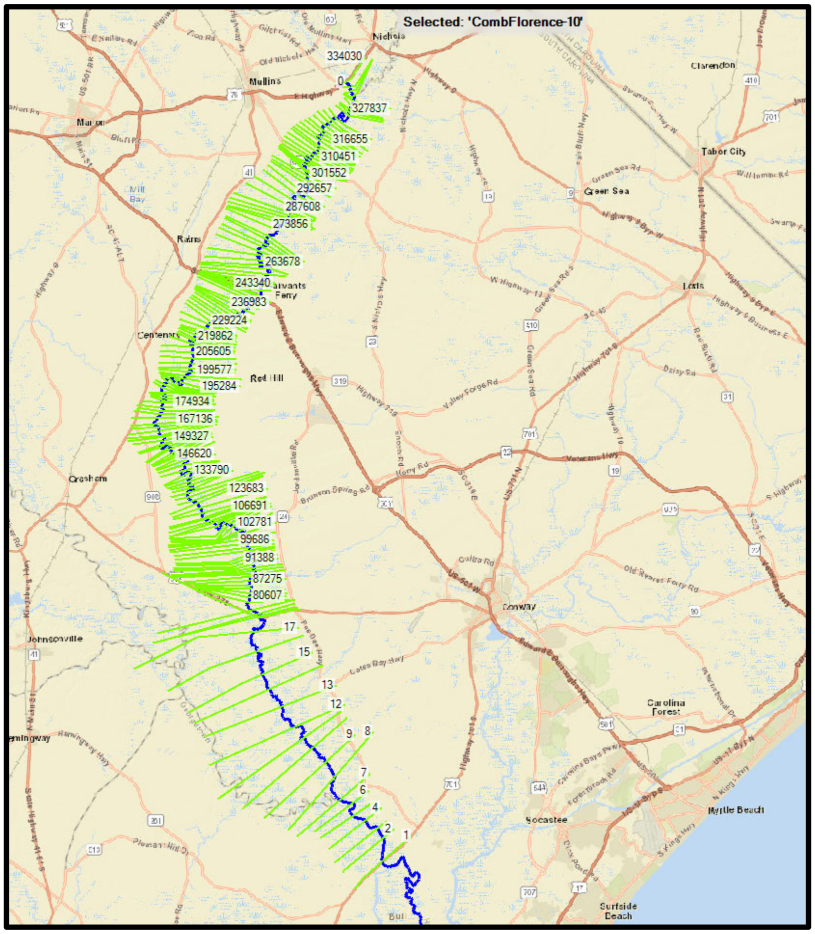


Figure 13: *Limits of downstream model*

A simulation of Hurricane Florence was used to calibrate the HEC-RAS model. USGS flood gages on the Little Pee Dee River at Galivants Ferry and the Pee Dee River at US 701 near Bucksport recorded actual peak flowrate and water surface elevations for Hurricane Florence. Setting downstream boundary conditions at US 701 with data from the gage, the HEC-RAS model replicated results at Galivants Ferry accurately.

In order to determine the point where a change in starting elevation will not affect the water surface elevation at a known point upstream (such as Marion County) a sensitivity analysis was conducted. The HEC-RAS model was executed starting at normal depth at US 701 then subsequent runs were executed starting at ten feet below and ten feet above normal depth. The results of the sensitivity analysis show that even with a starting water surface elevation at US 701 10 feet higher than the recorded high water elevation from Hurricane Florence, the water surface profile still ties back into the normal water surface profile at Galivants Ferry. This indicates that conditions in Horry County do not have a significant impact to peak flood stages along the Little Pee Dee River in Marion County.

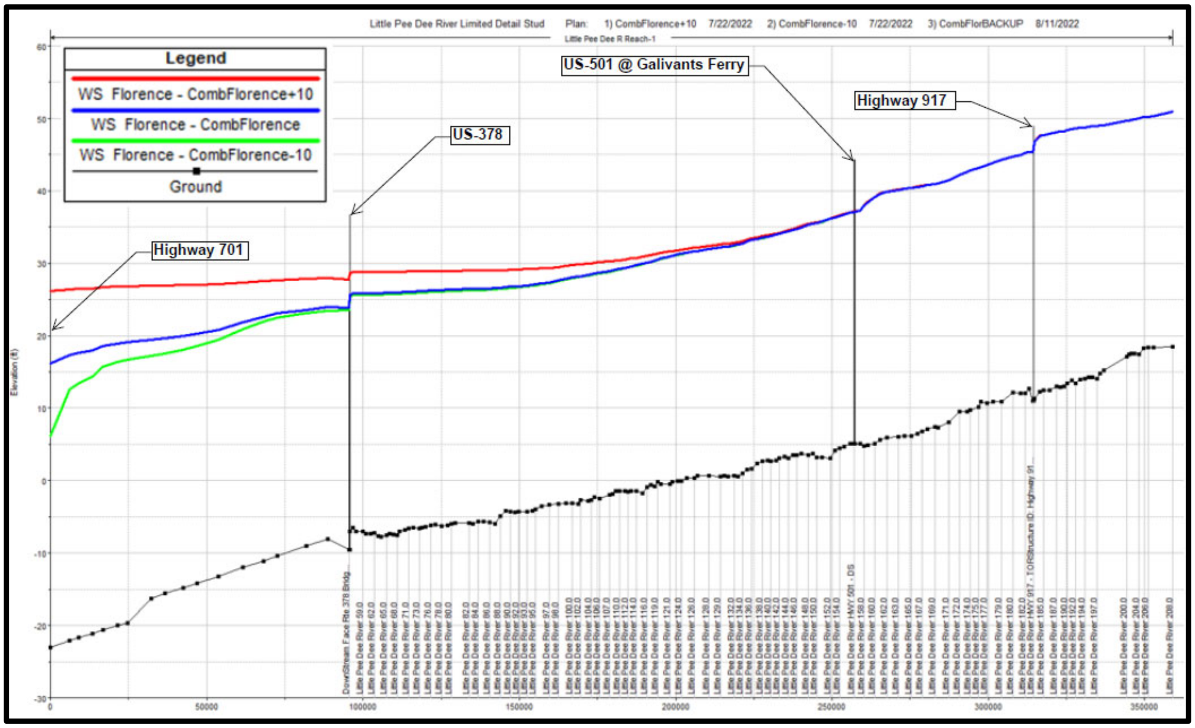


Figure 14: *Water surface profiles from downstream sensitivity analysis*

2. Project Goals and Objectives

The objective of the existing conditions analysis was to conduct a thorough review of all available data in order to create hydraulic and hydrologic models that replicate historic flooding throughout flood prone areas within the County. The existing conditions models and research coincide with reported flooding in Nichols, Mullins, Marion and Sellers. Apparent causes of flooding that were identified are:

- Inadequate maintenance of existing drainage features
  - Debris accumulation
  - Sediment build-up
  - Overgrown vegetation
- Undersized stormwater conveyance
- Collapsed/deteriorated stormwater conveyance
- Inadequate floodplain storage

Potential flood reduction and/or elimination projects were developed to address these apparent causes. A thorough analysis of all available hydraulic and hydrologic models, along with discussions with local authorities, highlighted potential problem areas within Marion, Nichols, Sellers and Mullins.

The objective of the alternative analysis was to perform extensive analysis on various alternatives, identifying viable projects that meet the criteria of eliminating flooding, improving level of service, or improving existing conditions through infrastructure improvement, stormwater management, natural condition restoration or buyouts. These potential projects were vetted for viability and impacts.

The objective of the project recommendations was to prioritize the projects to determine which alternatives are best recommended for implementation. This was done by developing a ranking system that considered both the project's BCA as well as impacts to LMI communities.

The overall project goal was to create a stormwater masterplan for Marion County. The final plan must identify flooding issues throughout the County, conduct an assessment of the existing stormwater system, develop, assess, and prioritize projects and establish an implementation strategy for projects to mitigate against future flooding. This was accomplished by studying the existing conditions, identifying and analyzing potential projects, and developing a ranking system that prioritizes the projects presented.

3. Summary of Coordination with Stakeholders

3.1 County Workshops

The Michael Baker team conducted three workshops with county and municipal officials to identify known areas of flooding or stormwater concerns. The input of the County and municipalities was critical in identifying repetitive damage areas and public safety hazards experienced due to flooding. Available records of flooding duration and high water marks were also discussed at the workshops. This gave our modeling team crucial information needed to calibrate hydraulic models. Other information such as available construction plans or as-builts of stormwater systems were also identified at the workshop.

A summary of the workshops is provided below.

On March 29, 2022, the project team met with Mayor Lawson Battle, Town Manager Sandee Rogers, and Nicole McDowell in the Town of Nichols. The Town was able to provide valuable information on previous studies done in the area, past flood events, and specific areas of concern. Sandee Rogers provided several pictures that document past flood events.

In March of 2019, the Town secured $185,000 Hazard Mitigation Grant Program Funding from FEMA and contracted with Woolpert to evaluate the flooding problems and mitigation opportunities by collecting data, providing modeling and analysis, and incorporating Town input. The Town was awarded $1.3 million in funding to implement some of the recommended projects from the Woolpert report, but the funding was never received. The Town provided a hard copy of the Woolpert report. The project team was able to reach out to Woolpert and obtain the associated hydraulic model for use in this study.

The Town also provided a copy of "Nichols Community Planning Project Next Steps 2019". This report was prepared by a Masters Degree level class (CRP 800 Direct Studies) in the fall of 2019 at Clemson University and is dated December 10, 2019.

Mayor Battle made the project team aware that also in 2019, The SC Floodwater Commission (SCFC) hosted a Nichols cleanup day to clean out the Town's ditches and improve the Town's drainage system. Mayor Battle and Ms. Rogers indicated that while the Town's ditches have been maintained, they continue to experience flooding due to poorly maintained County ditches downstream. One example given was the Awt Street outfall.

Figure 15: *Town of Nichols (upstream) end of Awt Street outfall*

Figure 16: *Marion County (downstream) end of Awt Street outfall*

In addition to meeting with the Town of Nichols on March 29, 2022, the project team was also able to meet with the City of Mullins. Mayor Robert Woodbury and Director of Public Works, Tarus Gilchrist were able to provide valuable information on previous studies done in the area, past flood events, and specific areas of concern.

Mr. Gilchrist has maintained and monitored the City's drainage system for years and was able to provide a list of problem areas for consideration in this study.

- Three Bridges Road Crossing
- East Front Street Road & Railroad Crossing
- East McIntyre Street Crossing
- West McIntyre Street Crossing
- Area bounded by Sandy Bluff Road, Melrose Avenue, Highland Drive, & Crestwood Street
- Outfalls from area bounded by North Main Street, Academy Street, East Front Street & City Limits
- Area bounded by City Limits, Westridge Drive, West Marion Street, & Seaboard Avenue

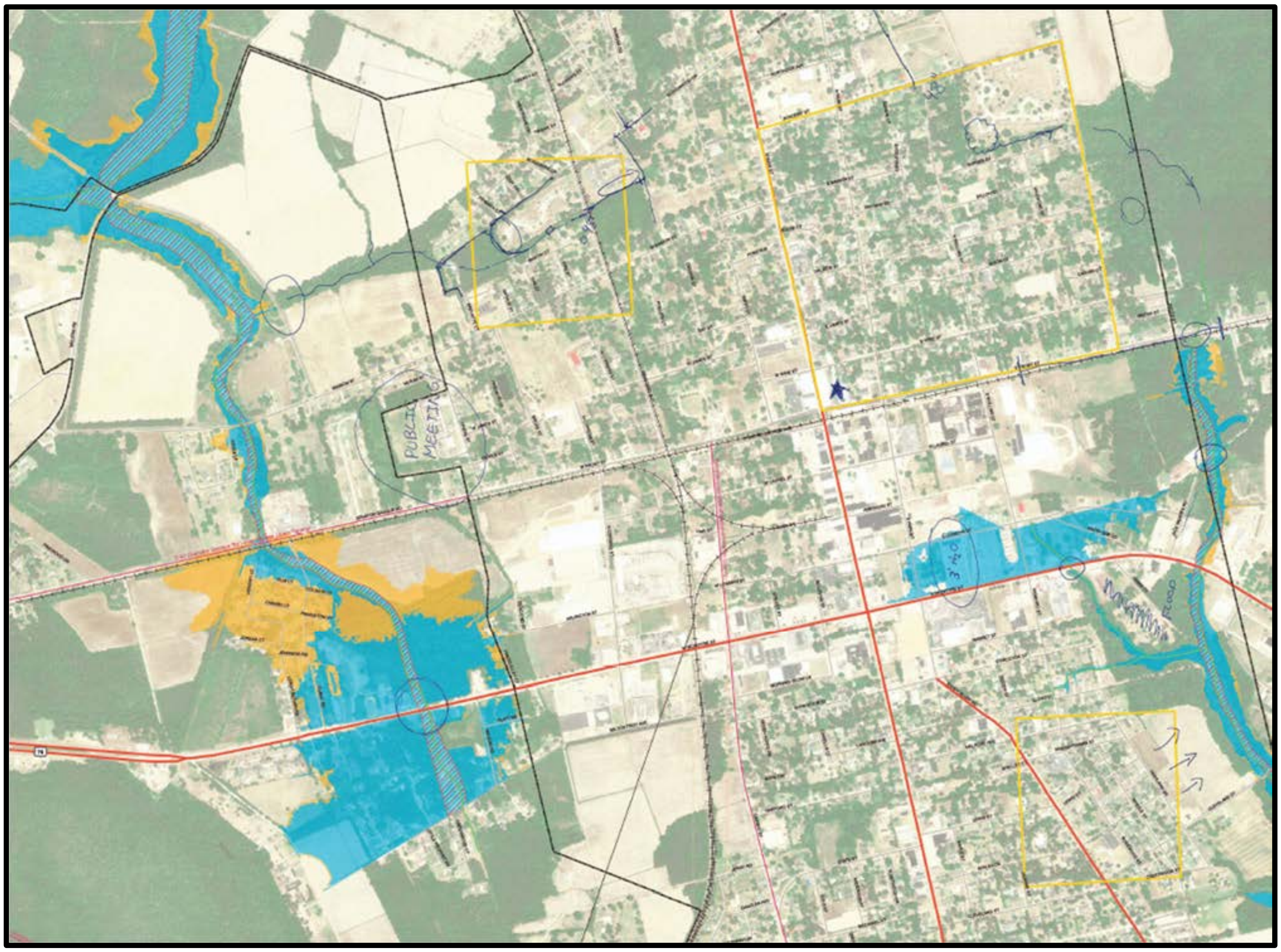


Figure 17: *Notes from meeting with City of Mullins*

Mayor Woodbury indicated that the County had received a grant to fund the West Mullins drainage project. Ditches were cleaned as part of this grant, but the work stopped at Front Street. Mayor Woodbury also notified the Team of the Northwest Square Study that was completed by Alliance Consulting Engineering, Incorporated. The City to date has been unsuccessful in locating and providing this study for consideration.

On April 5, 2022, the project team met with Marion County Administrator, Tim Harper. Mr. Harper indicated that debris build-up in the rivers, creeks and canals was contributing to the recent flooding. Catfish Creek (a manmade creek) was cleaned from US 576 to the Dillon County line before the big storms, but the big storms brought new debris back down. The County has previously received some SCDNR funds to do some cleanup but it is not enough. Marion County also contracts out beaver dam removal every winter in an attempt to stay ahead of water damming.

Mr. Harper also indicated that US 76 overtops near the Sheriff's Department and Detention Center in Marion and could be a potential area of interest in this study.

On June 1, 2022 the project team met with Mayor Frank Jones of the Town of Sellers. Notes from that meeting can be found in Figure 18 below.

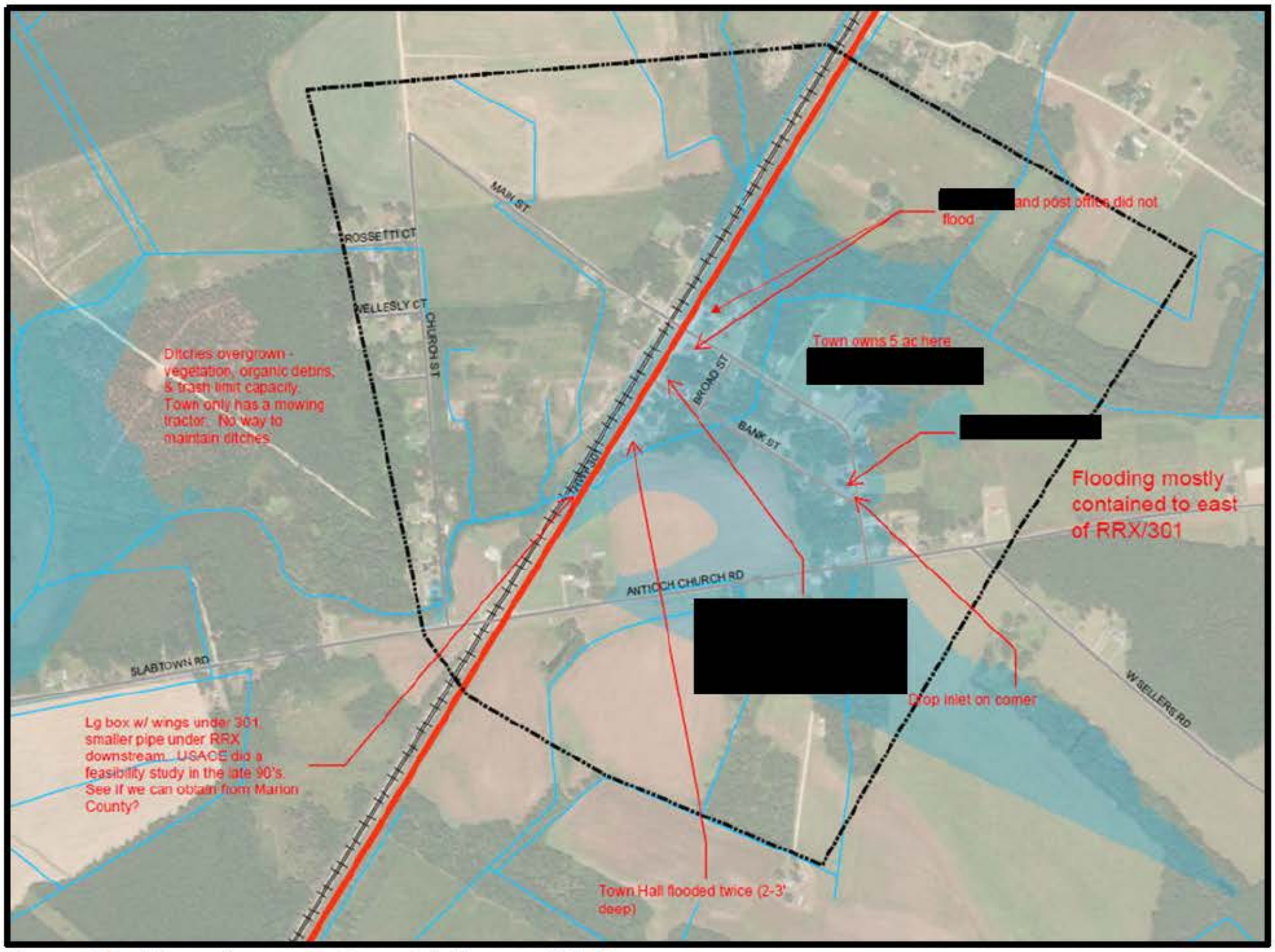


Figure 18: *Notes from meeting with Town of Sellers*

3.2. Perpetual Maintenance

During these workshops, a recurring complaint from the various municipalities was the lack of regular maintenance on the existing drainage features. Field reconnaissance within the watersheds verified that lack of proper maintenance is a substantial cause for a lot of the local flooding. While outside of the scope of this project, we felt it worth noting that finding a funding source for perpetual maintenance could go a long way towards flood reduction in these communities, especially for the smaller, more frequent, storm events.

3.2.1. Sellers

Most of the existing drainage conveyance systems within the Town of Sellers are overgrown or clogged with organic and inorganic debris. The late Mayor Frank Jones indicated that regular maintenance is a challenge due to a lack of manpower and equipment in the small community. With only one mowing tractor and only the mayor himself doing most of the mowing, many of the Town's ditches and pipes are overgrown and clogged, preventing proper conveyance of even the smallest storm events.

3.2.2. Marion

Marion County Administrator, Tim Harper, stated that debris build up within Catfish Creek is a perpetual source of flooding. Debris is brought down from development and flooding upstream as well as from beavers who consistently attempt to dam up the creek. Mr. Harper indicated that yearly maintenance is performed to relocate the beavers, however the organic build up from the continuous large storm events is still contributing to the frequent flooding.

3.3. Public Meetings & Website

Public meetings were held in the City of Marion, the City of Mullins, and the Town of Nichols on September 26th, September 28th, and October 13th, respectively. The meeting in Nichols was originally scheduled for September 29th, but was rescheduled due to Hurricane Ian.

Notice of these public meetings was provided via a social media flyer, posted by local municipalities' accounts, and physical mailers. See Figure 19 below for the social media flyer/mailer. Physical mailers were sent to approximately 1,800 addresses throughout Marion County. The locations that these mailers were sent to were determined by running a query in GIS for properties in relative proximity to the proposed projects.

Figure 19: *Public Notice Social Media Flyer/Mailer*

During the initial stakeholder meetings, it was determined that public outreach meetings would be more productive once a list of potential projects had been developed. With already having a list of prospective projects identified, there was more information available for the public to comment on and digest, and this was seen as a significant benefit. Approximately 15-20 individuals were in attendance at the Marion and Mullins meeting and approximately 5-10 individuals were in attendance at Nichols.

To further engage the public, a website was built that generally detailed this Stormwater Master Plan project's scope/intent and included the write-ups of the potential projects that were developed within the previously submitted Alternative Analysis Report as well as pertinent graphics, maps, and photographs. The website's domain name is marioncountystormwater.com.

A total of eight (8) feedback forms were provided; six (6) during the meetings and two (2) via website response/input. The forms received can be seen in Appendix G. This feedback was filtered/assessed, and two (2) additional potential projects were identified and further analyzed.

4. Design Criteria and Level of Service Definitions

Michael Baker developed design criteria targets to determine level of service performance by each of the analyzed systems. The level of service was defined by local design standards, SCDOT design criteria, SCOR or County input, and/or other published engineering guidelines/standards.

4.1. SCDOT

The following is a list of design criteria from SCDOT Requirements for Hydraulic Design Studies (2009) Section 1.1.

4.1.1 Design Frequencies.

The design discharge for establishing bridge location and bridge geometry for secondary roads is the 25-year discharge. For primary and interstate routes, the design discharge is the 50-year discharge. All stream crossings are to be analyzed for the 100-year flood to ensure that one (1) foot or less of backwater is caused by the proposed bridge when compared to unrestricted or natural conditions.

4.1.2 Floodway - Floodplain Requirements.

All floodplain crossings must meet the Federal Emergency Management Agency (FEMA) regulation requirements. FEMA should be contacted to determine if a Conditional Letter of Map Revision (CLOMR) or Letter of Map Revision (LOMR) has been issued for the subject stream.

4.1.3 Freeboard for Road Subgrades.

To protect the pavement, it is recommended that road subgrades be 1.0 foot above the design high-water level.

4.1.4 Cross-Line Pipes.

The design discharge for all cross-line pipes for primary roads (SC or US designation) and interstate routes is the 50-year peak discharge. For secondary roads, the design discharge for cross-line pipes is the 25-year peak discharge. The designer should analyze the 100-year or overtopping flood, whichever is less. This analysis does not change the design criteria.

4.1.5 Storm Drains and Roadside Ditches.

The design storm for storm drain systems and roadside ditches is the 10-year storm for drainage areas from 0 to 40 acres, the 25-year storm for drainage areas from 40 to 500 acres, and the 50-year storm for drainage areas greater than 500 acres.

4.2. City of Marion Zoning Ordinance

The following is a summary of standards and specifications for flood hazard areas from the City of Marion Ordinance.

SECTION 903. DEVELOPMENT STANDARDS AND SPECIFICATIONS FOR FLOOD HAZARD AREAS

In all designated flood hazard areas in the City of Marion, the following standards shall apply:

(1) *Residential construction.*

New construction or substantial improvement of any residential structure (including mobile homes) shall have the lowest floor, including basement, elevated to or above base flood elevation.

(2) *Non-residential construction.*

New construction or substantial improvement of any commercial, industrial or other nonresidential structure (including mobile homes) shall have the lowest floor, including basement, elevated to the level of the base flood elevation or, together with attendant utility and sanitary facilities, be flood-proofed so that below the base flood level the structure is water tight with walls substantially impermeable to the passage of water and with structural components having the capability of resisting hydrostatic and hydrodynamic loads and effects of buoyancy. A registered professional engineer or architect shall certify that the standards of this subsection are satisfied. Such certification shall be provided to the Building Official in accord with Section 1001.3(4)(c).

(3) *Elevated Buildings.*

New construction or substantial improvements of elevated buildings that include fully enclosed areas formed by foundation and other exterior walls below the base flood elevation shall be designed to preclude finished living space and designed to allow for the entry and exit of flood waters to automatically equalize hydrostatic flood forces.

(4) *Floodways.*

Located within flood hazard areas are areas designated as floodways. Since the floodway is an extremely hazardous area due to the velocity of flood waters which carry debris, potential projectiles and has erosion potential, the following provisions shall apply:

(a) Prohibit encroachments, including fill, new construction, substantial improvements and other developments unless certification (with supporting technical data) by a registered professional engineer is provided demonstrating that encroachments shall not result in any increase in flood levels during occurrence of the base flood discharge.

(b) All new construction and substantial improvements shall comply with all applicable flood hazard reduction provisions contained in this Ordinance.

(c) Prohibit the placement of mobile homes, except in an existing mobile home park or subdivision. A replacement mobile home may be placed on a lot in an existing mobile home park or subdivision provided that anchoring standards and elevation standards are met.

4.3 Code of Ordinance of the City of Mullins

Sec. 15.32.370. - Specific standards.

The following is a summary of specific standards for flood hazard areas from the City of Mullins Ordinance.

In all areas of special flood hazard (Zones A, AE, AH, AO, AI-30, V, and VE) where base flood elevation data has been provided, as set forth in section 15.32.030 or outlined in the duties and responsibilities of the local floodplain administrator section 15.32.350, the following provisions are required:

(1) *Residential construction.*

New construction and substantial improvement of any residential structure (including manufactured homes) shall have the lowest floor elevated no lower than two feet above the base flood elevation. No basements are permitted. Should solid foundation perimeter walls be used to elevate a structure, flood openings sufficient to automatically equalize hydrostatic flood forces, shall be provided in accordance with the elevated buildings requirements in subsection (4) of this section.

(2) *Non-residential construction.*

a. New construction and substantial improvement of any commercial, industrial, or non-residential structure (including manufactured homes) shall have the lowest floor elevated no lower than two feet, above the level of the base flood elevation. Should solid foundation perimeter walls be used to elevate a structure, flood openings sufficient to automatically equalize hydrostatic flood forces, shall be provided in accordance with the elevated buildings requirements in subsection (4) of this section. No basements are permitted. Structures located in A-Zones may be floodproofed in lieu of elevation provided that all areas of the structure below the required elevation are watertight with walls substantially impermeable to the passage of water, using structural components having the capability of resisting hydrostatic and hydrodynamic loads and the effect of buoyancy.

b. A registered, professional engineer or architect shall certify that the standards of this subsection are satisfied. Such certifications shall be provided to the official as set forth in the floodproofing certification requirements. A variance may be considered for wet-floodproofing agricultural structures in accordance with the criteria outlined in section 15.32.030. Agricultural structures not meeting the criteria of section 15.32.030 must meet the non-residential construction standards and all other applicable provisions of this ordinance. Structures that are floodproofed are required to have an approved maintenance plan with an annual exercise. The local floodplain administrator must approve the maintenance plan and notification of the annual exercise shall be provided to it.

(3) *Manufactured homes.*

a. Manufactured homes that are placed or substantially improved on sites outside a manufactured home park or subdivision, in a new manufactured home park or sub-division, in an expansion to an existing manufactured home park or subdivision, or in an existing manufactured home park or subdivision on which a manufactured home has incurred substantial damage as the result of a flood must be elevated on a permanent foundation such that the lowest floor of the manufactured home is elevated no lower than two feet above the base flood elevation and be securely anchored to an adequately anchored foundation system to resist flotation, collapse, and lateral movement.

b. Manufactured homes that are to be placed or substantially improved on sites in an existing manufactured home park or subdivision that are not subject to the provisions for residential construction in subsection (1) of this section must be elevated so that the lowest floor of the manufactured home is elevated no lower two feet than above the base flood elevation and be securely anchored to an adequately anchored foundation to resist flotation, collapse, and lateral movement.

c. Manufactured homes shall be anchored to prevent flotation, collapse, and lateral movement. For the purpose of this requirement, manufactured homes must be anchored to resist flotation, collapse, and lateral movement in accordance with section 40-29-10 of the South Carolina Manufactured Housing Board Regulations, as amended. Additionally, when the elevation requirement would be met by an elevation of the chassis 36 inches or less above the grade at the site, the chassis shall be supported by reinforced piers or engineered foundation. When the elevation of the chassis is above 36 inches in height an engineering certification is required.

d. An evacuation plan must be developed for evacuation of all residents of all new, substantially improved or substantially damaged manufactured home parks or subdivisions located within flood prone areas. This plan shall be filed with and approved by the local floodplain administrator and the local emergency preparedness coordinator.

(4) *Elevated buildings.*

New construction and substantial improvements of elevated buildings that include fully enclosed areas below the lowest floor that are usable solely for the parking of vehicles, building access, or limited storage in an area other than a basement, and which are subject to flooding shall be designed to preclude finished space and be designed to automatically equalize hydrostatic flood forces on exterior walls by allowing for the entry and exit of floodwaters.

(5) *Floodways.*

Located within areas of special flood hazard established in section 15.32.030 are areas designated as floodways. The floodway is an extremely hazardous area due to the velocity of floodwaters that carry debris and potential projectiles and has erosion potential. The following provisions shall apply within such areas:

a. No encroachments, including fill, new construction, substantial improvements, additions, and other developments shall be permitted, unless:

1. It has been demonstrated through hydrologic and hydraulic analyses performed in accordance with standard engineering practice that the proposed encroachment would not result in any increase in the flood levels during the occurrence of the base flood. Such certification and technical data shall be presented to the local floodplain administrator.

2. A conditional letter of map revision (CLOMR) has been approved by FEMA. A letter of map revision must be obtained upon completion of the proposed development.

b. If this section is satisfied, all new construction and substantial improvements shall comply with all applicable flood hazard reduction provisions of article III of this chapter.

c. No manufactured homes shall be permitted, except in an existing manufactured home park or subdivision. A replacement manufactured home may be placed on a lot in an existing manufactured home park or subdivision provided the anchoring and the elevation standards of section 15.32.370(3) and the encroachment standards of subsection (5)a of this section are met.

d. Permissible uses within floodways may include general farming, pasture, outdoor plant nurseries, horticulture, forestry, wildlife sanctuary, game farm, and other similar agricultural, wildlife, and related uses. Also, lawns, gardens, play areas, picnic grounds, and hiking and horseback riding trails are acceptable uses, provided that they do not employ structures or fill. Substantial development of a permissible use may require a no-impact certification. The uses listed in this subsection are permissible only if and to the extent that they do not cause any increase in base flood elevations or changes to the floodway configuration.

4.4. Summary

For designated FEMA flood hazard areas, the base flood elevation is the 100-year or 1% chance recurrence interval storm. City ordinances in Marion and Mullins address building restrictions in FEMA regulated floodplains and floodways. For SCDOT structures, all floodplain crossings must meet FEMA regulation requirements and all stream crossings are to be analyzed for the 100-year flood to ensure that one (1) foot or less of backwater is caused by the proposed structure when compared to unrestricted or natural conditions. Due to these requirements, it is recommended that all Major systems (streams and rivers modeled in HEC-RAS and FEMA regulated floodplains and floodways) have a design level of service of 100-year or 1% chance recurrence interval.

For crossline pipes that are not on FEMA regulated streams or streams defined as Major above, The design discharge for all crossline pipes for primary roads (SC or US designation) and interstate routes is recommended to be the 50-year peak discharge. For secondary roads, the design discharge for crossline pipes is the 25-year peak discharge.

For the Localized systems (stormdrain systems and open channels modeled in XPSWMM that are not in FEMA flood hazard areas) it is recommended that the general design storm be the 10-year storm for drainage areas from 0 to 40 acres, the 25-year storm for drainage areas from 40 to 500 acres, and the 50-year storm for drainage areas greater than 500 acres. This is consistent with SCDOT criteria. The proposed level of service for stormdrains and open channels can be adjusted if necessary to account for specific system, benefit-cost ratio, or other unique factors.

5. Comprehensive List of All Projects Considered

During the alternatives analysis phase of this project, a list of 17 potential projects was developed. Two (2) additional projects were added as a result of public outreach, and project Q was expanded to detail three (3) properties, bringing the total number of projects analyzed to 21, and the total list of projects to ID A-S. The following is the final matrix of alternatives that were analyzed as potential projects for development.

Table 15: *Potential Projects Matrix (added potential projects bolded)*

MARION COUNTY STORMWATER MASTERPLAN – POTENTIAL PROJECTS MATRIX			
Project ID	**Project Location**	**Alternative Description**	**Category**
A	Sellers	Railroad Crossing Improvements	Fully Meets Design Standards
B	Sellers	Stormwater Parks	Low Impact Design and/or Retrofit
C	Marion	US 76/Sheriff's Department/Detention Center Outfall Improvements	Fully Meets Design Standards
D	Marion	Catfish Creek Restoration	Stream/Wetland Restoration
E	Mullins	Three Bridge Road Crossing Improvements	Fully Meets Design Standards
F	Mullins	Housing Authority Flooding Alleviation	Low Impact Design and/or Retrofit
G	Mullins	East Front Street Road & Railroad Crossing Improvements	Fully Meets Design Standards
H	Mullins	East McIntyre Street Crossing Improvements	Fully Meets Design Standards
I	Mullins	West McIntyre Street Crossing Improvements	Fully Meets Design Standards
J	Mullins	Southeast Mullins Drainage Conveyance Improvements	Fully Meets Design Standards
K	Mullins	Seaboard Avenue Outfall System Improvements	Low Impact Design and/or Retrofit
L	Nichols	Awt Road Crossing Improvements	Improves Level of Service
M	Nichols	Airport Annexation	Potential Buyouts
N	Nichols	Golf Course Annexation	Potential Buyouts
O	Nichols	Downtown/Main Street Runoff Reduction	Low Impact Design and/or Retrofit
P	Nichols	Nichols Evacuation Route	Improves Level of Service
Q	Marion County	Great Pee Dee River Flooding	Potential Buyouts
R	**Marion**	**Phil Court Berm Removal on Lower Catfish Creek**	**Stream/Wetland Restoration**
S	**Nichols**	**Canal Street SC Highway 9 Crossing Improvements**	**Fully Meets Design Standards**

The two (2) additional projects that were considered based on public feedback are the Phil Court Berm Removal on Lower Catfish Creek and the Canal Street SC Highway 9 Crossing Improvements in Nichols. Project details of the analysis of each of the projects have been provided within Appendix E.

Also, throughout the course of this project development effort, slight adjustments/clarifications were made to the scope of projects C, D, P, and Q. The revised project write-ups are included in Appendix E of this final report.

6. Alternative Selection Criteria and Project Prioritization Matrix

Analysis of the existing conditions revealed numerous projects for consideration. Hydraulic models outlined the limits of flooding. Within mapping, pinch points could be identified that are causing water to back up in existing systems. Sensitivity analyses were performed to determine what changes increased flooding and what changes reduced flooding.

Further, the input supplied by local officials and the public coupled with the design criteria and modeling described above resulted in the selection of the identified alternatives.

The next step in the stormwater planning process is to utilize a ranking system to prioritize the list of potential projects. The prioritization is based on scoring projects on a 100-point scale with a higher point total indicating a more feasible/higher priority project.

The basis for this scoring system is provided in the South Carolina Office of Resilience's Disaster Recovery Division Mitigation Program Policy and Procedure Manual, dated 9/9/2022. Table 16 below depicts the scoring criteria described therein and outlines the maximum points possible for each prioritization category.

Table 16: *Prioritization Categories and Points*

Prioritization Category	Sub-Category	Maximum Points
LMI % Served	*LMI % X 20 points*	20
Level of Flood Risk Reduction	Minimal increase	10
Quantity of Flood Risk Reduction	10-25 Structures	10
Benefit-Cost Ratio	75-100%	20
Leveraged Funding	No potential cost share identified	10
Permitting/Scheduling	Significant challenges	10
Mobility Improvement	Significant mobility improvements	5
Phasing Considerations	Limited Contribution	5
Project Synergies	Limited cost savings	5
Environmental Impact	Neutral Impact	5
		100

The two (2) largest portions of this prioritization scoring process, both valued at a maximum of 20 points, are Low-to-Moderate Income (LMI) Percent Served (essentially prioritizing positive impacts within low-to-moderate income groups) and Benefit-Cost Ratio (determined via a Benefit-Cost Analysis). These two (2) scoring criteria will be discussed in separate sections below.

The remaining eight (8) scoring criteria valuations are determined by essentially choosing between three (3) or four (4) standard options that result in linear scoring between zero (0) and the maximum score of that criteria (either five (5) or ten (10) points). For example, within the Permitting/Scheduling category, scorers can choose between "Significant Challenges", "Potential Challenges", and "Little to No Challenges" options resulting in zero (0), five (5), or ten (10) points, respectively.

7. Recommended Project List

The proposed potential projects were scored via the project prioritization criteria presented in the matrix above and ranked based on this scoring. Table 17 below depicts the projects ranked by their resultant prioritization score.

Table 17: *Project Prioritization List*

MARION COUNTY STORMWATER MASTER PLAN - PROJECT PRIORITIZATION					
Project ID	Prioritization Score	BCR (B/C) @ 7%	BCR (B/C) @ 3%	Project Location	Alternative Description
A	72.2	1.47	2.68	Sellers	Railroad Crossing Improvement
Q1	70.4	12.74	-	Marion County	Great Pee Dee River Flooding - [redacted] Bear Pond Rd, Gresham SC 29546
Q2	70.4	5.56	-	Marion County	Great Pee Dee River Flooding - [redacted] Bear Pond Rd, Gresham SC 29546
Q3	70.4	25.84	-	Marion County	Great Pee Dee River Flooding - [redacted] Goose Pond Rd, Gresham SC 29546
H	69.4	1.27	2.33	Mullins	East McIntyre Street Crossing Improvements
N	68.2	1.23	2.72	Nichols	Golf Course Annexation
M	66.2	1.23	2.72	Nichols	Airport Annexation
P	64.2	1.23	2.27	Nichols	Nichols Evacuation Route
E	62	1.21	2.19	Mullins	Three Bridge Road Outfall Improvments
D	60.2	7.65	14.71	Marion	Catfish Creek Restoration
K	58	0.67	1.48	Mullins	Seaboard Avenue Outfall System Improvements
I	57.2	1.17	2.15	Mullins	West McIntyre Street Crossing Improvements
F	55.2	0.36	0.80	Mullins	Housing Authority Flooding Alleviation
O	54.2	1.34	2.45	Nichols	Downtown/North Main Street Runoff Reduction
B	50.2	1.18	2.59	Sellers	Stormwater Parks
L	50.2	1.08	1.95	Nichols	Awt Road Crossing Improvements
J	45.4	1.21	2.25	Mullins	Southeast Mullins Drainage Conveyance Improvements
R	45	1.01	2.23	Marion	Phil Court Berm Removal on Lower Catfish Creek
C	44.8	0.91	1.68	Marion	US 76/Sheriff's Department/Detention Center Outfall Improvements
S	41.2	0.44	0.82	Nichols	Canal Street SC Highway 9 Crossing Improvements
G	34.4	0.31	0.57	Mullins	East Front Street Road & Railroad Crossing Improvements

The scores range from 72.2 to 34.4 with the potential project A – Railroad Crossing Improvements in Sellers topping the list. Three (3) projects (F, S, & G), highlighted in peach, are deemed completely infeasible with a BCR below one (1), even when using a discount rate of 3%. The three (3) identified properties within Project Q - Great Pee Dee River Flooding in greater Marion County, are the most straight forward potential projects as those parcels in Gresham are great candidates for buy-outs.

Potential project H – East McIntyre Street Crossing Improvements in Mullins would address an issue that was brought up by community officials, as well as local residents, to greatly reduce the potential for upstream flooding and repetitious damage.

Projects N, M, and P are all located in the Town of Nichols. If either project N or M location is annexed and developed residentially, there would be viable opportunities for residents whose home is currently located within the 100-year floodplain to pursue a buy-out, and then relocate within this expanded municipal boundary of Nichols. These projects could result in significant growth for the Town and, depending on the site chosen, would be scalable for increased tax base and have the potential to attract new residents to the Town. Project P, coupled with either of these annex options or standing alone, would supply the residents within the project survice area with a way out during a 100-year flooding event while also allowing local/state/national rescue personel a more direct route to supply aid.

Some of the projects were favorable candidates for American Rescue Plan Act (ARPA) funding. Administered through the SC Office of Resilience, $55 million was made available to counties, cities, and towns to carry out stormwater infrastructure projects. In order to assist the local governments with their applications, available data from the following projects was submitted to their respective municipalities for inclusion on ARPA applications should they choose to pursue that.

- US 76/Sheriff's Department/Detention Center Outfall Improvements (Marion)
- Three Bridges Road Outfall Improvements (Mullins)
- East McIntyre Street Crossing Improvements (Mullins)
- West McIntyre Street Crossing Improvements (Mullins)
- Awt Road Crossing Improvements (Nichols)

8. Anticipated Permitting Requirements for Each Project

A summary of anticipated permitting requirements for each of the potential projects are listed in Table 18 below.

Table 18: *Anticipated permitting requirements per potential project*

Project ID	Project Location	Alternative Description	Anticipated Permitting Requirements
A	Sellers	Railroad Crossing Improvement	Railroad, SCDOT Encroachment, FEMA LOMR
B	Sellers	Stormwater Parks	SCDHEC Land Disturbance, USACE
C	Marion	US 76/Sheriff's Department/Detention Center Outfall Improvements	SCDOT Encroachment
D	Marion	Catfish Creek Restoration	SCDHEC Land Disturbance, USACE, FEMA LOMR
E	Mullins	Three Bridge Road Outfall Improvments	SCDOT Encroachment
F	Mullins	Housing Authority Flooding Alleviation	SCDHEC Land Disturbance
G	Mullins	East Front Street Road & Railroad Crossing Improvements	Railroad, SCDOT Encroachment, SCDHEC Land Disturbance
H	Mullins	East McIntyre Street Crossing Improvements	SCDOT Encroachment
I	Mullins	West McIntyre Street Crossing Improvements	SCDOT Encroachment
J	Mullins	Southeast Mullins Drainage Conveyance Improvements	SCDOT Encroachment, SCDHEC Land Disturbance
K	Mullins	Seaboard Avenue Outfall System Improvements	SCDHEC Land Disturbance
L	Nichols	Awt Road Crossing Improvements	N/A
M	Nichols	Airport Annexation	Legal Review likely required
N	Nichols	Golf Course Annexation	Legal Review likely required
O	Nichols	Downtown/North Main Street Runoff Reduction	SCDOT Encroachment
P	Nichols	Nichols Evacuation Route	SCDOT Encroachment, SCDHEC Land Disturbance
Q1	Marion County	Great Pee Dee River Flooding - [redacted] Bear Pond Rd, Gresham SC 29546	N/A
Q2	Marion County	Great Pee Dee River Flooding - [redacted] Bear Pond Rd, Gresham SC 29546	N/A
Q3	Marion County	Great Pee Dee River Flooding - [redacted] Goose Pond Rd, Gresham SC 29546	N/A
R	Marion	Phil Court Berm Removal on Lower Catfish Creek	SCDHEC Land Disturbance, USACE
S	Nichols	Canal Street SC Highway 9 Crossing Improvements	SCDOT Encroachement, USACE

9. Project BCA/BCR's and Estimated Costs

The Benefit-Cost Analysis (BCA) for each project was performed using FEMA-approved methodologies and tools such as the BCA Toolkit. The BCA Toolkit uses the Office of Management and Budget cost-effectiveness guidelines.

In order to assign damage costs to some of the projects that may not impact structures, but are road flooding hazards, we also consulted the U.S. Department of Transportation publication Benefit Cost Analysis Guidance for Discretionary Grant Programs, March 2022 (Revised). Figure 20, below, comes from this publication and gives recommended monetized values associated with crashes, injury crashes, fatalities, etc.

Recommended Monetized Value(s)

KABCO Level	Monetized Value (2020 $)
O – No Injury	$3,900
C – Possible Injury	$77,200
B – Non-incapacitating	$151,100
A – Incapacitating	$554,800
K – Killed	$11,600,000
U – Injured (Severity Unknown)	$210,300
# Accidents Reported (Unknown if Injured)	$159,800

Crash Type	Monetized Value (2020 $)
Injury Crash[1]	$302,600
Fatal Crash[1]	$12,837,400

1) Monetization values for injury crashes and fatal crashes are based on an estimate of approximately 1.44 injuries per injury crash and 1.09 fatalities per fatal crash, based on an average of the most recent five years of data in NHTSA's National Crash Statistics. The fatal crash value is further adjusted for the average number of injuries per fatal crash.

References and Notes

Treatment of the Economic Value of Preventing Fatalities and Injuries in Preparing Economic Analyses (2021)
https://www.transportation.gov/office-policy/transportation-policy/revised-departmental-guidance-on-valuation-of-a-statistical-life-in-economic-analysis

Note: The KABCO level values shown result from multiplying the KABCO-level accident's associated MAIS-level probabilities by the recommended unit Value of Injuries for each MAIS level, and then summing the products. Accident data may not be presented on an annual basis when it is provided to applicants (i.e. an available report requested in Fall 2011 may record total accidents from 2005-2010). For the purposes of the BCA, is important to annualize data when possible. For MAIS-based unit values, please see the VSL guidance linked above.

Figure 20: *Image of Table A-1: Value of Reduced Fatalities and Injuries from USDOT's Benefit-Cost Analysis Guidance for Discretionary Grant Programs*

Several sources were referenced for documented road flooding in an effort to substantiate/confirm assumptions, calculations, and hydrologic/hydraulic models:

- news articles
- first-hand information from municipalities, and residents
- SCDOT road closures from the 2016 or 2018 hurricanes

SCDOT pay items coupled with a database of costs from previously constructed projects (with approximately 15-years of data), cost data acquired from material suppliers, and past engineering experiences were used to determine a conservative and preliminary potential cost for the construction projects associated with the potential projects list. Further, a 25-35% contingency as well as estimated soft-costs (survey, design, permitting, etc.) were implemented within these estimates.
Some of the projects proposed did not fit easily into the guidelines above and creative engineering judgement was necessary to perform the BCA. The challenges faced included:

- Buyout and/or relocation projects
    - Additional guidance was provided, FEMA Memorandum - Cost Effectiveness Determinations for Acquisitions and Elevations in Special Flood Hazard Areas Using Pre-calculated Benefits. However, within the FEMA BCA Toolkit V6.0.0 the benefit value for a buyout conflicted with this memo by supplying the standard benefit as $323,000. This value was used for relevant projects.
- How to monetize the impact of being stranded without access to emergency services as is the premise for the Nichols Evacuation Route project.

- Assumptions were made regarding incapacitating injury or fatalities in these cases.

These BCA's result in a Benefit-Cost Ratio (Benefit over Cost) and a BCR greater than 1.0 essentially designates if a potential project is viable. The FEMA BCA Toolkit V6.0.0 spreadsheet utilizes the concept of "Net Present Value" by which it employs a discount rate to effectively show that benefits are worth more if they are experienced sooner and therefore future benefits decline per year. The BCR's, using both a 7% and 3% discount rate, for each of the potential projects can be found in Table 17.

10. LMI Community Impact Results and Qualitative / Quantitative Impact Statements

As mentioned previously the LMI % Served scoring category is essentially prioritizing positive impacts within low-to-moderate income groups for each of the potential projects. This is done by multiplying the LMI percentage of the block group, within census tracts, that the subject potential projects service area is located in by 20-points. For example, if the project is in a block group that is 51% LMI then the resultant score would represent 10.2 points.

It should be noted that the data used for this determination was developed by the U.S. Department of Housing and Urban Development (HUD) utilizing information from 2011 to 2015 and is the most current data available at this time. There is potential that as projects progress through the vetting/grant program the current LMI % data will need to be gathered and utilized at that time. This may require utilizing tax records or conducting actual in-the field/door-to-door surveys.

Figure 21 below depicts the potential projects overlayed on 50% LMI break-point imagery.

Table 19 below depicts the approximate LMI percentage present within the project service area associated with each of the projects. The proposed projects would all positively impact the quality of life of the low-to-moderate income communities within each project service area.

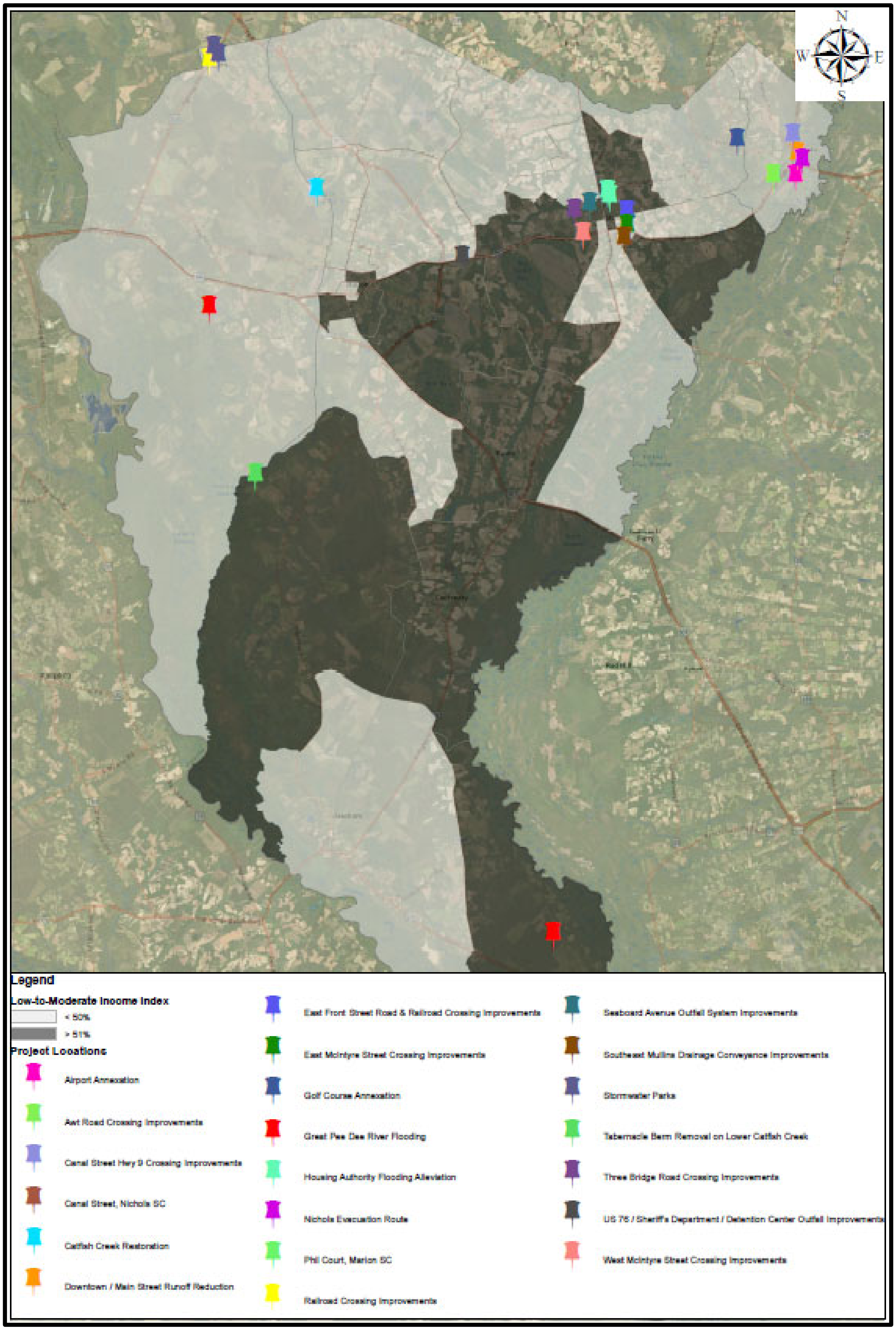


Figure 21: *Depiction of Low to Moderate Income Assessment*

Table 19: *LMI % per project service area*

Project ID	Alternative Description	LMI %
A	Railroad Crossing Improvements	41
B	Stormwater Parks	41
C	US 76/Sheriff's Department/Detenction Center Improvements	54
D	Catfish Creek Restoration	41
E	Three Bridge Road Crossing Improvements	65
F	Housing Authority Flooding Alleviation	51
G	East Front Street Road & Railroad Crossing Improvements	47
H	East McIntyre Street Crossing Improvements	47
I	West McIntyre Street Crossing Improvements	51
J	Southeast Mullins Drainage Conveyance Improvements	47
K	Seaboard Avenue Outfall System Improvements	65
L	Awt Road Crossing Improvements	36
M	Airport Annexation	36
N	Golf Course Annexation	33
O	Dowtown/Main Street Runoff Reduction	36
P	Nichols Evacuation Route	36
Q	Great Pee Dee River Flooding	57
R	Tabernacle Berm Removal on Lower Catfish Creek	60
S	Canal Street Hwy 9 Crossing Improvements	36

11. List of Potentially Impacted Properties

Potentially impacted properties were identified for each of the proposed potential projects. A summary of the total number of these parcels per project is presented in Table 20 below.

Table 20: *Potentially impacted properties, per project*

Project ID	Project Location	Alternative Descripition	Number of Potentially Impacted Properties
A	Sellers	Railroad Crossing Improvement	134
B	Sellers	Stormwater Parks	134
C	Marion	US 76/Sheriff's Department/Detention Center Outfall Improvements	6
D	Marion	Catfish Creek Restoration	46
E	Mullins	Three Bridge Road Outfall Improvments	16
F	Mullins	Housing Authority Flooding Alleviation	9
G	Mullins	East Front Street Road & Railroad Crossing Improvements	87
H	Mullins	East McIntyre Street Crossing Improvements	16
I	Mullins	West McIntyre Street Crossing Improvements	99
J	Mullins	Southeast Mullins Drainage Conveyance Improvements	179
K	Mullins	Seaboard Avenue Outfall System Improvements	13
L	Nichols	Awt Road Crossing Improvements	5
M	Nichols	Airport Annexation	34
N	Nichols	Golf Course Annexation	62
O	Nichols	Downtown/North Main Street Runoff Reduction	425
P	Nichols	Nichols Evacuation Route	133
Q	Marion County	Great Pee Dee River Flooding	168
Q1	Marion County	Great Pee Dee River Flooding - [redacted] Bear Pond Rd, Gresham SC 29546	1
Q2	Marion County	Great Pee Dee River Flooding - [redacted] Bear Pond Rd, Gresham SC 29546	1
Q3	Marion County	Great Pee Dee River Flooding - [redacted] Goose Pond Rd, Gresham SC 29546	1
R	Marion	Phil Court Berm Removal on Lower Catfish Creek	2
S	Nichols	Canal Street SC Highway 9 Crossing Improvements	7

Tables containing the full attribute information associated with all potentially impacted parcels, per project, is located in Appendix H of this report.

12. List of Potential Buyout Properties

Potential buyout properties were identified throughout the development of our proposed potential Project Q for this County-wide stormwater master plan. A total of 168 properties were recognized to be potential candidates for buyout, counting the three (3) specific projects identified in Q1, Q2, and Q3. Further assessment would be necessary, on a case by case basis, to determine the suitability for buyout. Appendix I contains the full attribute information associated with these potential buyout properties.

13. Risk Assessment of Each Project

A risk assessment was conducted for each project to categorize the level of risk associated with the actual execution/completion/implementation of the potential proposed projects. The projects were placed into three (3) risk categories: low, moderate, and high. The factors that were considered during this assessment were: anticipated permitting requirements/hurdles, overall estimated project cost/scale, and potential stakeholder/public scrutiny. A low risk potential project represents minimal anticipated permitting requirements, relatively low estimated cost/small scale, and likely supportive stakeholders/low levels of potential public scrutiny. While a high risk potential project represents significant anticipated permitting requirements, relatively high estimated cost/large scale, and likely unsupportive stakeholders/high levels of potential public scrutiny. Table 21 below depicts the assessed risk level of each of the potential projects.

Table 21: *Risk level per project*

Project ID	Project Location	Alternative Descripition	Significant Permitting Requirements	High Cost or Large Scale	High Level of Public Scrutiny	Risk Level
A	Sellers	Railroad Crossing Improvement	X	X		Moderate
B	Sellers	Stormwater Parks	X	X	X	High
C	Marion	US 76/Sheriff's Department/Detention Center Outfall Improvements				Low
D	Marion	Catfish Creek Restoration	X	X	X	High
E	Mullins	Three Bridge Road Outfall Improvments				Low
F	Mullins	Housing Authority Flooding Alleviation		X		Moderate
G	Mullins	East Front Street Road & Railroad Crossing Improvements	X		X	Moderate
H	Mullins	East McIntyre Street Crossing Improvements				Low
I	Mullins	West McIntyre Street Crossing Improvements			X	Lox
J	Mullins	Southeast Mullins Drainage Conveyance Improvements		X	X	Moderate
K	Mullins	Seaboard Avenue Outfall System Improvements		X		Moderate
L	Nichols	Awt Road Crossing Improvements				Low
M	Nichols	Airport Annexation				Low
N	Nichols	Golf Course Annexation			X	Moderate
O	Nichols	Downtown/North Main Street Runoff Reduction		X	X	Moderate
P	Nichols	Nichols Evacuation Route		X		Moderate
Q1	Marion County	Great Pee Dee River Flooding - [redacted] Bear Pond Rd, Gresham SC 29546				Low
Q2	Marion County	Great Pee Dee River Flooding - [redacted] Bear Pond Rd, Gresham SC 29546				Low
Q3	Marion County	Great Pee Dee River Flooding - [redacted] Goose Pond Rd, Gresham SC 29546				Low
R	Marion	Phil Court Berm Removal on Lower Catfish Creek	X	X		Moderate
S	Nichols	Canal Street SC Highway 9 Crossing Improvements	X	X		High

14. General Exhibit of the Proposed Projects

General exhibits depicting the location for each of the potential projects listed in this report can be found in Figures 22 through 26 below.

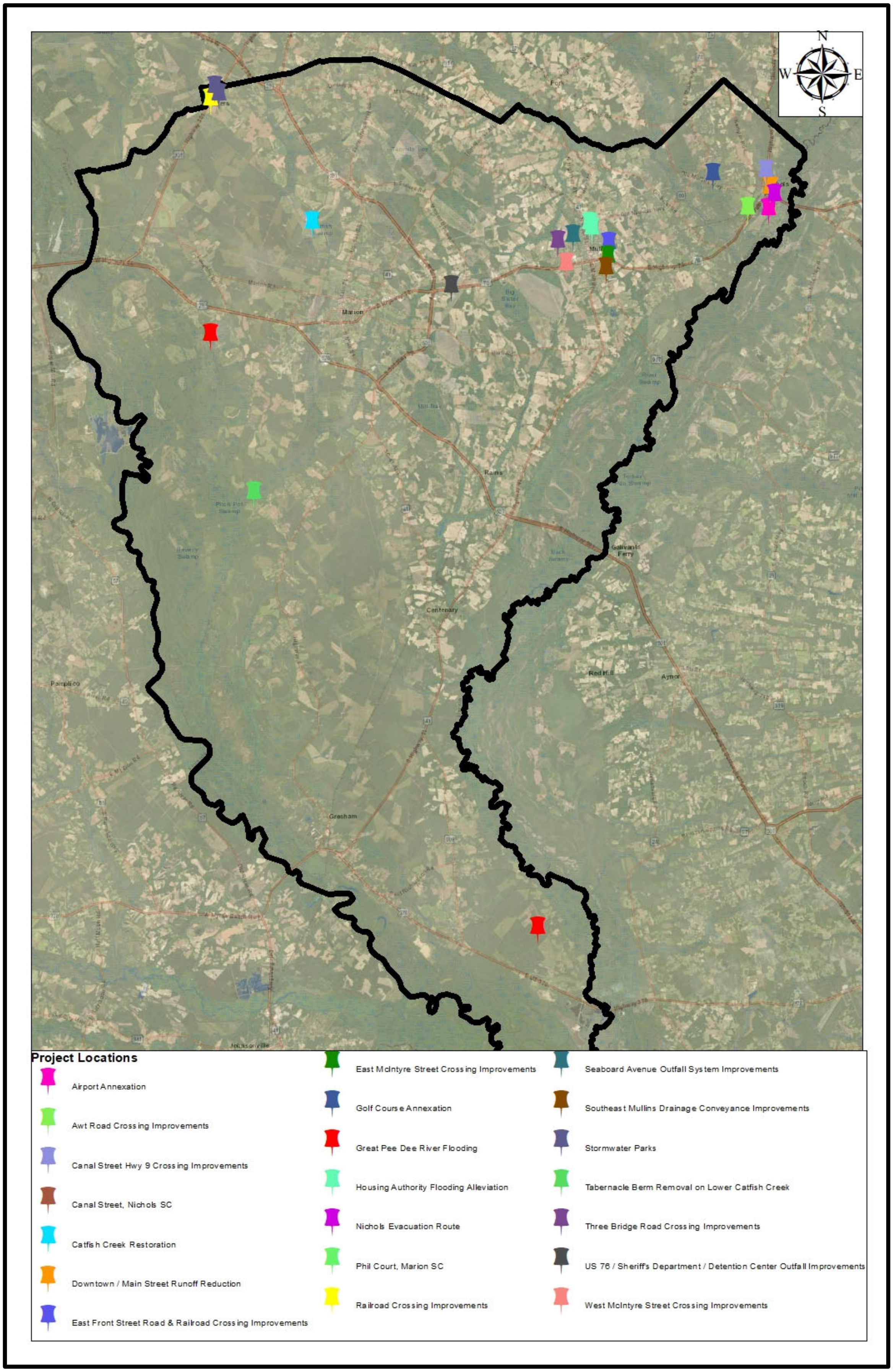


Figure 22: *Proposed project locations within Marion County*

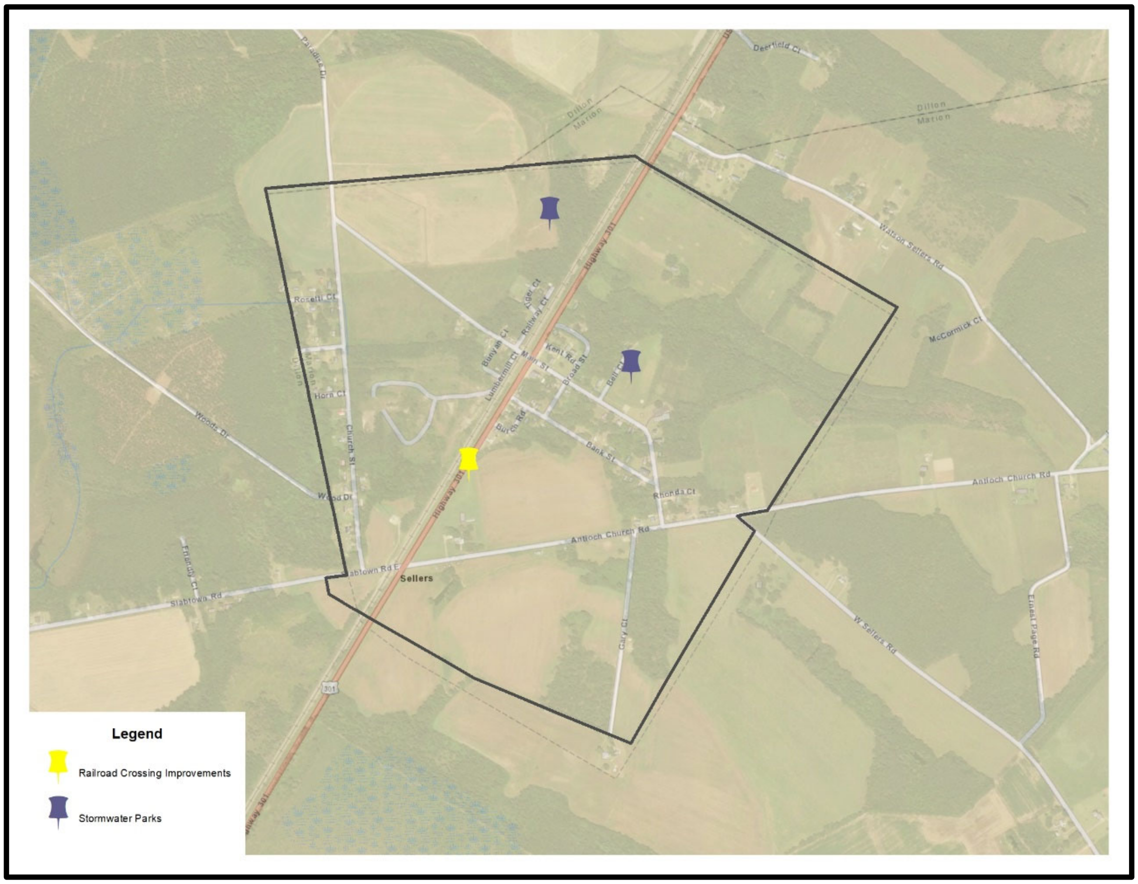


Figure 23: *Proposed project locations in Sellers*

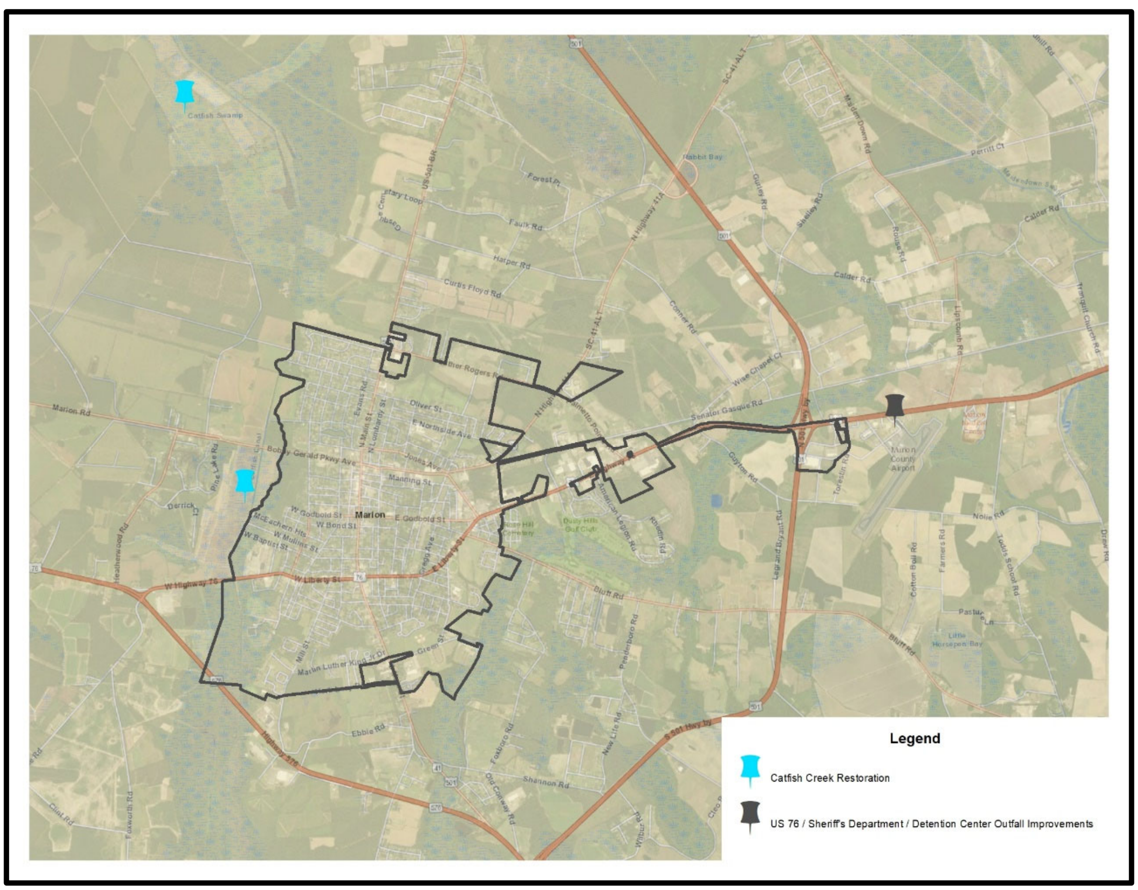


Figure 24: *Proposed project locations in Marion*

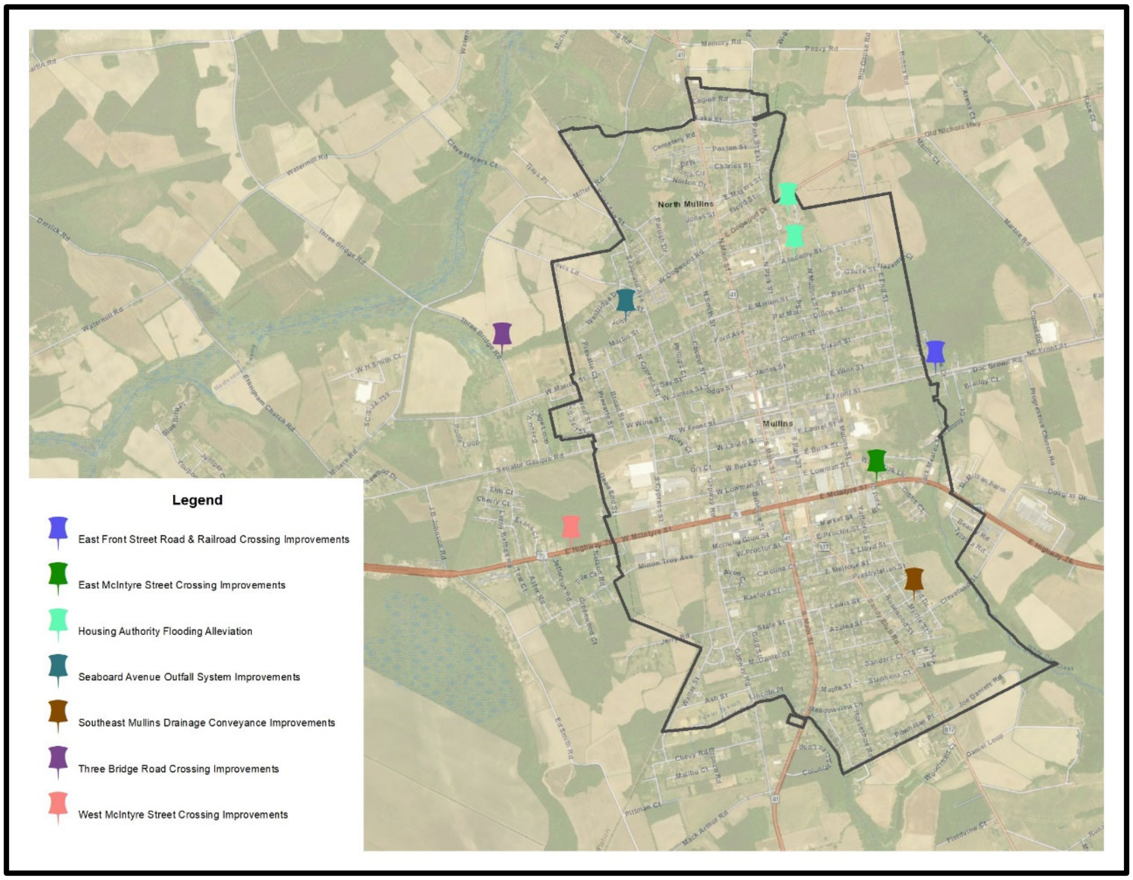


Figure 25: *Proposed project locations in Mullins*

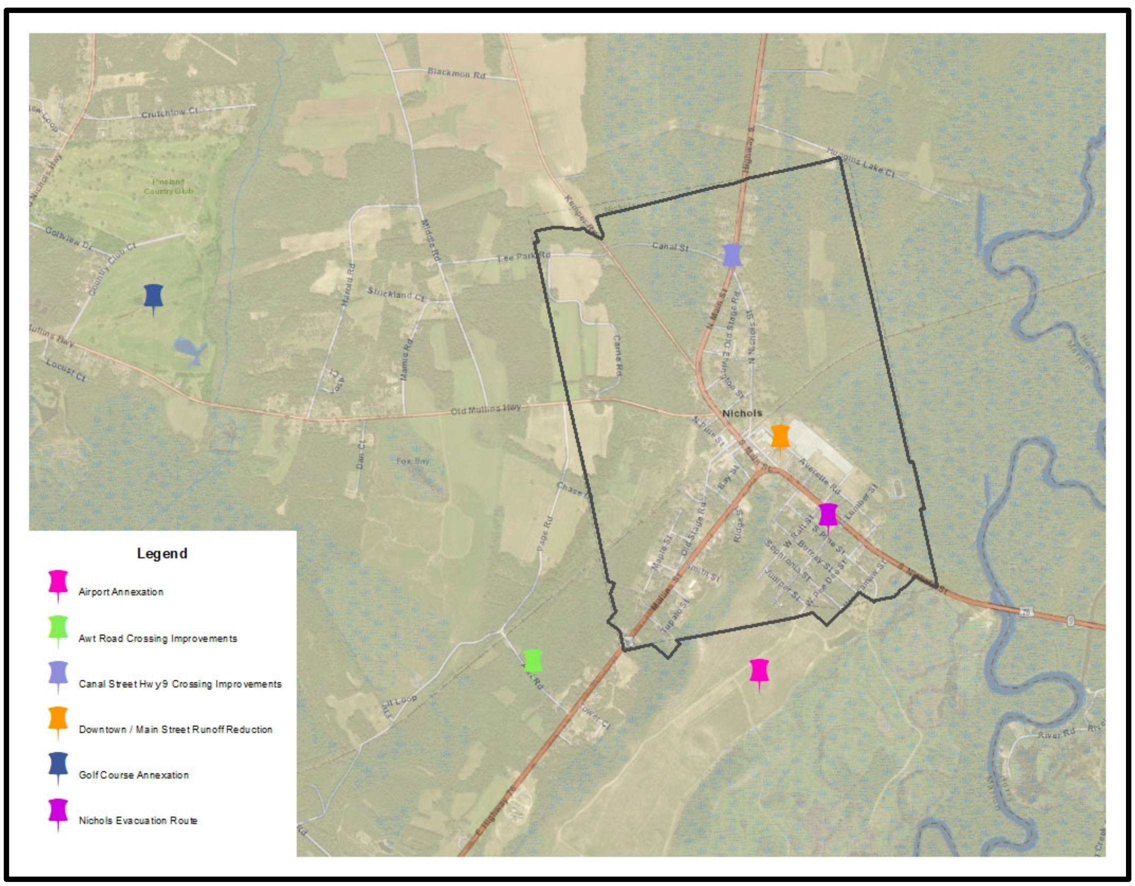


Figure 26: *Proposed project locations in Nichols*

15. Potential Project Concept Plans

Example concept plans were developed for the following projects and can be found in Appendix F.

- East Front Street Roadway and Railroad Crossing Improvements (Mullins)
- East McIntyre Street Crossing Improvements (Mullins)
- Three Bridges Road Outfall Improvements (Mullins)
- West McIntyre Street Crossing Improvements (Mullins)
- Awt Road Crossing Improvements (Nichols)
- Railroad Crossing Improvements (Sellers)

A concept plan was developed for the East Front Street Roadway and Railroad Crossing Improvements project (Project G) even though the ranking system rated it as infeasible. Even though the BCR was determined to be less than 1.0, it should be noted that there would still be an improvement in the level of service for this facility should the project be implemented.

16. Digital Deliverable – GIS Database

16.1. Preparation and Organization

Different geospatial datasets availed and created during the development of the stormwater masterplan were formatted and organized in compliance with the SCOR geospatial deliverables guideline. These datasets consist of information gathered from external sources, information gathered through communication with residents and local stakeholders, information collected through survey and field visits, as well as model inputs/features/properties for the various HEC-RAS and XPSWMM models utilized.

The geographic coordinate system named 'GCS_WGS_1984' was adopted while preparing the feature classes. Coordinate system transformations were performed for data acquired from external sources as necessary. While preparing the shapefile for the field survey, the projected coordinate system named 'NAD_1983_2011_StatePlane_South_Carolina_FIPS_3900_Ft_Intl' was used, since the survey measurements were performed with reference to it. The same coordinate system was also used for the DEM raster dataset for Marion County.

Information on the existing stormwater infrastructure within the project area was obtained through survey and/or field reconnaissance. Feature classes were created for both datasets which contained information on the stream crossing type, size, material, and channel geometry if applicable. Additionally, photos of the existing infrasturcture were taken and included as rasters within their respective attribute tables as shown in Figure 27 below.

X Coordinate	Y Coordinate	Elevation with respect to NAVD88	Type of survey point	Photo
894381.6118	2461443.196	78.292	EP -	
894385.0037	2461455.971	78.668	CRW -	
894390.8296	2461467.37	78.227	EP -	
894397.5139	2461487.813	74.094	PIPE 48RCP	<Raster>
894390.8045	2461489.47	73.481	PIPE 48RCP	<Raster>
894425.7972	2461550.071	74.131	X	
894380.0321	2461424.57	72.968	PIPE 48RCP	<Raster>
894373.2423	2461426.086	72.559	PIPE 48RCP	<Raster>
894364.4479	2461372.459	74.084	X	
894603.1651	2461680.767	74.166	X	
894633.9739	2461692.886	73.001	PIPE 48RCP	<Raster>
894637.913	2461687.317	73.081	PIPE 48RCP	<Raster>
894650.6561	2461690.641	73.093	PIPE 48RCP	<Raster>
894646.8876	2461696.527	73.014	PIPE 48RCP	<Raster>
894656.2982	2461698.687	72.93	PIPE 48RCP	<Raster>
894658.8429	2461693.011	73.247	PIPE 48RCP	<Raster>
894670.6408	2461699.022	78.544	EP -	
894680.4478	2461702.695	78.783	CRW	
894690.1494	2461706.091	78.667	EP -	
894704.5277	2461710.534	73.548	PIPE 48RCP	<Raster>
894707.3411	2461705.02	73.761	PIPE 48RCP	<Raster>
894789.2004	2461730.087	74.751	X	
894081.6612	2460710.155	72.316	X	
894024.6457	2460651.743	72.736	PIPE 6X5BOXCULVERTX2	<Raster>
894057.1326	2460598.081	72.716	PIPE 6X5BOXCULVERTX2	<Raster>
893967.0145	2460544.093	72.686	X	
893957.9086	2460499.664	72.214	PIPE 4X5CONCRETE	<Raster>
893981.6788	2460460.129	72.275	PIPE 4X5CONCRETE	<Raster>
893952.3913	2460433.539	72.332	X	
895654.0565	2461641.336	76.499	PIPE 5X5BOXCULVERTX2	<Raster>
895660.8803	2461627.247	83.58	EP -	
895668.8362	2461617.462	83.995	CRW -	

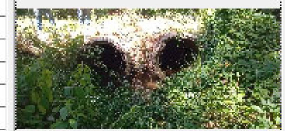


Figure 27: *Photo stored as raster in the feature class attribute table*

The feature classes were stored in an Esri file geodatabase. Other supporting files were stored in different folders which are shown below:

1. CAD: *.dwg file for survey data on existing stormwater infrastructure across the Marion County
2. Documents: Standard Operation Procedure (SOP), previous reports, and other relevant documents
3. Imagery:
   a. DEM: DEM raster for Marion County
   b. Photos: Photos takes during survey and field visits
   c. For_Thumbnail: .png file that has been used as metadata thumbnail for the raster of Marion County DEM
4. Maps: *.aprx map files
5. Source: data obtained from external sources in original format
6. Tables: tabular data in *.csv format

Also, the ‘GIS Data Submission Form’ and a ‘ReadMe’ text file were included in the deliverables. The ‘ReadMe’ text file includes a summary of the contents of the deliverables to provide the end user an idea of where the different datasets are stored. The directory structure of the deliverables is depicted in Figure 28.

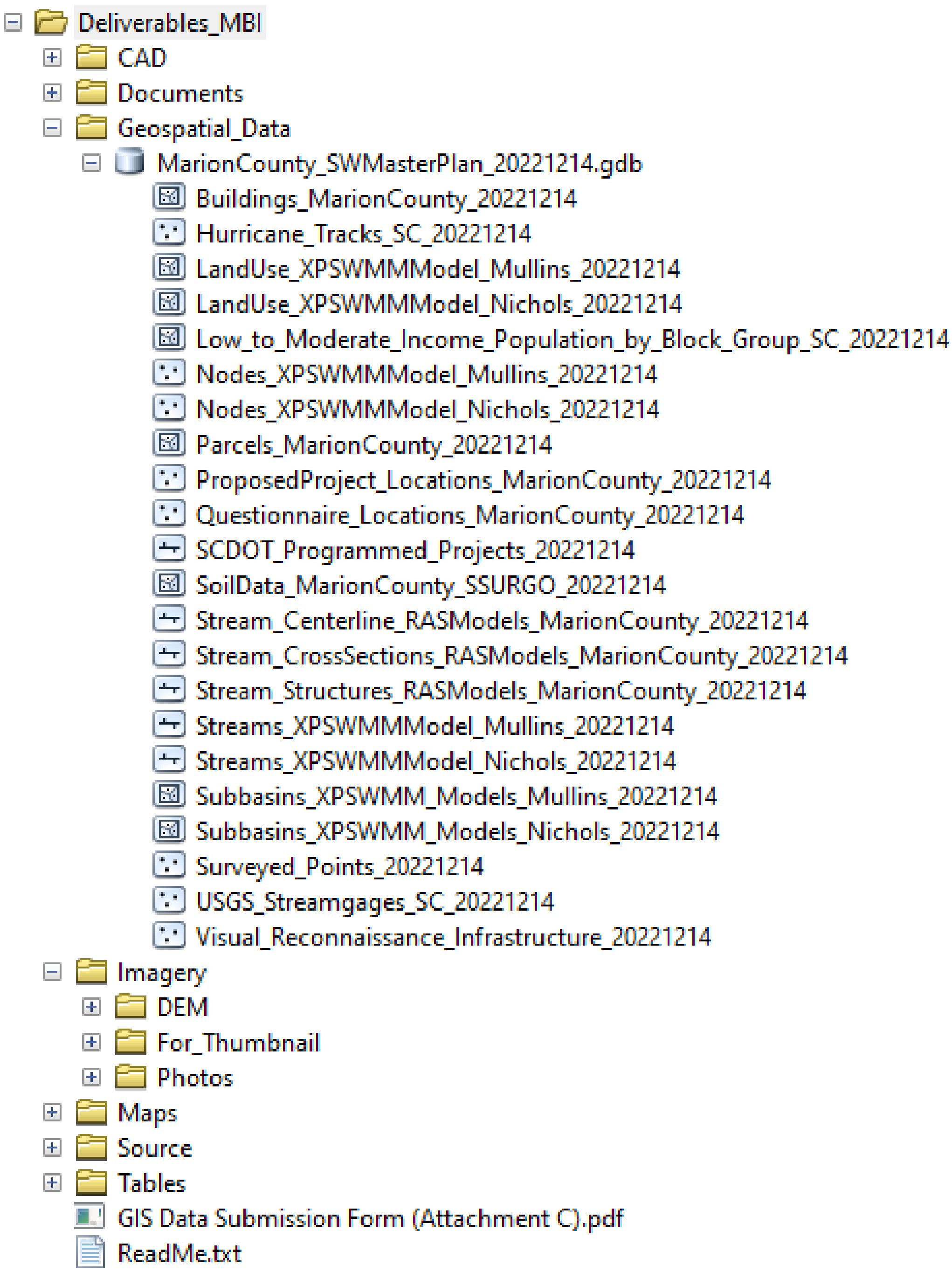


Figure 28: *Structure of the geospatial deliverables*

16.2. Metadata

Metadata for the feature classes stored in the geodatabase, as well as for the DEM raster, were created conforming to the FGDC guidelines. The metadata contains both a 'Summary' and 'Description' of the geospatial data (see Figure 29 below). The 'Description' section elaborated on the data/information provided by the geospatial data along with its source. Additional information such as unit and datum of measurement were included as necessary. Furthermore, the metadata outlined alias, field description, data type, and other relevant information for different attribute fields of the geospatial data (see Figure 30).

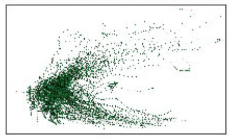
Item Description - Hurricane_Tracks_SC_20221214

Description | Preview

Print | Edit | Validate | Export | Import

Hurricane_Tracks_SC_20221214

File Geodatabase Feature Class



Tags

There are no tags for this item.

Summary

Point feature class for storm tracks for South Carolina.

Description

This point feature class represents tracks for the Atlantic basin tropical storms and hurricanes which impacted the state of South Carolina. It is projected in the geographic coordinate system of GCS_WGS_1984. The feature class was obtained from https://data-scdnr.opendata.arcgis.com/maps/sc-hurricanes-public. It contains information on ID, name, year of occurrence, date and time of occurrence, type, wind speed in mph, pressure in millibars, and category (if hurricane) for the storms.

Credits

There are no credits for this item.

Use limitations

There are no access and use limitations for this item.

Extent

West -102.400000 East 8.000000
North 73.000000 South 8.500000

Scale Range

Maximum (zoomed in) 1:5,000
Minimum (zoomed out) 1:150,000,000

ArcGIS Metadata ►

Topics and Keywords ►

THEMES OR CATEGORIES OF THE RESOURCE climatologyMeteorologyAtmosphere, environment, location

Figure 29: *Summary and description for the feature class within the metadata*

Item Description - Hurricane_Tracks_SC_20221214

Description | Preview

Print | Edit | Validate | Export | Import

FIELD wind ►
* ALIAS wind
* DATA TYPE SmallInteger
* WIDTH 2
* PRECISION 0
* SCALE 0

FIELD DESCRIPTION
Wind speed in mph during the storm

DESCRIPTION SOURCE
SCDNR

ENDING DATE OF VALUES 2022-12-14

Hide Field wind ▲

FIELD pressure ►
* ALIAS pressure
* DATA TYPE SmallInteger
* WIDTH 2
* PRECISION 0
* SCALE 0

FIELD DESCRIPTION
Pressure in millibars during the storm

DESCRIPTION SOURCE
SCDNR

ENDING DATE OF VALUES 2022-12-14

Hide Field pressure ▲

FIELD hurcat ►
* ALIAS hurcat
* DATA TYPE SmallInteger
* WIDTH 2
* PRECISION 0
* SCALE 0

FIELD DESCRIPTION
Category of the hurricane

DESCRIPTION SOURCE
SCDNR

ENDING DATE OF VALUES 2022-12-14

Figure 30: *Information on feature class attribute field within the metadata*

Appendix A: Data Compilation and Collection Log

Data Compilation and Collection Log

Marion County Stormwater Masterplan

Description of original data source					
Data description	**Spatial or Non-Spatial**	**Original collection agency**	**Data location (Where obtained from)**	**Date of original data publication**	Special Notes
FEMA HEC-RAS model for Little Pee Dee River	Spatial and Non-Spatial	FEMA	Flood Risk Study Engineering Library	2/13/2010	Includes FWDTs, General, Hydraulic Databases, Hydraulic Models and Profiles. Downloaded from: https://hazards.fema.gov/wps/portal/frisel
FEMA HEC-RAS model for Sellers Branch	Spatial and Non-Spatial	FEMA	Flood Risk Study Engineering Library	1/25/2010	Includes FWDTs, General, Hydraulic Databases, Hydraulic Models and Profiles. Downloaded from: https://hazards.fema.gov/wps/portal/frisel
FEMA HEC-RAS model for White Oak Creek Tributary 1-1	Spatial and Non-Spatial	FEMA	Flood Risk Study Engineering Library	12/7/2009	Includes FWDTs, General, Hydraulic Databases, Hydraulic Models and Profiles. Downloaded from: https://hazards.fema.gov/wps/portal/frisel
FEMA DFIRMs	Spatial	FEMA	Flood Risk Study Engineering Library	10/18/2011	Digital Flood Insurance Rate Maps. Downloaded from: https://hazards.fema.gov/wps/portal/frisel
FEMA National Flood Hazard Layer - Marion County	Spatial	FEMA	FEMA Flood Map Service Center	10/18/2011	FEMA Map Service Center - National Flood Hazard Layer (NFHL) Database Search Results
FEMA Flood Insurance Study Marion County, SC and Unincorpotaed Areas	Non-spatial	FEMA	FEMA Flood Map Service Center	10/18/2011	FEMA Flood Map Service Center | Search All Products
FIMA NFIP Redacted Claims	Spatial and Non-Spatial	FEMA	OpenFEMA Dataset: FIMA NFIP Redacted Claims	7/22/2020	https://www.fema.gov/openfema-data-page/fima-nfip-redacted-claims
LMI Data	Spatial and Non-Spatial	HUD	United States Department of Housing and Urban Development	2022	Low to Moderate Income data. 2020 and 2021 LMI data is based on the 2015 Census while the 2022 data is based on the 2020 Census.
SVI	Spatial and Non-Spatial	CDC	CDC/ATSDR SVI Data and Documentation Download	1/31/2020	https://www.atsdr.cdc.gov/placeandhealth/svi/data_documentation_download.html
IMPROVED MODELING OF THE GREAT PEE DEE RIVER: DOCUMENTATION IN SUPPORT OF FEMA APPEAL	Non-spatial	Horry County	FEMA	7/15/2016	Report in support of appealing the Great Pee Dee FEMA model.
Estimating the Magnitude and Frequency of Floods in Small Urban Streams in South Carolina, 2001	Non-spatial	USGS	USGS Publication Database	5/18/2004	https://pubs.er.usgs.gov/publication/sir20045030
Estimating the Magnitude and Frequency of Floods in Rural Basins of North Carolina-Revised	Non-spatial	USGS	USGS Publication Database	11/29/2001	https://pubs.er.usgs.gov/publication/wri014207
Techniques for Estimating the Magnitude and Frequency of Floods in Rural Basins of South Carolina, 1999	Non-spatial	USGS	USGS Publication Database	2002	https://pubs.usgs.gov/wri/wri024140
Preliminary Peak Stage and Streamflow Data at Selected U.S. Geological Survey Streamgaging Stations in North and South Carolina for Flooding Following Hurricane Florence, September 2018	Non-spatial	USGS	USGS Publication Database	10/24/2018	https://pubs.er.usgs.gov/publication/ofr20181172
All SCDOT current programmed projects. Last updated Feb 24, 2022	Spatial	SCDOT	SCDOT ArcGIS Online portal	5/17/2018	https://scdot.maps.arcgis.com/home/item.html?id=c4e70c3021564509b4b54e49e95664be
Zipped file of all FIRM maps for All Jurisdictions of Marion County including the index file. Last Effective Date 10/18/2011.	Spatial	FEMA	FEMA Flood Map Service Center	10/18/2011	https://msc.fema.gov/util/bundle/confirm?type=FINAL_PRODUCT&subType=FIRM_PANEL&bucket=EFFECTIVE&CID=45067C

Data Compilation and Collection Log

Marion County Stormwater Masterplan

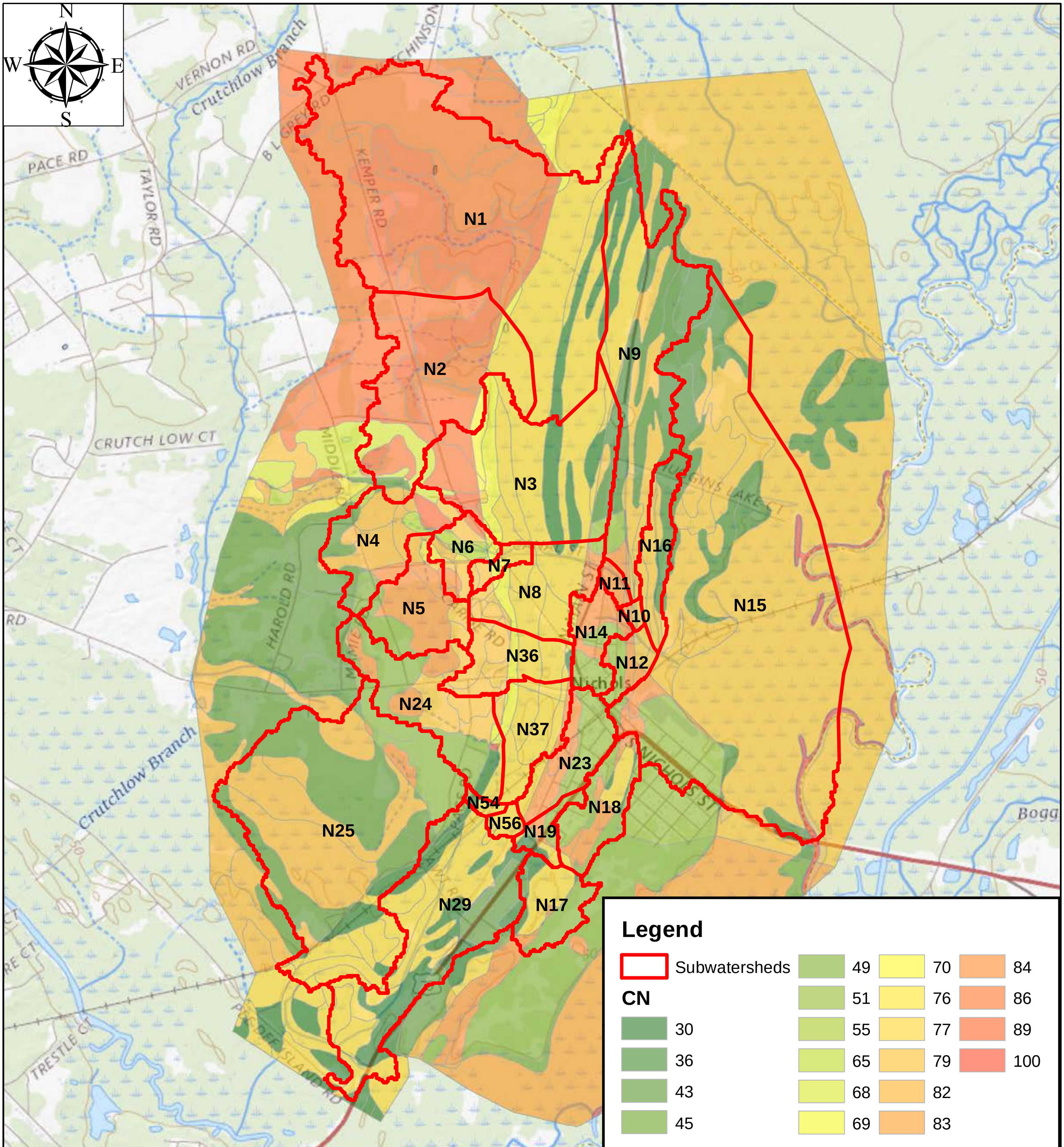
Description of original data source					
Data description	**Spatial or Non-Spatial**	**Original collection agency**	**Data location (Where obtained from)**	**Date of original data publication**	Special Notes
Zipped file of all current LOMC files for Marion County.	Non-spatial	FEMA	FEMA Flood Map Service Center	10/18/2011	https://msc.fema.gov/util/bundle/confirm?type=LOMC&subType=LOMA&bucket=EFFECTIVE&CID=45067C
The Hydrology Section of the SCDNR has records of more than 14,000 water wells located in the Coastal Plain counties of South Carolina. Find wells with Geophysical Logs, Chemical Analysis, Drill Logs, and Pump Tests, and other well data such as depth, flow rates, casing, and more.	Spatial	SCDNR	SCDNR Open Data site	10/11/2019	https://data-scdnr.opendata.arcgis.com/search?tags=hydrology%2Cwater
Storm tracks for tropical cyclones - Atlantic basin tropical storms and hurricanes - that impacted the State of South Carolina.	Spatial	SCDNR	SCDNR Open Data site	4/10/2019	https://data-scdnr.opendata.arcgis.com/maps/sc-hurricanes-public
An updated list of all registered MS4 Systems. Last updated 07/13/2020.	Spatial	SCDHEC	SCDHEC's portal for geospatial content	9/13/2020	https://sc-department-of-health-and-environmental-control-gis-sc-dhec.hub.arcgis.com/maps/ms4-designations-municipal-separate-storm-sewer-system
A list of all public water supply intakes. Last updated Sep 3,2021.	Spatial	SCDHEC	SCDHEC's portal for geospatial content	9/3/2021	https://sc-department-of-health-and-environmental-control-gis-sc-dhec.hub.arcgis.com/maps/public-water-supply-intakes
A list of all public water supply wells. Last updated Sep 3,2021.	Spatial	SCDHEC	SCDHEC's portal for geospatial content	9/3/2021	https://sc-department-of-health-and-environmental-control-gis-sc-dhec.hub.arcgis.com/maps/public-water-supply-wells-1
HEC-2 data for Catfish Canal Study	Non-spatial	FEMA	FEMA Engineering Library via Data Request	5/1/1984	HEC-2 input/output
HEC-2 data for Fowler Branch Study and Re-Study	Non-spatial	FEMA	FEMA Engineering Library via Data Request	8/11/1987	HEC-2 input/output
Lumber River Study Report	Non-spatial	FEMA	FEMA Engineering Library via Data Request	3/1/1978	HEC-2 input/output
HEC-2 data for Maidendown Swamp Tributary Study	Non-spatial	FEMA	FEMA Engineering Library via Data Request	7/17/1987	HEC-2 input/output
HEC-2 data for Smith Swamp Study	Non-spatial	FEMA	FEMA Engineering Library via Data Request	5/1/1984	HEC-2 input/output
HEC-2 data for White Oak Creek Study and Re-Study	Non-spatial	FEMA	FEMA Engineering Library via Data Request	3/1/1982	HEC-2 input/output
Marion County LiDAR	Spatial	SCDNR	SCDNR LiDAR Database	2008	https://scdnr.maps.arcgis.com/apps/webappviewer/index.html?id=d9cc9b40f4554a438f053f7f5e08f93f
Horry County LiDAR	Spatial	SCDNR	SCDNR LiDAR Database	2009	https://scdnr.maps.arcgis.com/apps/webappviewer/index.html?id=d9cc9b40f4554a438f053f7f5e08f93f
Dillon County LiDAR	Spatial	SCDNR	SCDNR LiDAR Database	2008	https://scdnr.maps.arcgis.com/apps/webappviewer/index.html?id=d9cc9b40f4554a438f053f7f5e08f93f
Marion County Parcels	Spatial	Marion County	Marion County GIS	Current	Parcel data for Marion County

Data Compilation and Collection Log

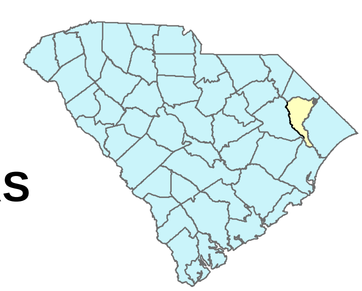
Marion County Stormwater Masterplan

Description of original data source					Special Notes
Data description	**Spatial or Non-Spatial**	**Original collection agency**	**Data location (Where obtained from)**	**Date of original data publication**	
Clemson Report for the Town of Nichols	Non-spatial	Clemson University	Town of Nichols	2019	Report prepared by Clemson University for the Town of Nichols
Woolpert report for the Town of Nichols	Non-spatial	Woolpert	Town of Nichols	2020	Report prepared by Woolpert for the Town of Nichols
2D HECRAS Model for the Lumber River	Non-spatial	Woolpert	Woolpert	2020	2D HECRAS model of the Lumber River created by Woolpert
SCDOT Bridge Information	Spatial	SCDOT	SCDOT Bridge Database	Ongoing	Old bridge plans, inspection reports, load ratings, etc. for all bridges and bridge sized culverts in the National Bridge Inventory database
SCDOT Old Plans	Non-spatial	SCDOT	SCDOT Plans Online	Varies	Old SCDOT plans for various crossings within Marion County
Building footprints within Marion County	Spatial	Marion County	Marion County GIS	Current	Building footprints within Marion County
Soils Data for Marion County	Spatial	USDA	WebSoilSurvey	2019	Soil data for all of Marion County
USGS StreamGage Data	Spatial	USGS	USGS National Water Information System	Current	Stream gage data for all gages located within South Carolina
USGS Highwater Marks	Spatial	USGS	USGS	Current	https://stn.wim.usgs.gov/FEV/

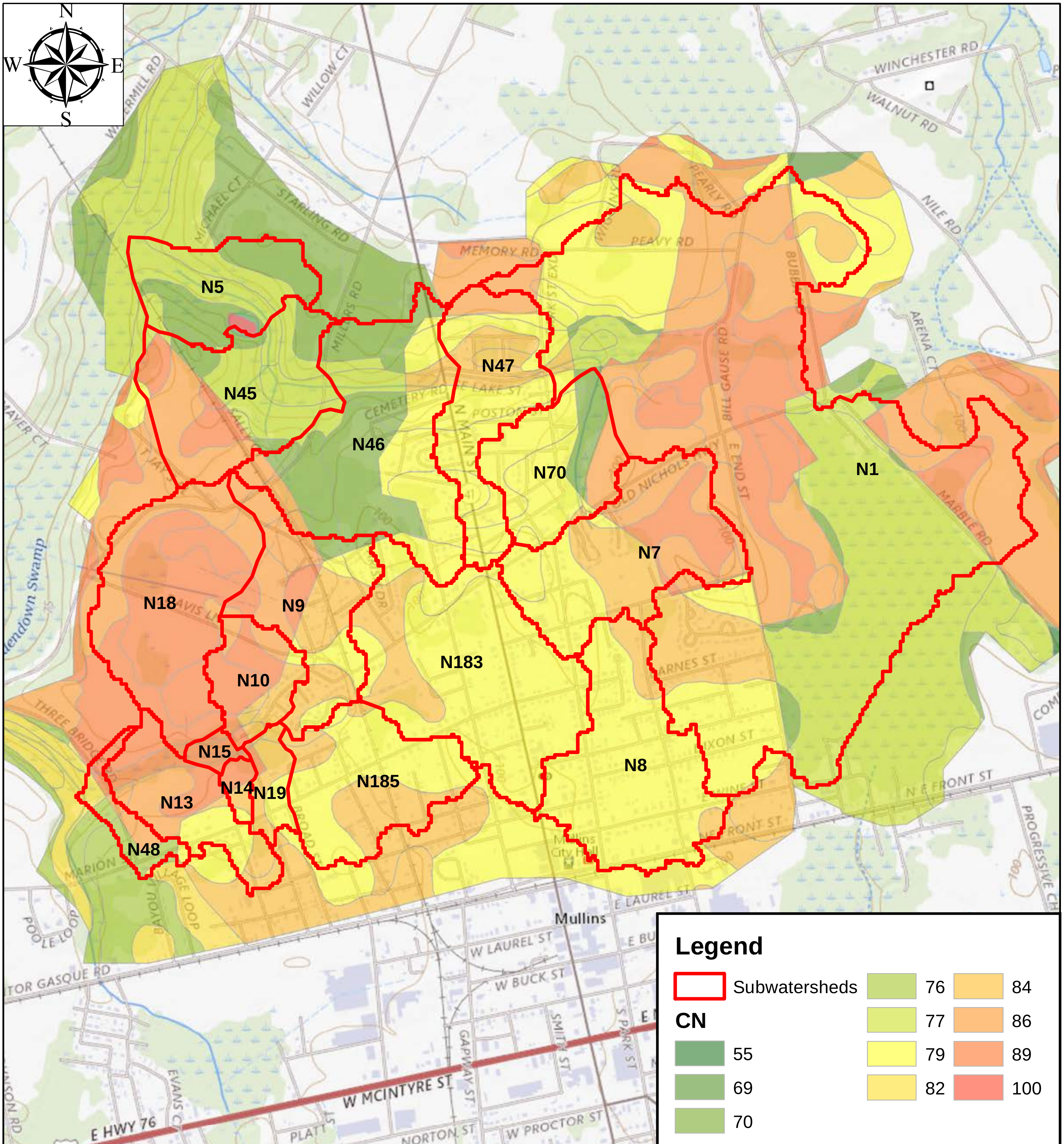
Appendix B: XPSWMM Graphics and Output



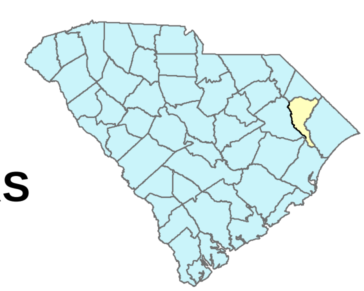
MARION COUNTY
STORMWATER MASTERPLAN
NICHOLS RUNOFF CURVE NUMBERS

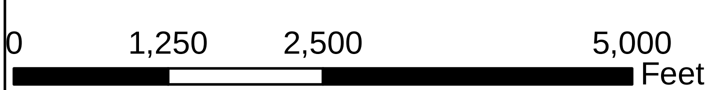


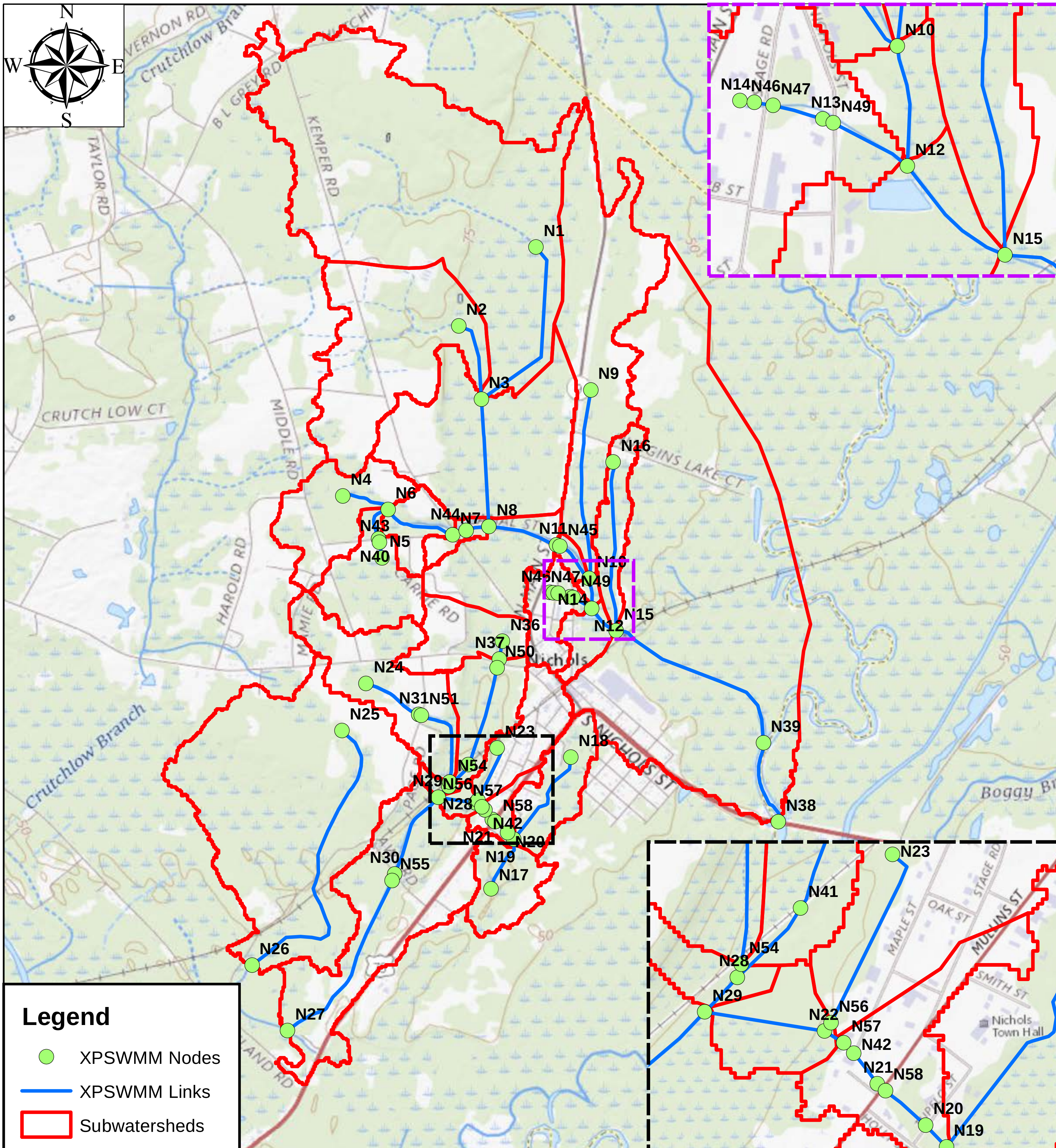
0 2,500 5,000 10,000
Feet



MARION COUNTY
STORMWATER MASTERPLAN
MULLINS RUNOFF CURVE NUMBERS

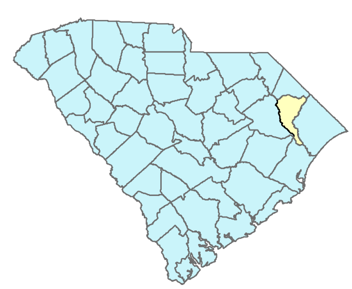


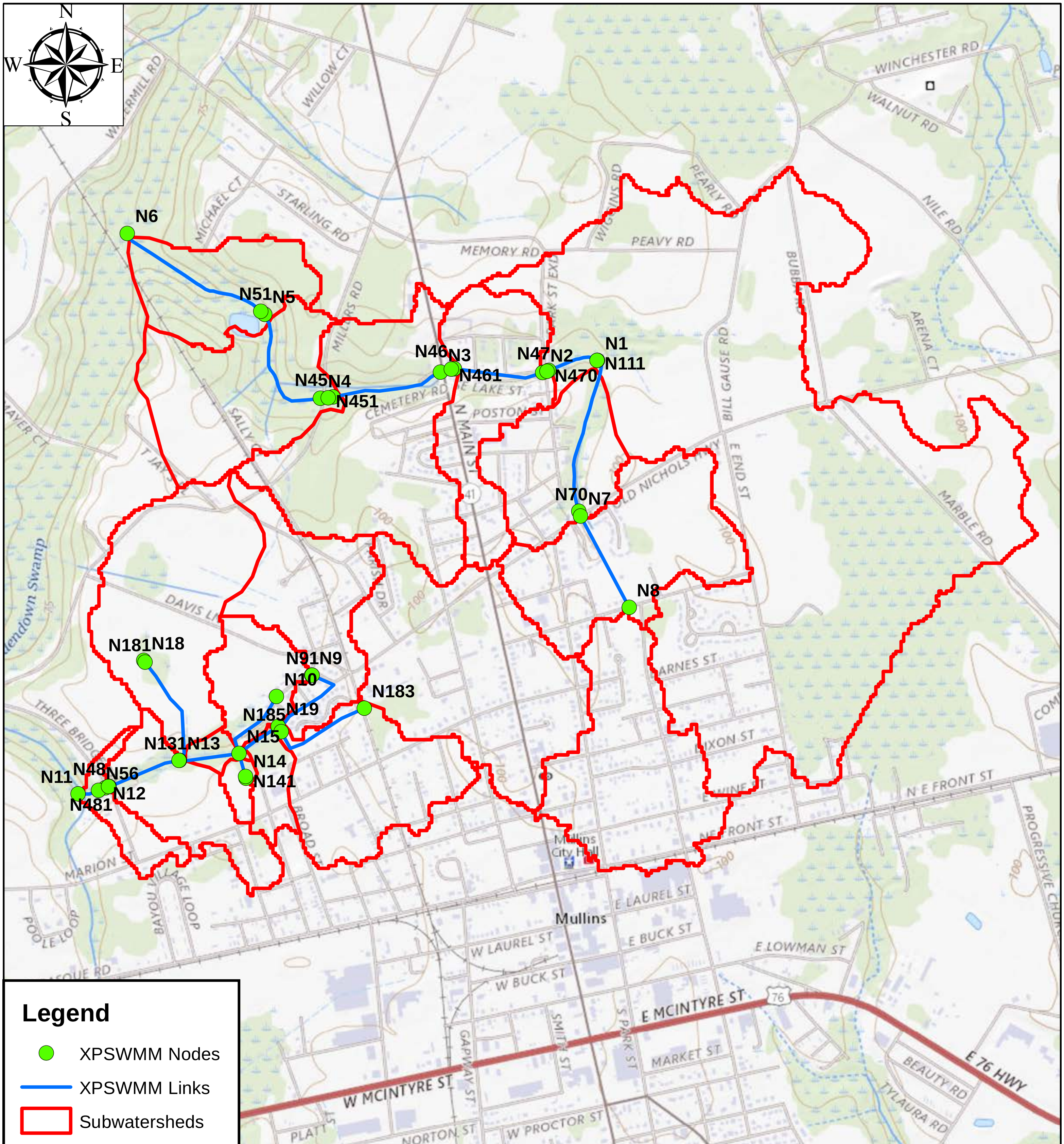


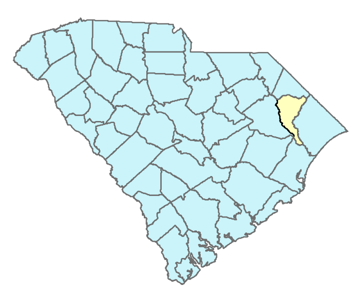


MARION COUNTY
STORMWATER MASTERPLAN
NICHOLS XPSWMM SCHEMATIC

0 2,500 5,000 10,000 Feet





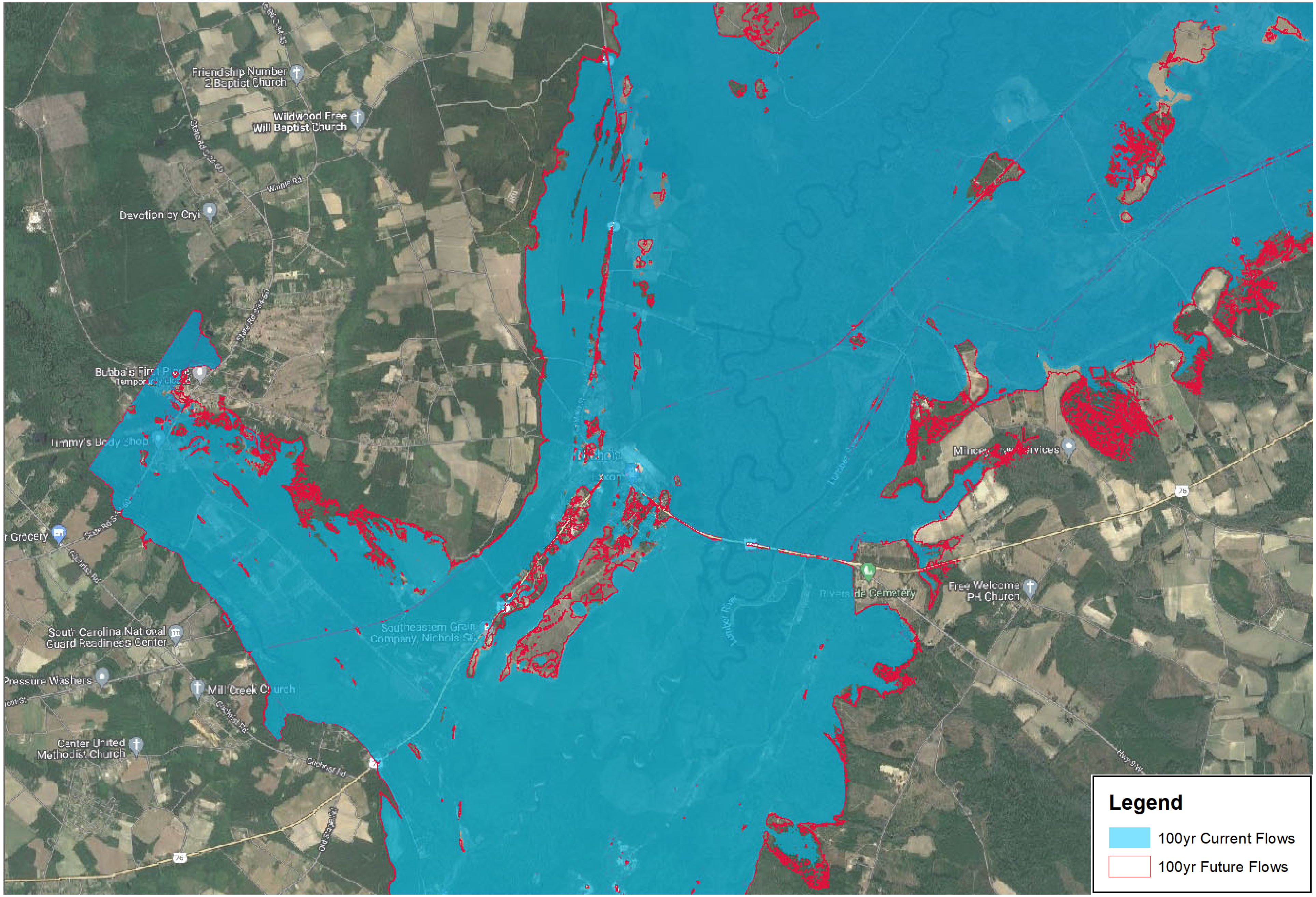


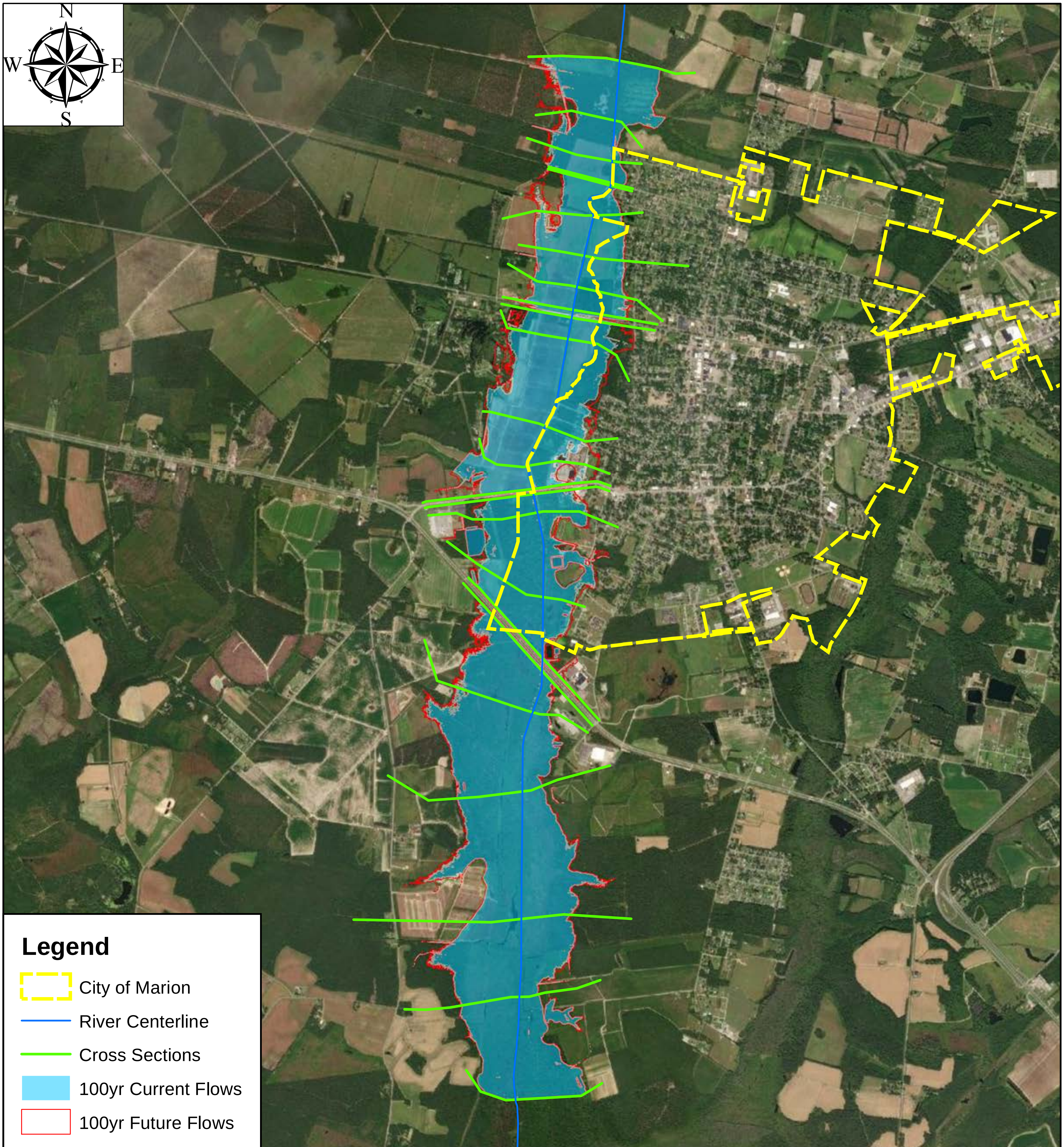
MARION COUNTY
STORMWATER MASTERPLAN
MULLINS XPSWMM SCHEMATIC

0 1,250 2,500 5,000
Feet

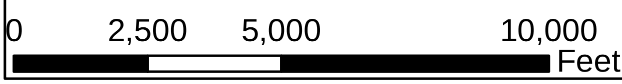
Appendix C: HEC-RAS Graphics and Output

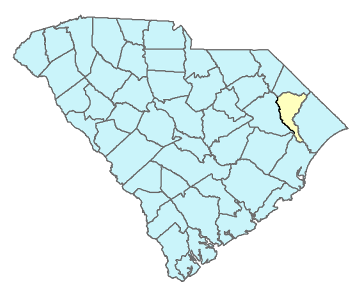
Lumber River 100yr Inundation Map near Nichols, SC

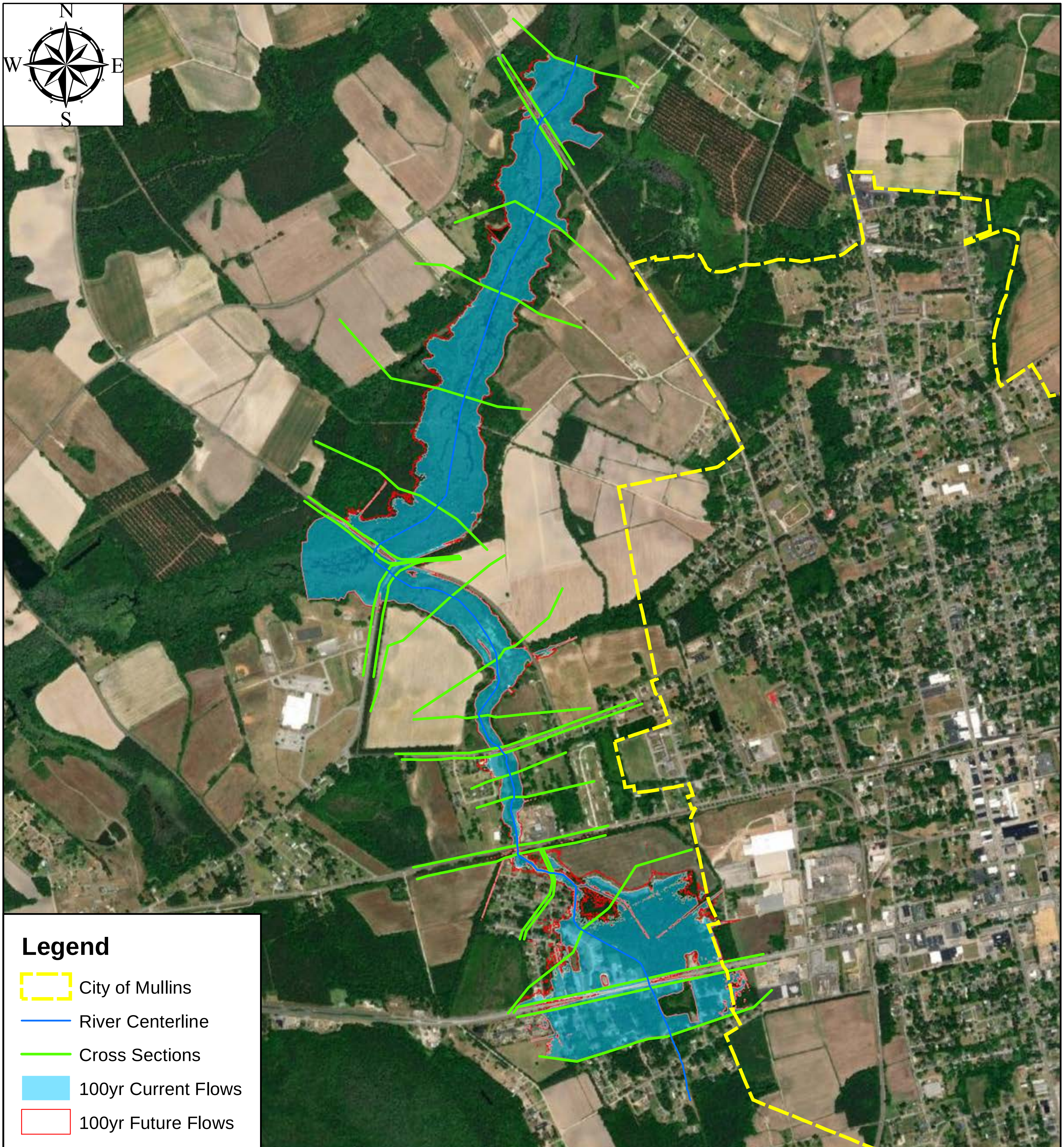




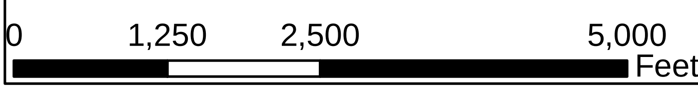
MARION COUNTY
STORMWATER MASTERPLAN
CATFISH CANAL
100YR FLOODING MAP

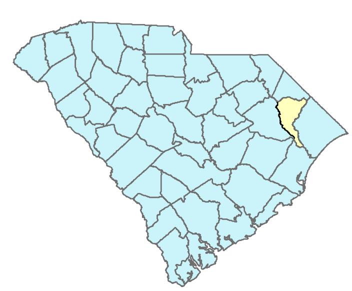


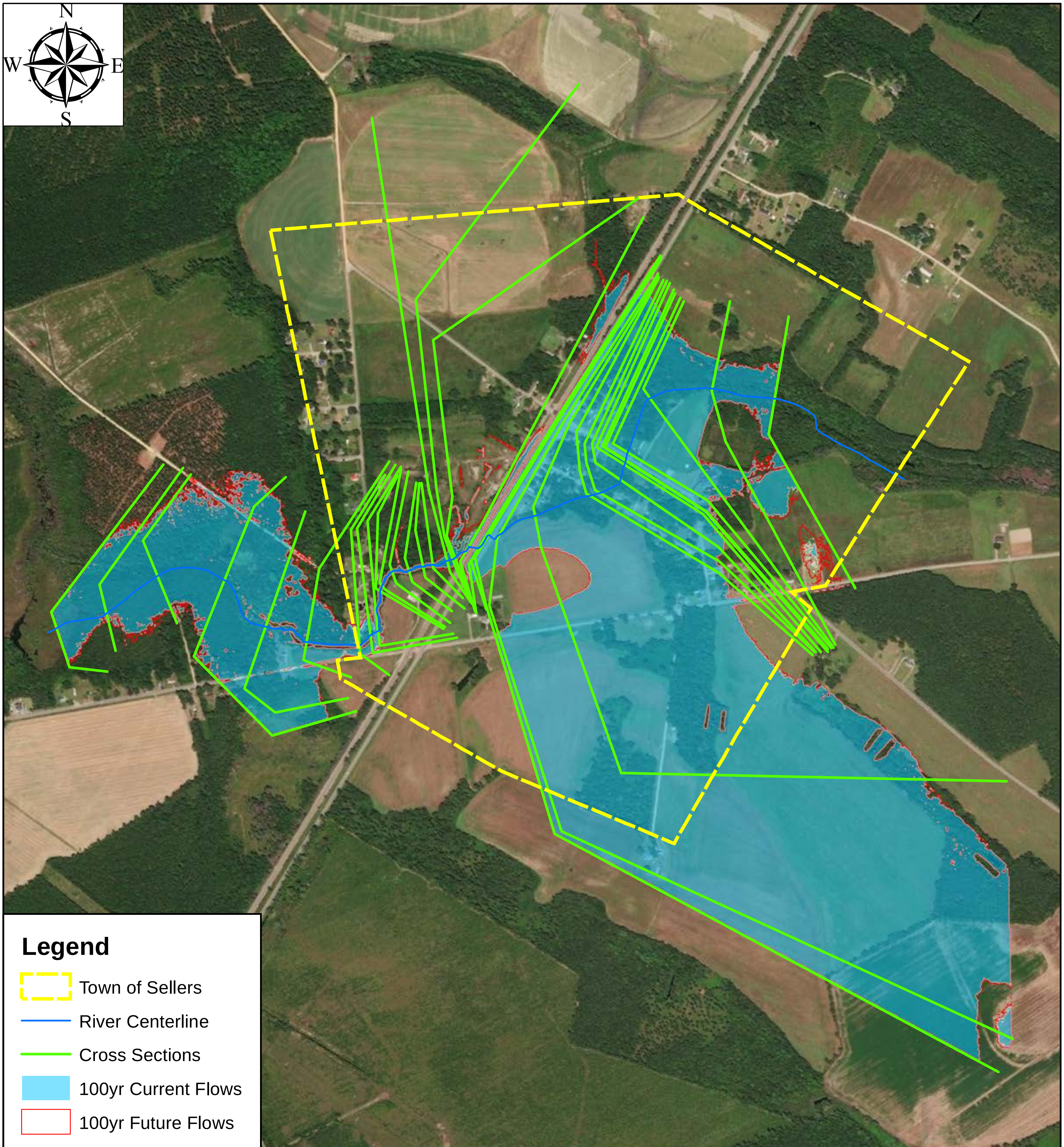




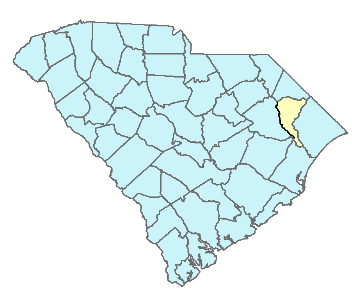
MARION COUNTY
STORMWATER MASTERPLAN
MAIDENDOWN SWAMP &
MAIDENDOWN SWAMP TRIB
100YR FLOODING MAP



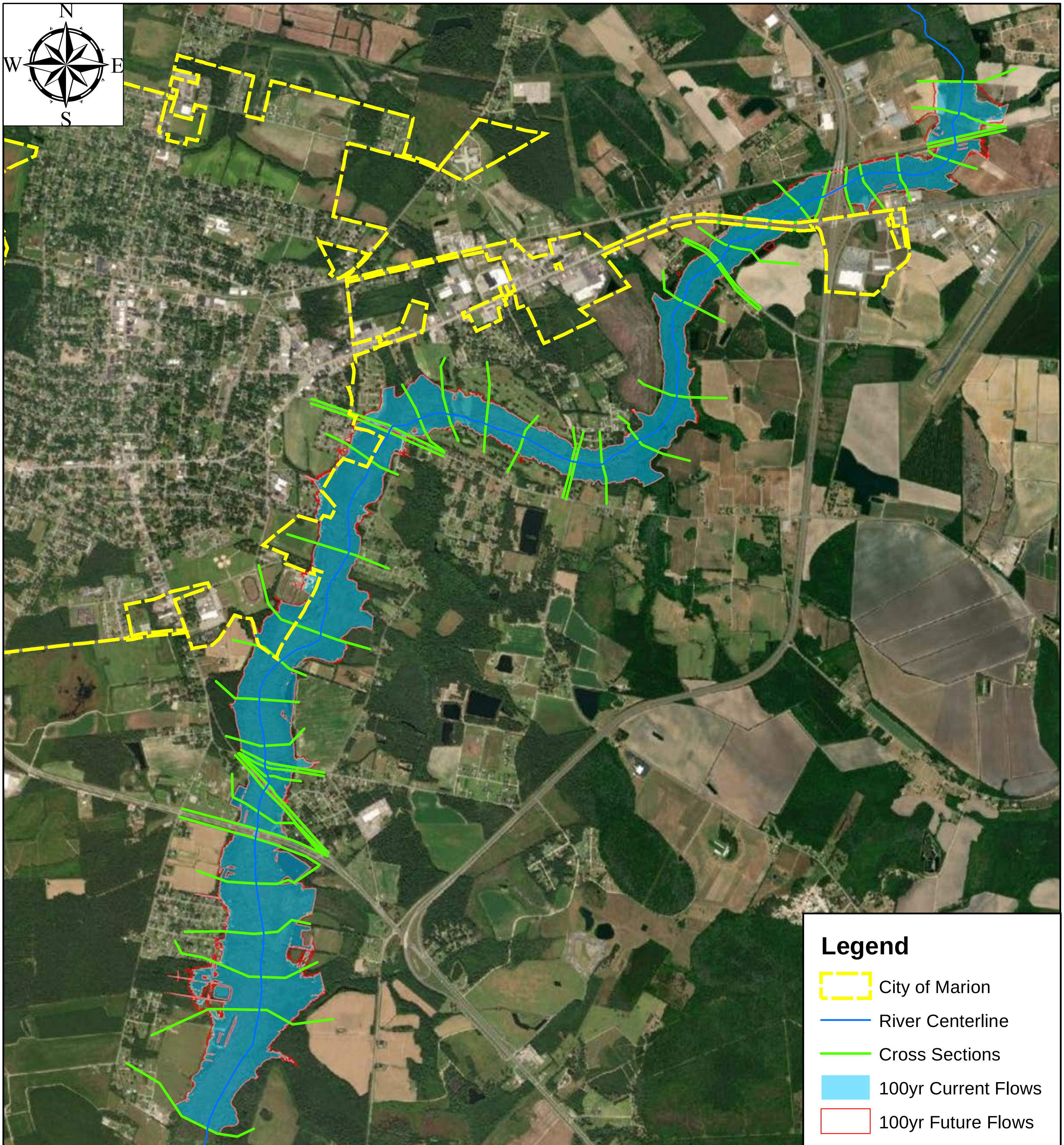




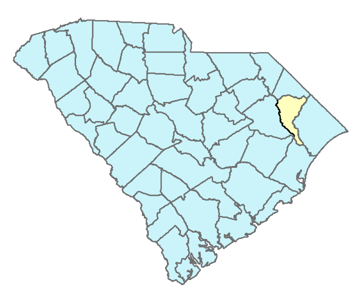
MARION COUNTY
STORMWATER MASTERPLAN
SELLERS BRANCH
100YR FLOODING MAP

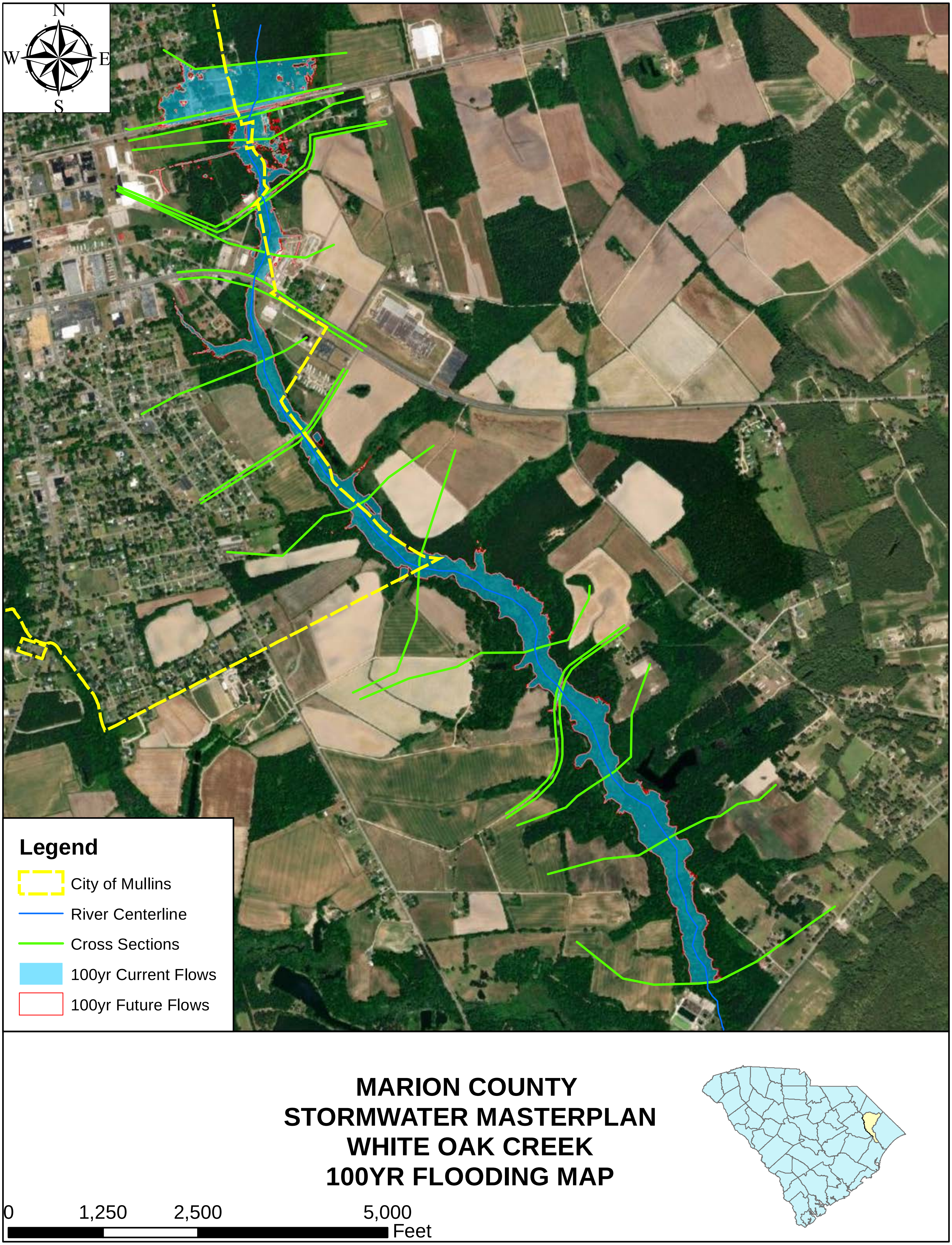


0 1,250 2,500 5,000
Feet

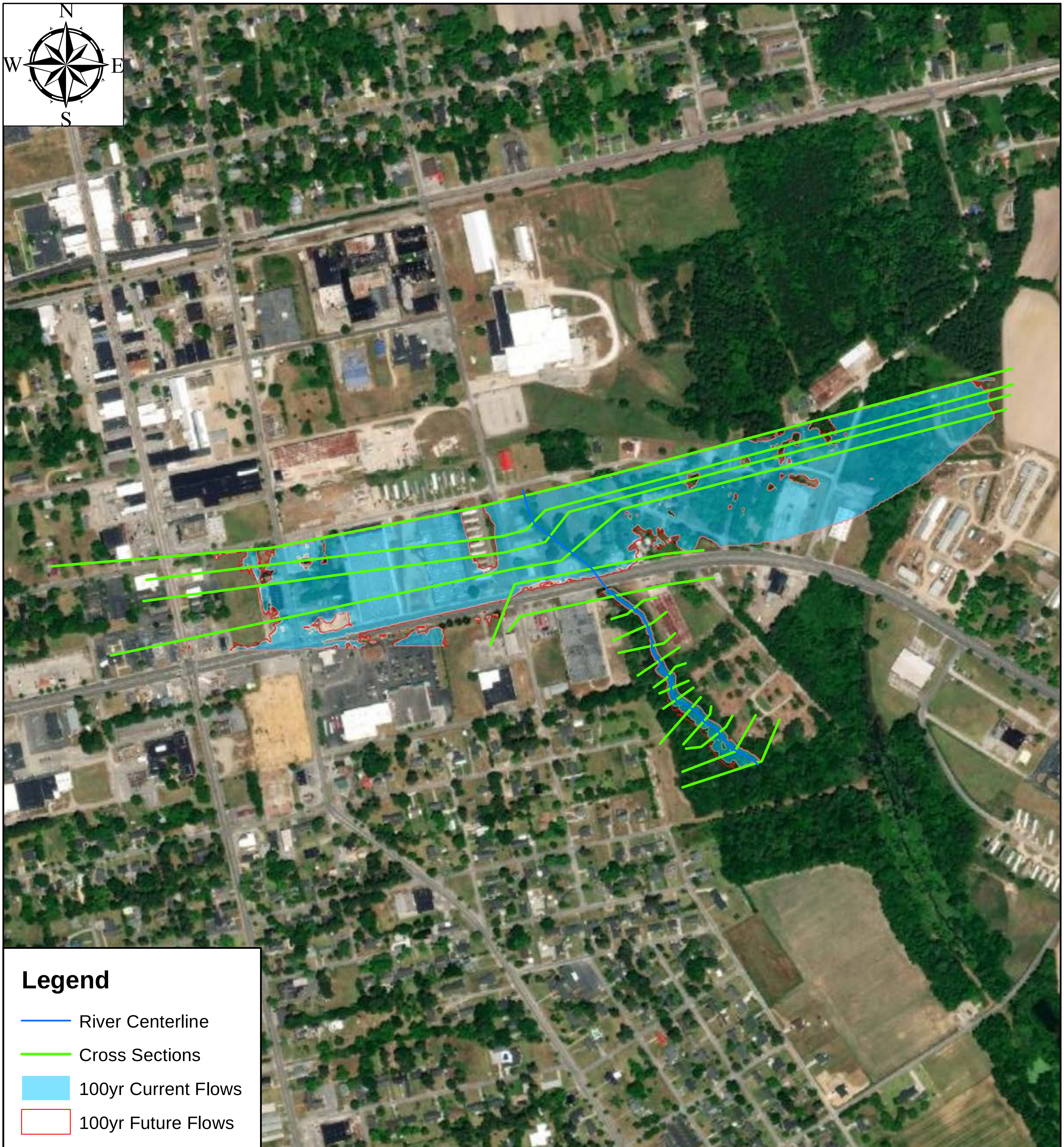


MARION COUNTY
STORMWATER MASTERPLAN
SMITH SWAMP
100YR FLOODING MAP

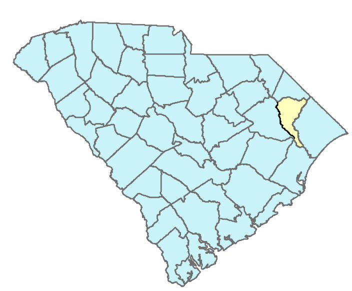




MARION COUNTY
STORMWATER MASTERPLAN
WHITE OAK CREEK
100YR FLOODING MAP

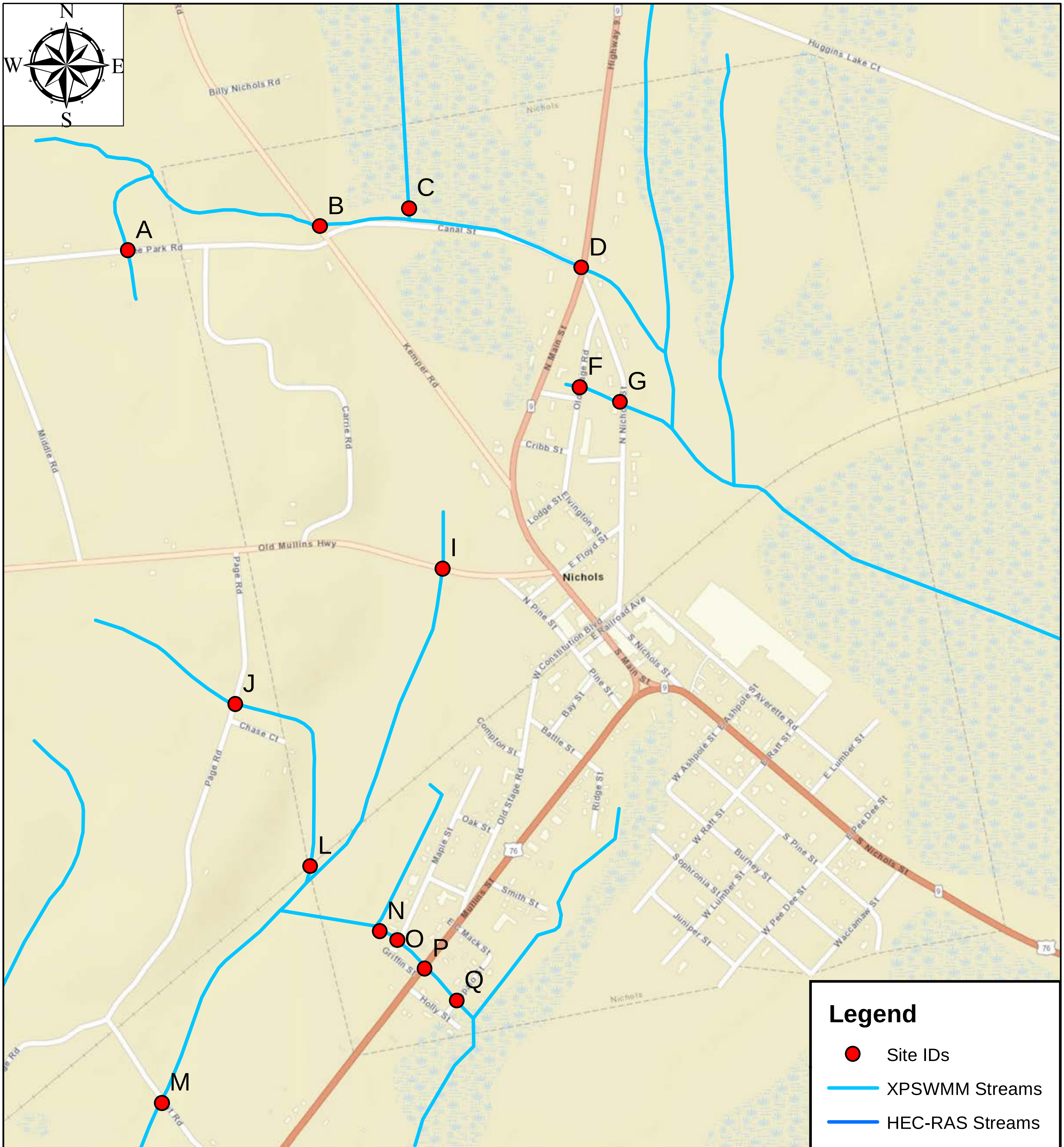


MARION COUNTY
STORMWATER MASTERPLAN
WHITE OAK CREEK TRIB 1-1
100YR FLOODING MAP



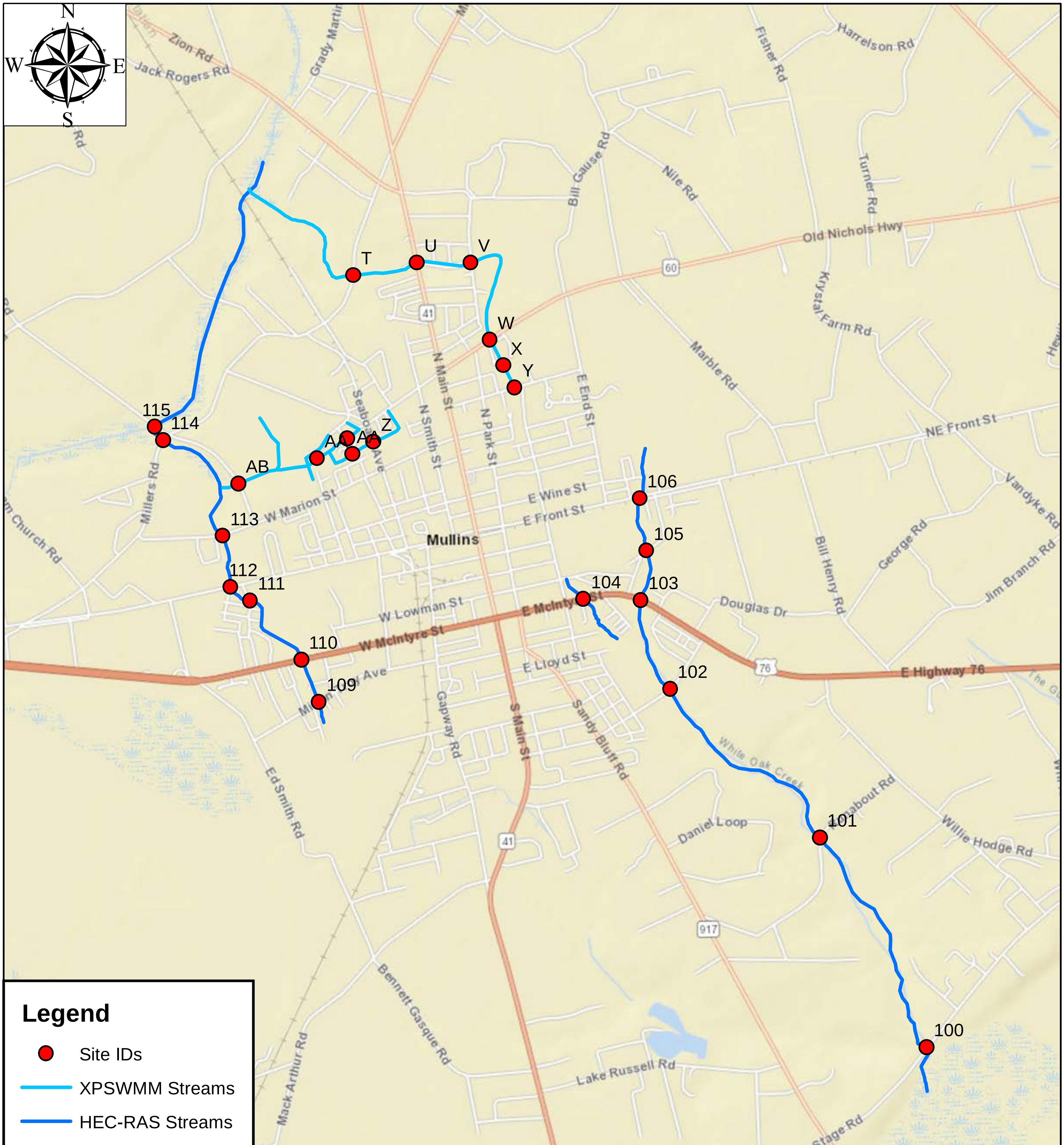
0 500 1,000 2,000
Feet

Appendix D: Existing Infrastructure Data Collection

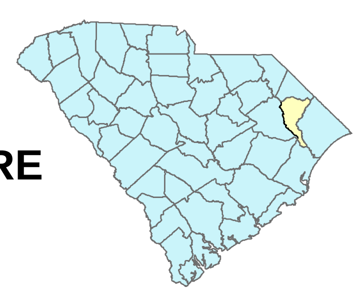


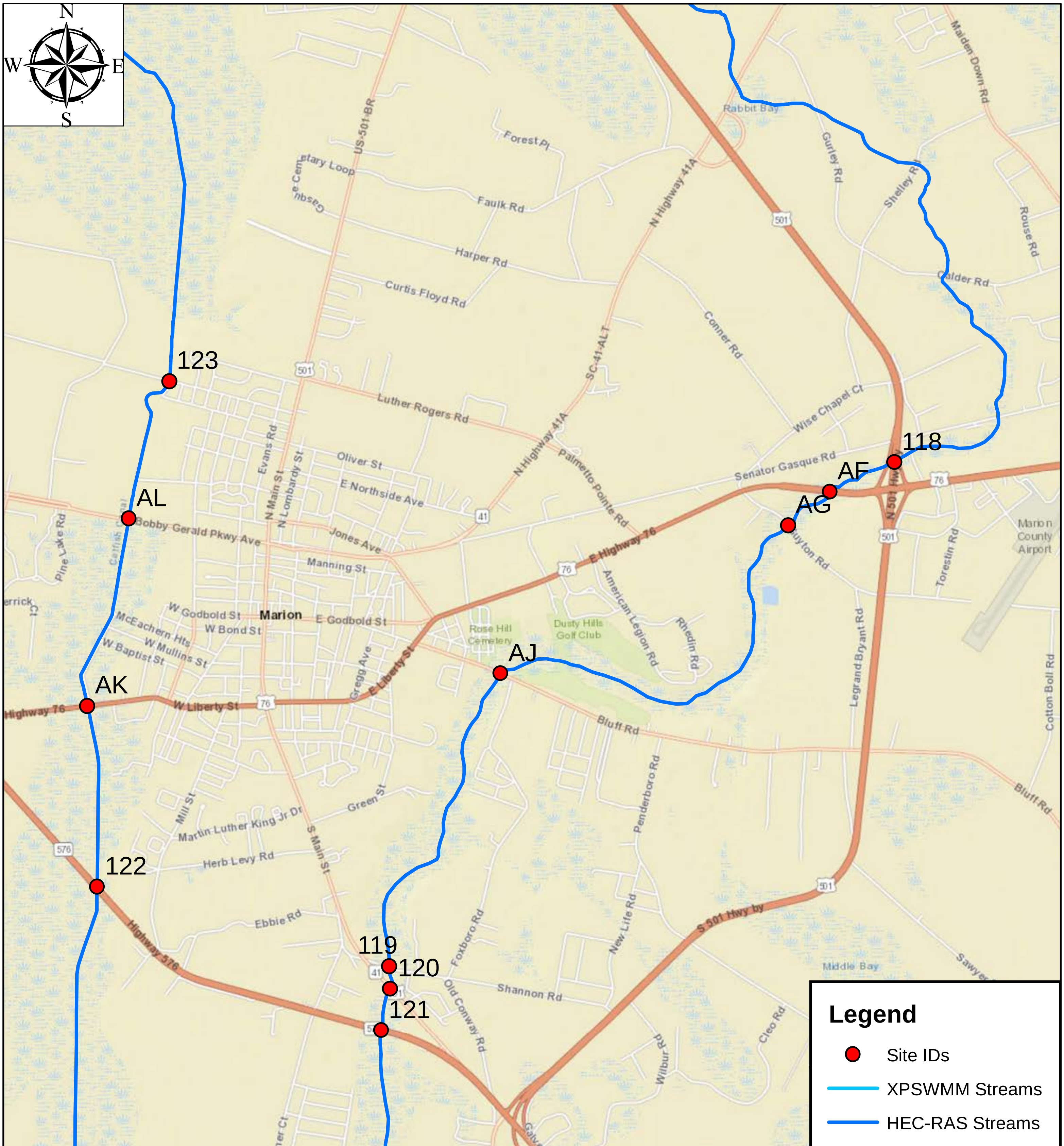
MARION COUNTY
STORMWATER MASTERPLAN
NICHOLS EXISTING INFRASTRUCTURE

0 750 1,500 3,000 Feet

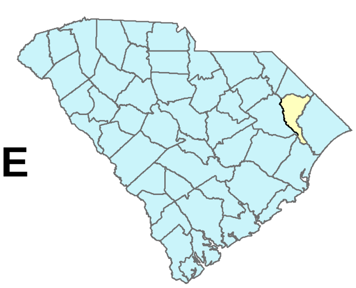


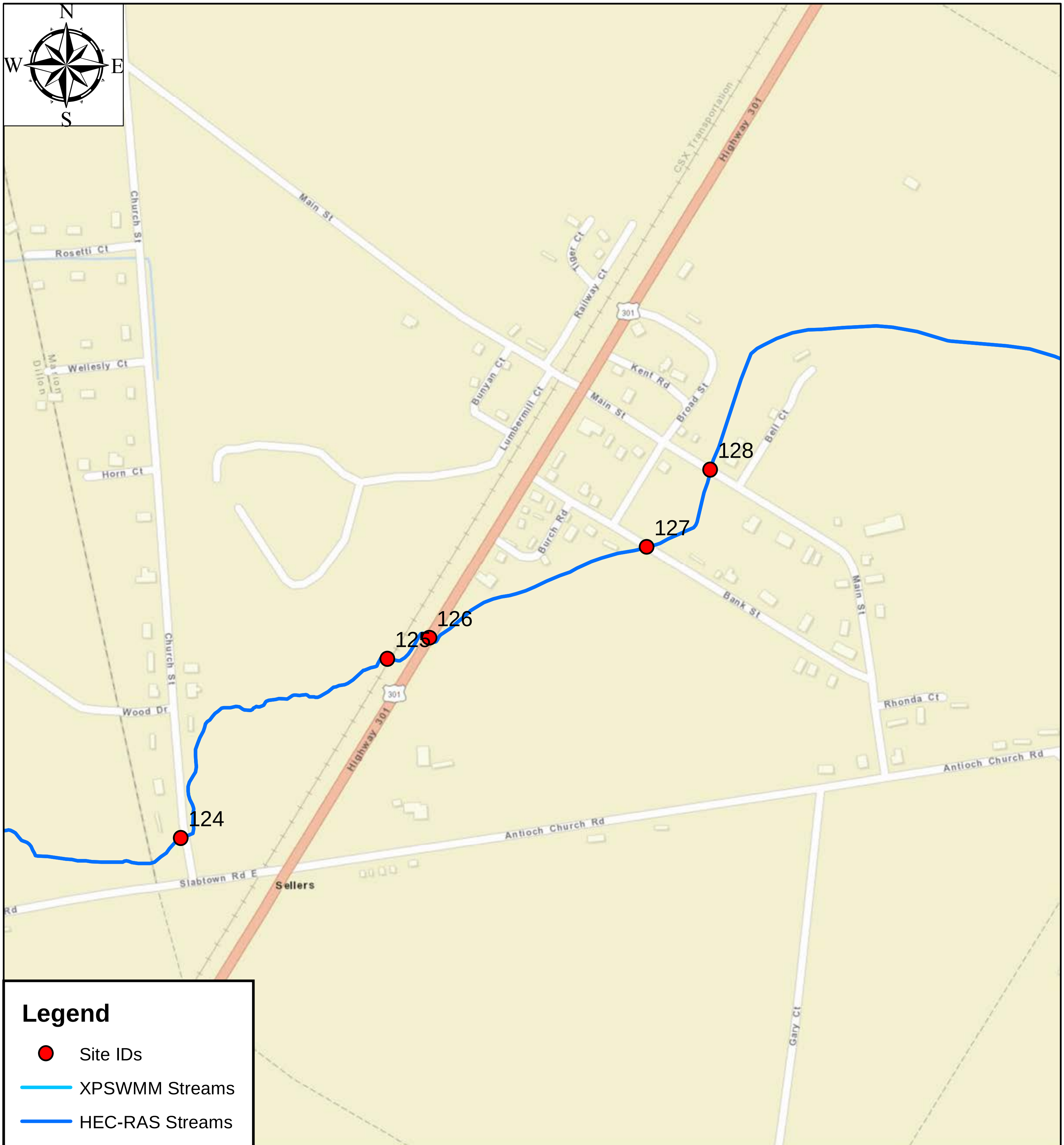
MARION COUNTY
STORMWATER MASTERPLAN
MULLINS EXISITING INFRASTRUCTURE



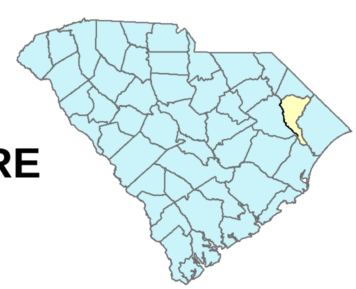


MARION COUNTY
STORMWATER MASTERPLAN
MARION EXISTING INFRASTRUCTURE





MARION COUNTY
STORMWATER MASTERPLAN
SELLERS EXISTING INFRASTRUCTURE



0 500 1,000 2,000
Feet

Site ID A

Looking upstream of 18in HDPE pipe

Looking downstream of 18in HDPE pipe

Site ID B

Upstream ditch

Upstream face of existing 36in CMP

Downstream face of existing 36in CMP

Site ID C

Flooded area without a defined channel

Flooded area without a defined channel

Flooded area without a defined channel

Flooded area without a defined channel

Site ID C (cont.)

Flooded area without a defined channel

Site ID D

Looking downstream inside 8ft x 6ft RCBC

Looking downstream inside 8ft x 6ft RCBC

Outlet of box culvert

Outlet of box culvert

Site ID D (Cont.)

Upstream face of box culvert

Drop inlet connecting storm drainage to box culvert

Site ID E

Upstream face of existing 30in RCP

Downstream outlet of existing 30in RCP

Site ID F

Upstream face of existing 30in RCP

Downstream face of existing 30in RCP

Site ID G

Upstream face of existing 30in RCP

Downstream face of existing 30in RCP

Site ID I

Upstream face of existing (1) 30in RCP and (2) 36in RCP

Downstream ditch

Downstream face of existing (1) 30in RCP and (2) 36in RCP

Site ID J

Upstream face of existing 48in RCP

Downstream face of existing 48in RCP

Site ID L

Upstream face of existing (2) 42in RCP

Site ID M

Upstream face of existing (2) 24in HDPE pipes

Downstream ditch of existing (2) 24in HDPE pipes

Site ID N

Upstream face of existing 48in CMP

Downstream ditch

Downstream face of existing 48in CMP

Site ID O

Upstream face of existing 48in HDPE pipe

Downstream face of existing 48in HDPE pipe

Upstream ditch

Site ID P

Inlet at upstream end of culvert

Downstream face of existing 36in CMP

Upstream face of existing 36in CMP

Inlet at downstream end of culvert

Site ID Q

Upstream drop inlet for closed system

Broken pipe downstream of drop inlet

Site ID R

Upstream face of existing 15in RCP

Downstream face of existing 15in RCP

Site ID T

Looking upstream

Upstream face of existing bridge crossing

Downstream face of existing bridge crossing

Site ID U

Upstream face of existing bridge crossing

Looking upstream

Downstream face of existing bridge crossing

Site ID V

Upstream face of existing bridge crossing

Downstream face of existing bridge crossing

Site ID W

Upstream face of existing (1) 48in RCP and (1) 36in RCP

Upstream face of existing 48in HDPE pipe

Riprap protecting upstream channel bank

Site ID X

Drop inlet of closed system between Academy Street and E Dogwood Drive

Site ID Y

Upstream drop inlet

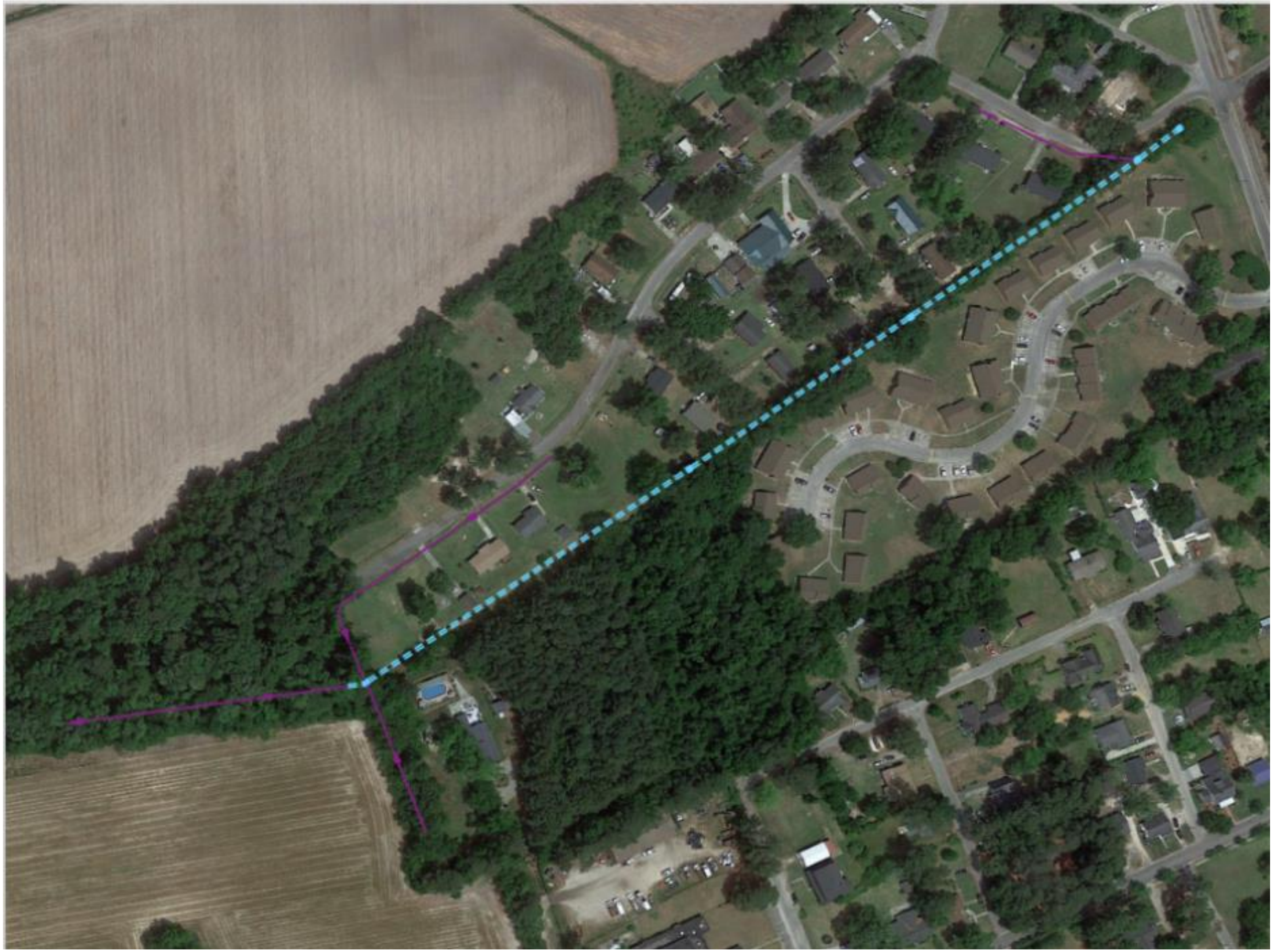
Downstream drop inlet

Looking downstream

Site ID Z

Upstream end of closed system that runs west between Johnson Street and Martin Street

Site ID AA



Location is a combination of open and closed drainage

Site ID AB

Looking upstream of existing broken 48in RCP

Upstream face of existing broken 48in RCP

Downstream ditch

Site ID AJ

Downstream face of bridge

Site ID AG

Downstream face of bridge

Site ID AF

Downstream face of bridge

Upstream face of bridge

Site ID AK

Downstream face of bridge

Upstream face of bridge

Site ID AL

Downstream face of bridge

Michael Baker
INTERNATIONAL

Site ID 100

Downstream face of bridge crossing

Upstream face of bridge crossing

Looking downstream of bridge crossing

Site ID 101

Looking downstream of 72in CMP

Looking upstream of 72in CMP

Looking upstream of CMP (2)

Site ID 102

Downstream face of bridge crossing

Upstream face of bridge crossing

Looking downstream of bridge crossing

Looking upstream of bridge crossing

Site ID 103

Looking downstream of 6ft x 6ft box culvert

Looking upstream of 6ft x 6ft box culvert

Looking downstream from 48in RCP

Looking downstream of 5ft x 5ft box culvert and 48in RCP

Downstream face of 48in RCP

Downstream face of box culvert

Downstream face of 48in RCP

Looking downstream of 48in RCP

Looking upstream of 48in RCP

Site ID 106

Downstream end of double 48in RCP

Downstream end of double 48in RCP

Downstream end of single 48in RCP under railroad

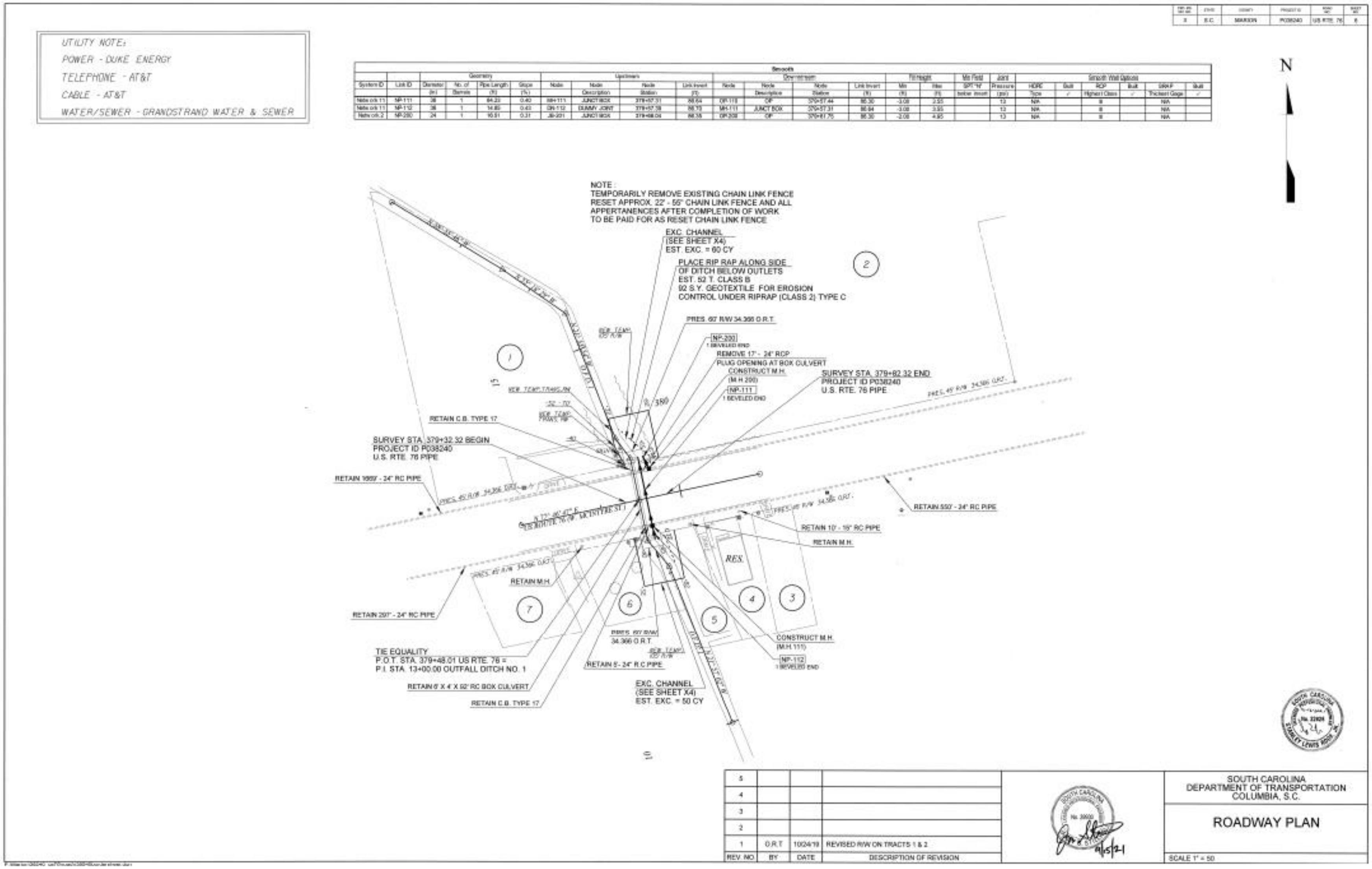
Site ID 109

Looking downstream of double 36in RCP

Looking downstream of double 36in RCP

Michael Baker
INTERNATIONAL

Site ID 110



Location is a combination of open and closed drainage

Site ID 111

Downstream face of bridge crossing

Looking upstream of bridge crossing

Looking downstream of bridge crossing

Site ID 112

Looking downstream of double 8ft x 5ft box culvert

Downstream face of double 8ft x 5ft box culvert

Circular culvert draining to stream

Upstream face of double 8ft x 5ft box culverts under railroad

Site ID 113

Looking downstream of 8 ft RCP

Upstream face of 8 ft RCP

Looking upstream of 8 ft RCP

Site ID 114

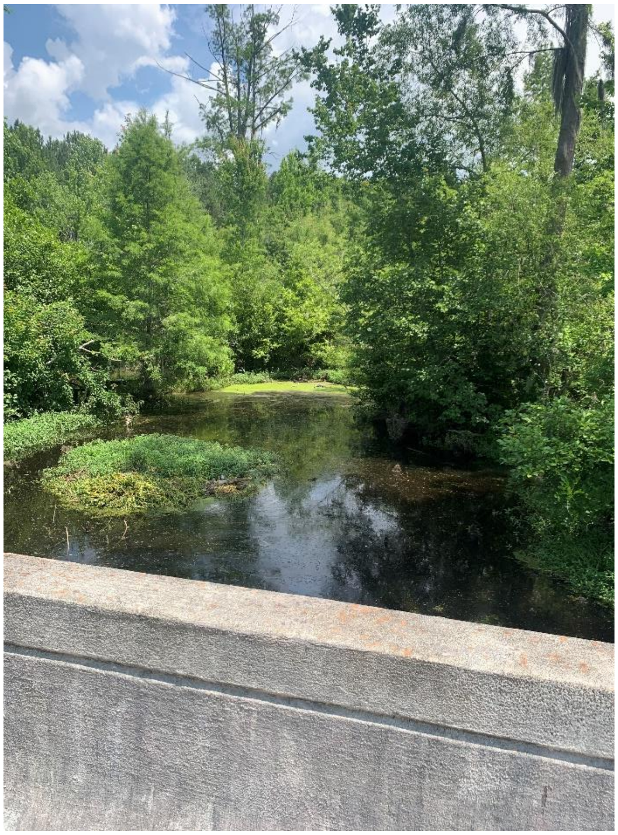
Downstream face of bridge crossing

Upstream face of bridge crossing

Looking downstream of bridge crossing

Looking upstream of bridge crossing

Site ID 115



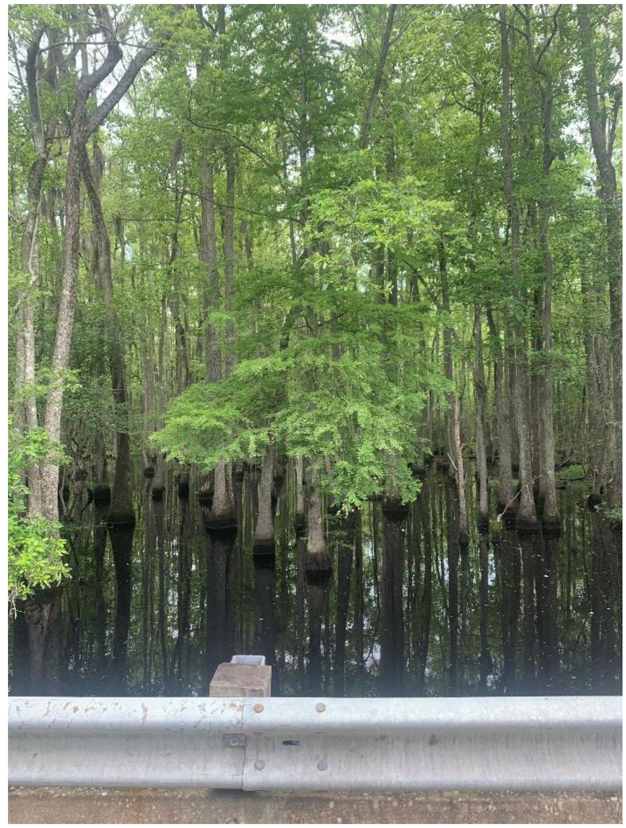
Looking downstream of bridge crossing

Looking upstream of bridge crossing

Looking upstream of bridge crossing (2)

Site ID 119

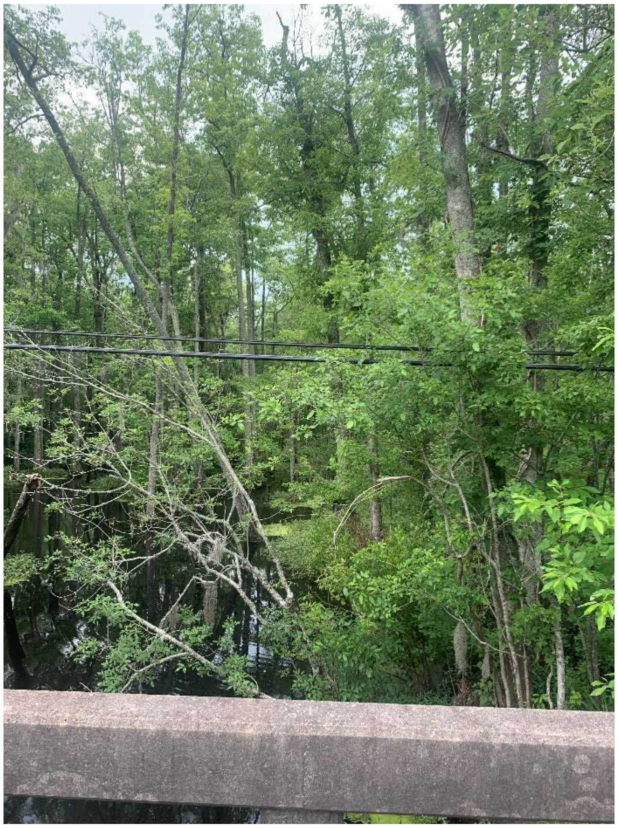
Looking downstream of bridge crossing



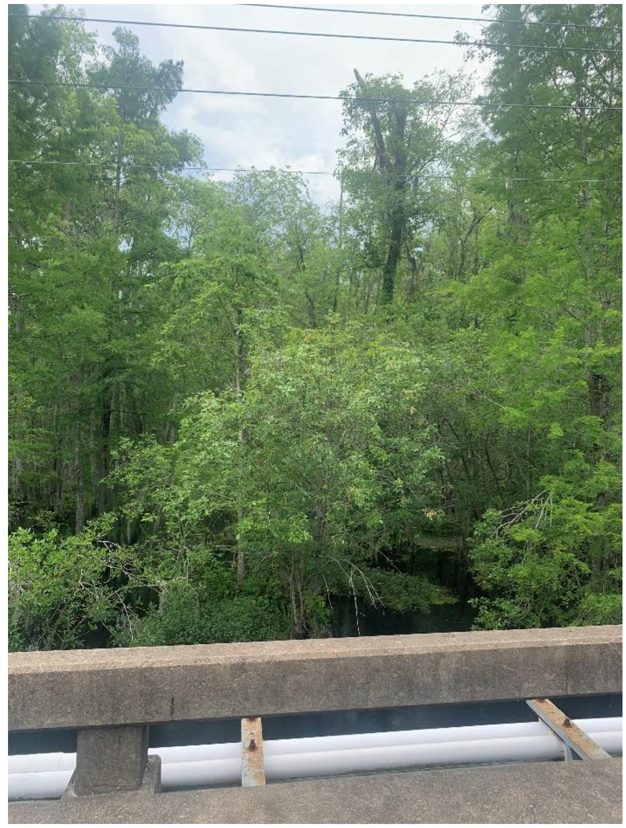
Looking upstream of bridge crossing

Looking downstream of bridge crossing (2)

Site ID 120

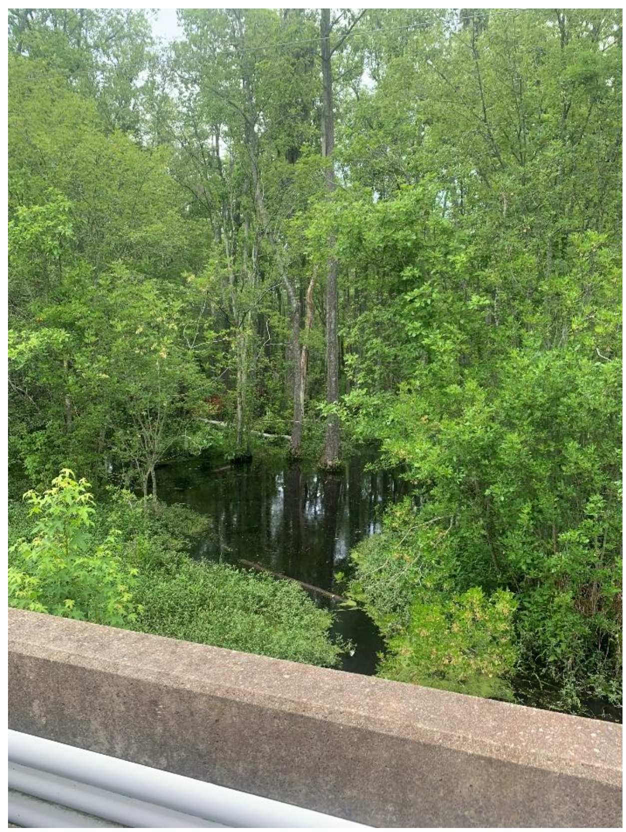


Looking downstream of bridge crossing



Looking upstream of bridge crossing

Looking downstream of bridge crossing (2)



Looking upstream of bridge crossing (2)

Site ID 121

Looking downstream of bridge crossing

Looking upstream of bridge crossing

Site ID 122

Looking downstream of bridge crossing

Looking upstream of bridge crossing

Michael Baker INTERNATIONAL

Site ID 123

Downstream face of bridge crossing

Upstream face of bridge crossing

Site ID 124

Looking downstream of double 48in RCP

Looking upstream of double 48in RCP

Site ID 125

Looking downstream of 48in arch culvert

Downstream face of 48in arch culvert

Site ID 126

Looking downstream of 6ft x 5ft double box culvert

Looing upstream of 6ft x 5ft double box culvert

Site ID 127

Downstream face of double 48in RCP

Looking upstream of double 48in RCP

Looking downstream of double 48in RCP

Site ID 128

Downstream face of double 48in RCP under sidewalk

Looking downstream of double 48in RCP

Upstream face of double 48in RCP

Looking upstream of double 48in RCP

Appendix E: Project Scores, Project Profiles, Benefit-Cost Analyses, & Supporting Documentation

A - Railroad Crossing Improvements - Sellers, SC

A - Railroad Crossing Improvements - Sellers, SC			
Prioritization Category	**Sub-Category**	**Points**	**Maximum Point**
LMI % Served	*LMI % X 20 points*	8.2	20
Level of Flood Risk Reduction	Above a 25-year / 24-hour storm event level of protection	10	10
Quantity of Flood Risk Reduction	50+ Structures	10	10
Benefit-Cost Ratio	75-100%	20	20
Leveraged Funding	Limited potential cost share identified	5	10
Permitting/Scheduling	Potential challenges	5	10
Mobility Improvement	Significant mobility improvements	5	5
Phasing Considerations	Limited Contribution	3	5
Project Synergies	Limited cost savings	3	5
Environmental Impact	Neutral Impact	3	5
		72.2	100

RAILROAD CROSSING IMPROVEMENTS

Sellers, South Carolina

Category:
Fully Meets Design Standards

Purpose:
To reduce and/or alleviate flooding upstream of the railroad and US 301 which includes the majority of the Town of Sellers

Background

Sellers Branch flows from east to west and passes through downtown Sellers as shown in Figure A1. There are four main hydraulic crossings along Sellers Branch which include double 48” reinforced concrete pipes under Main Street, double 48” reinforced concrete pipes under Bank Street, a double 6’(W) x 5’(H) box culvert under Highway 301 (Figure A2), and a single 48” x 60” cast in place arch pipe under the railroad (Figure A3).

Figure A1: Sellers Branch centerline with parcel boundaries

Figure A2: Existing double 6'(W) x 5'(H) box culvert under Highway 301

Figure A3: Existing single 48" x 60" cast in place arch pipe under the railroad

Potential Project

After reviewing the water surface profile from the existing condition HEC-RAS model, it was evident that the railroad crossing was acting as a pinch point along the stream and backing water up into the downtown area. As can be seen in Figures A2 and A3 above, there is a significant decrease in available flow area at the railroad crossing compared to the upstream Highway 301 crossing. To reduce or eliminate the restriction caused by the existing railroad culvert, two improvements were investigated; upsize the crossing under the railroad or reduce the peak flowrate to the existing crossing to an acceptable rate that would result in no headwater build up at the railroad.

This potential project discusses the impacts and benefits of upsizing the existing railroad culvert. A double 6'(W) x 5'(H) box culvert was first selected as this size matches the structure size immediately upstream of the railroad crossing. The change in the 100-year water surface profile is shown below in Figure A4. The red line represents the 100-year water surface profile along Sellers Branch with the existing railroad crossing in place. The blue line represents the 100-year water surface elevation with a new double 6'(W) x 5'(H) box culvert under the railroad. The difference in water surface elevation upstream of the railroad and Highway 301 is approximately 5'. Figure A5 shows the 100-year flood depths with the existing railroad infrastructure in place. The red polygons in the graphic show structure footprints within the area. Figure A6 shows the 100-year flood depths with the upsized railroad crossing in place. From a comparison of Figure A5 and A6, one can see that the upsized crossing decreases the limits of flooding which results in the removal of several structures from the 100-year floodplain. Additionally for those structures still located within the floodplain, the floodplain depth is significantly reduced.

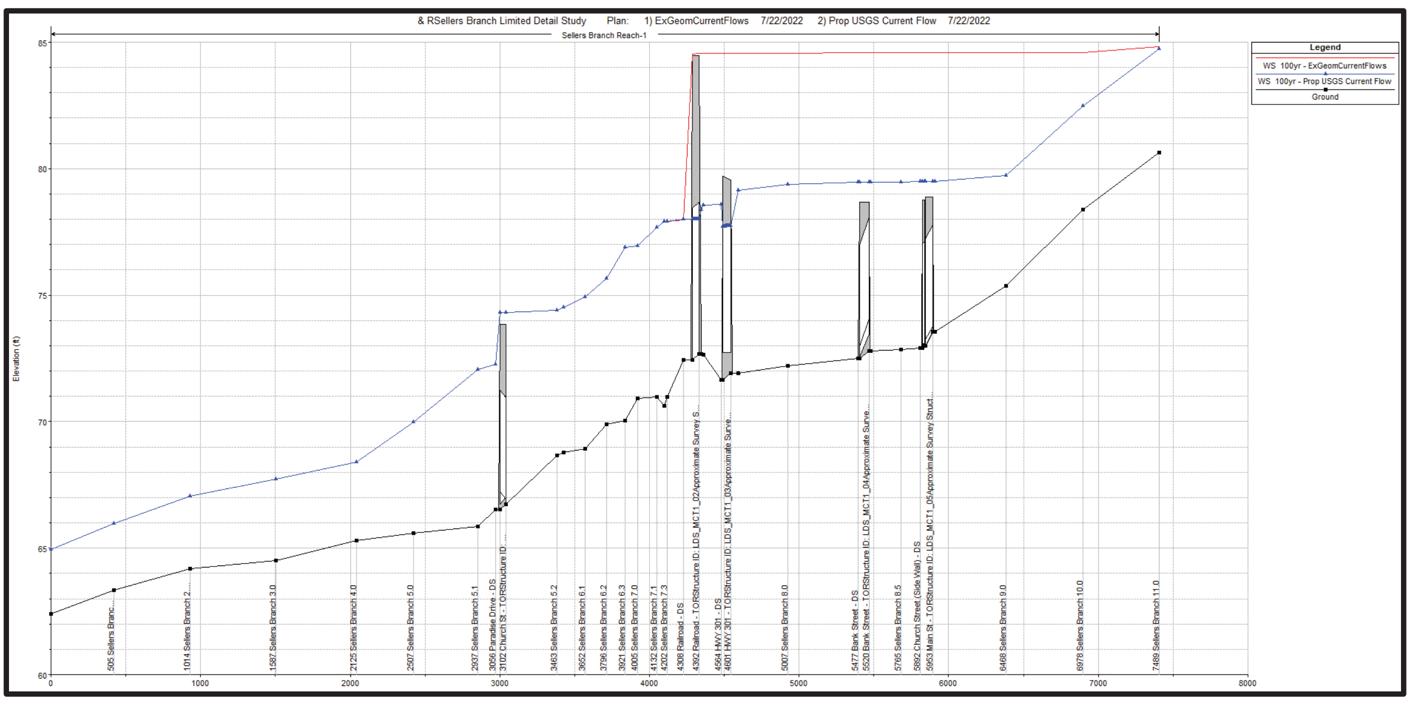


Figure A4: 100-yr water surface profile along Sellers Branch showing existing condition (red) and proposed improvements (blue)

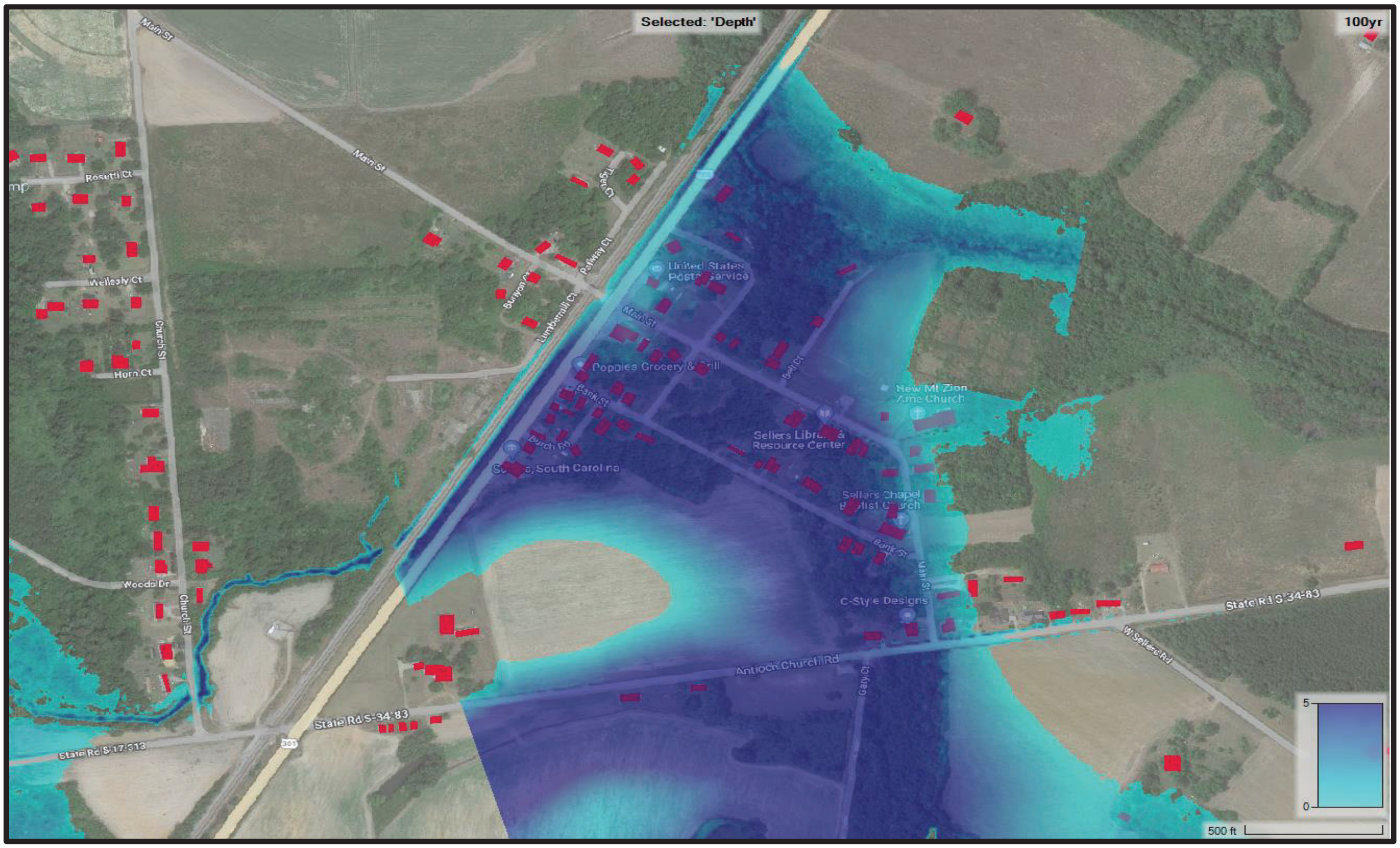


Figure A5: 100-yr flood depth with existing railroad infrastructure in place

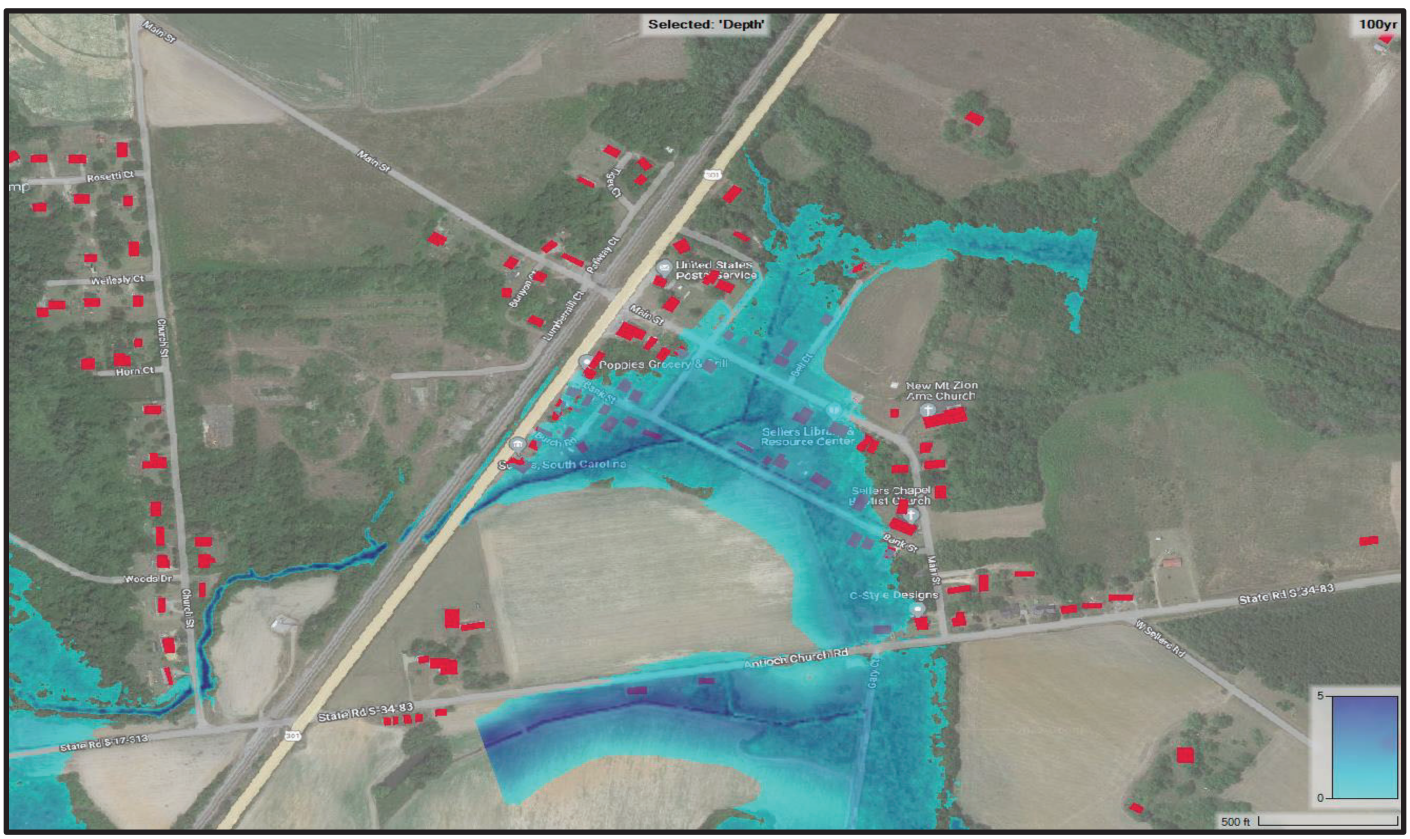


Figure A6: 100-yr flood depth with upsized railroad crossing

Additional Considerations

Sellers Branch is in a detailed FEMA Zone AE without an established floodway. Any improvements may require FEMA coordination, but at a minimum will require coordination with the local floodplain manager.

Updated topographic information may be required to better define the floodplain inundation limits as the existing LiDAR is from 2008.

Finished floor elevations on structures within the floodplain will be required to ensure structures are above the floodplain.

As can be seen in Figure A6 above, not all structures are outside the 100-year floodplain with the upsized railroad crossing.

PROJECT BENEFITS

Reduces upstream flooding in the Town

Significantly reduces depth of flooding upstream

Improves level of service of US 301

Removes several structures from the 100-year floodplain

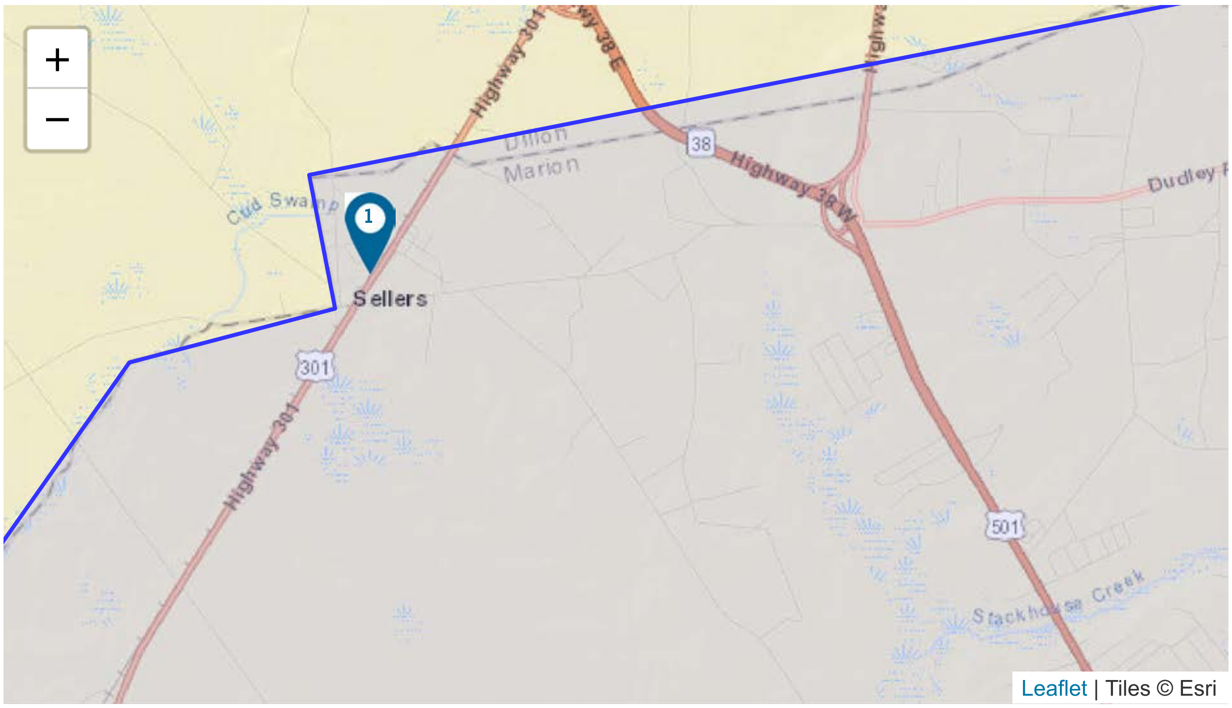
FEMA

Benefit-Cost Calculator

V.6.0 (Build 20221028.1600 | Release Notes)

Benefit-Cost Analysis

Project Name: A - Railroad Crossing Improvements - Sellers, SC



				Using 7% Discount Rate			Using 3% Discount Rate (For FY22 BRIC and FMA only)		
Map Marker ▲	Mitigation Title	Property Type	Hazard	Benefits (B)	Costs (C)	BCR (B/C)	Benefits (B)	Costs (C)	BCR (B/C)
1	Drainage Improvement @ 34° 16' 51.8199600"; -79° -28' -31.5699600"		DFA - Riverine Flood	$ 859,690	$ 585,801	1.47	$ 1,602,784	$ 597,730	2.68
TOTAL (SELECTED)				**$ 859,690**	**$ 585,801**	**1.47**	**$ 1,602,784**	**$ 597,730**	**2.68**
TOTAL				**$ 859,690**	**$ 585,801**	**1.47**	**$ 1,602,784**	**$ 597,730**	**2.68**

Property Configuration

Property Title:	Drainage Improvement @ 34° 16' 51.8199600"; -79° -28' -31.5699600"
Property Location:	29592, Marion, South Carolina
Property Coordinates:	34.2810528, -79.4754361
Hazard Type:	Riverine Flood
Mitigation Action Type:	Drainage Improvement
Property Type:	Roads & Bridges
Analysis Method Type:	Professional Expected Damages

Cost Estimation

Drainage Improvement @ 34° 16' 51.8199600"; -79° -28' -31.5699600"

Project Useful Life (years):	50
Project Cost:	$572,000
Number of Maintenance Years:	50 Use Default:Yes
Annual Maintenance Cost:	$1,000

Damage Analysis Parameters - Damage Frequency Assessment

Drainage Improvement @ 34° 16' 51.8199600"; -79° -28' -31.5699600"

Year of Analysis was Conducted:	2022
Year Property was Built:	1960
Analysis Duration:	63 Use Default:Yes

Roads and Bridges Properties

Drainage Improvement @ 34° 16' 51.8199600"; -79° -28' -31.5699600"

Estimated Number of One-Way Traffic Detour Trips per Day:	0
Additional Time per One-Way Detour Trip (minutes):	0
Number of Additional Miles:	0
Federal Rate ($):	0.625 Use Default:Yes
Economic Loss Per Day of Loss of Function ($):	0

Comments

-

Number of Trips:

Railroad crossing not roadway crossing.

Professional Expected Damages Before Mitigation

Drainage Improvement @ 34° 16' 51.8199600"; -79° -28' -31.5699600"

	ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
25	1	645,920	911,400	0	0	0	1,557,320

Comments

-

Damages Before Mitigation:

Using the FEMA Flood Damage Calculator, and assuming approximately 43-structures are removed from the 25-year floodplain (based on hydraulic modeling) and approximately half of the impacted structures (1,000-SF) are relieved of 4-foot of flood damage and the other half are relieved of 1-foot of flood, damage cost values of $43,400 per impacted structure (21) and $29,360 per impacted structure (22) were used.

Annualized Damages Before Mitigation

Drainage Improvement @ 34° 16' 51.8199600"; -79° -28' -31.5699600"

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
25	1,557,320	62,293
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	1,557,320	62,293

Professional Expected Damages After Mitigation

Drainage Improvement @ 34° 16' 51.8199600"; -79° -28' -31.5699600"

	ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
0	0	0	0	0	0	0	0

Annualized Damages After Mitigation

Drainage Improvement @ 34° 16' 51.8199600"; -79° -28' -31.5699600"

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	0	0

Standard Benefits - Ecosystem Services

Drainage Improvement @ 34° 16' 51.8199600"; -79° -28' -31.5699600"

Total Project Area (acres):	0
Percentage of Urban Green Open Space:	0.00%
Percentage of Rural Green Open Space:	0.00%
Percentage of Riparian:	0.00%
Percentage of Coastal Wetlands:	0.00%
Percentage of Inland Wetlands:	0.00%
Percentage of Forests:	0.00%
Percentage of Coral Reefs:	0.00%
Percentage of Shellfish Reefs:	0.00%
Percentage of Beaches and Dunes:	0.00%
Expected Annual Ecosystem Services Benefits:	$0

Benefits-Costs Summary

Drainage Improvement @ 34° 16' 51.8199600"; -79° -28' -31.5699600"

Total Standard Mitigation Benefits:	$859,690
Total Social Benefits:	$0
Total Mitigation Project Benefits:	$859,690
Total Mitigation Project Cost:	$585,801
Benefit Cost Ratio - Standard:	1.47
Benefit Cost Ratio - Standard + Social:	1.47

BCA Cost Estimate - A - Railroad Crossing Improvements, Sellers SC

HARD COSTS

ITEM	IDESCR	IDESCRL	QUANTITY	UNITS	UNIT COST	COST
1031010	MOBILIZATION	MOBILIZATION		LS	5%	$ 13,298.20
1071000	TRAFFIC CONTROL	TRAFFIC CONTROL		LS	0%	$ -
2011000	CLEAR. & GRUB. WITHIN R/W	CLEARING & GRUBBING WITHIN RIGHT OF WAY		LS	3.5%	$ 9,308.74
2028500	REM&DISP.OF EX.CULV CAST IN PLACE 48" x 60" CULVERT	REMOVAL & DISPOSAL OF EXISTING CULVERT CAST IN PLACE 48" x 60" CULVERT	1	EA	$ 20,000.00	$ 20,000.00
7221023	6'X5' PCBOX CULV.{M-273}FH<2	6'X5' PCBOX CULV.{M-273}FH<2 6'X 5'	94	LF	$ 1,840.00	$ 172,960.00
8041020	RIP-RAP (CLASS B)	RIP-RAP (CLASS B)	200	TON	$ 98.38	$ 19,676.00
8048105	GEOTEX/EROS.CONT(CLASS1)TYPE B	GEOTEXTILE FOR EROSION CONTROL UNDER RIPRAP(CLASS 1)TYPE B	200	SY	$ 4.14	$ 828.00
8101000	SEEDING (MULCHED)	SEEDING (MULCHED)	1	MSY	$ 750.00	$ 750.00
8153000	SILT FENCE	SILT FENCE	500	LF	$ 3.50	$ 1,750.00
	RAILROAD TRACK/BALLAST REBUILD	RAILROAD TRACK/BALLAST REBUILD	100	LF	$ 500.00	$ 50,000.00
	RAIL SHOOFLY (DESIGN AND CONSTRUCTION)	RAIL SHOOFLY (DESIGN AND CONSTRUCTION)		LS		$ -
	CONTINGENCY	CONTINGENCY 35% (ADDITIONAL CONTINGENCY FOR RAIL PROJECTS)	-	-		$ 100,999.83
					SUB-TOTAL:	$ 265,964.00
					HARD COST TOTAL:	$ 389,570.77

SOFT COSTS

RAILROAD CONSTRUCTION OBSERVATION	RAILROAD CONSTRUCTION OBSERVATION		$ 60,000.00
RAILROAD ENGINEERING REVIEW	RAILROAD CONSULTANT DESIGN REVIEW		$ 25,000.00
DESIGN	SURVEY, STRUCTURAL DESIGN, HYDRO DESIGN, AND ENVIRO COMPLIANCE		$ 77,914.15
PERMITTING & FEES	LAND DISTURBANCE/NPDES PERMITTING, ENVIRO, SCDOT, ETC.		$ 19,478.54
		SOFT COST TOTAL:	$ 182,392.69
		GRAND TOTAL:	$ 571,963.46
		ROUNDED TOTAL:	$ 572,000.00

B - Stormwater Parks - Sellers, SC

B - Stormwater Parks - Sellers, SC			
Prioritization Category	**Sub-Category**	**Points**	**Maximum Point**
LMI % Served	*LMI % X 20 points*	8.2	20
Level of Flood Risk Reduction	Above a 25-year / 24-hour storm event level of protection	10	10
Quantity of Flood Risk Reduction	10-25 Structures	4	10
Benefit-Cost Ratio	25-50%	7	20
Leveraged Funding	No potential cost share identified	0	10
Permitting/Scheduling	Potential challenges	5	10
Mobility Improvement	Significant mobility improvements	5	5
Phasing Considerations	Limited Contribution	3	5
Project Synergies	Limited cost savings	3	5
Environmental Impact	Green Infrastructure or Improved Impact	5	5
		50.2	100

STORMWATER PARKS

Sellers, South Carolina

Category:
Low Impact Development and/or Retrofit

Purpose:
To reduce large storm event peak flow rates observed at the Main Street crossing and downstream which includes the majority of the Town of Sellers

Background

Sellers Branch flows from east to west and passes through downtown Sellers as shown in Figure B1. A tributary joins with the upper reach of Sellers Branch just north of State Road S-34-196 after crossing under the railroad and US-301. This confluence is north/upstream of the Main Street crossing. These two (2) reaches drain catchments that contribute the majority of stormwater flow through the Town of Sellers, an approximately 0.6 square mile area.

Figure B1: Sellers Branch centerline with tributary streams shown on ariel background. Source: StreamStats.usgs.gov/ss/

Potential Project

In conjunction with the previously proposed potential project in Sellers, Railroad Crossing Improvements, there is potential to supply a stormwater park/detention facility at two (2) locations upstream of the confluence of the upper reach of Sellers Branch and its northwest tributary.

The first location for a potential stormwater park/detention facility is Parcel TMS 6011506000000 that is currently owned by the Town of Sellers and appears to currently contain a small playground and mainly operate as an open-space recreational area. Figure B2 below from Marion County GIS details some parcel information.

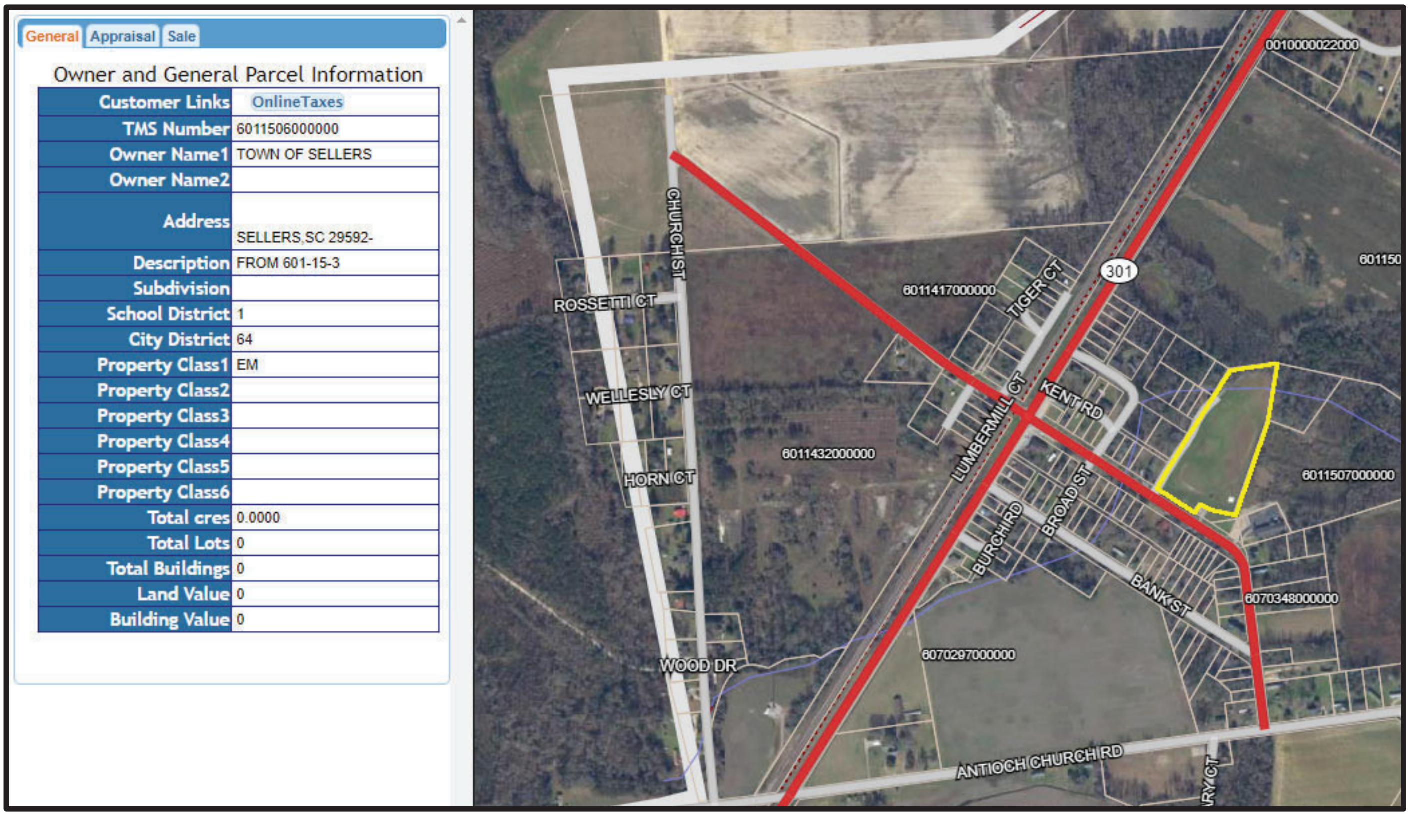


Figure B2: Parcel TMS 6011506000000 information. Source: https://marionsc.wthgis.com/

An approximately 0.27 square mile area could potentially be routed through a stormwater park/detention facility located on this property. See Figure B3 below. As this property is already owned by the Town of Sellers there would be no procurement costs, and as it already appears to be used for recreation there would not be any major change or loss of use.

Via preliminary and conceptual level design it was determined that, with excavation, approximately 1,000,000 cubic-feet of storage could be provided with a 3-ft permanent pool and 10-ft of vertical storage capacity. A reduction of approximately 26% of the 100-year peak flow rate and 43% of the 50-year peak flow rate was conceptually determined to be possible. Figure B4 below depicts conceptual drafting associated with the potential stormwater park/detention facility.

Depending on configuration/layout, a multiuse path (with appropriate safety considerations) could be incorporated and if stocked and adequately maintained recreational fishing could be provided.

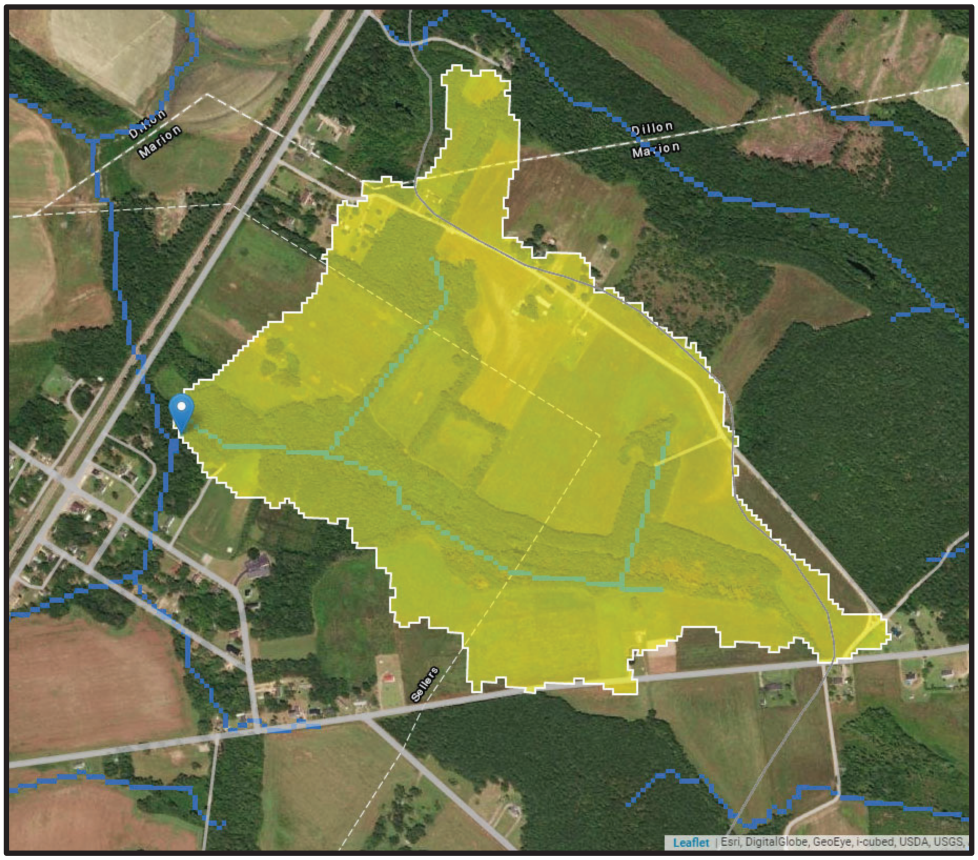


Figure B3: Drainage area of Upper Sellers Branch upstream of confluence with northwest tributary, 0.27 square miles.

Figure B4: Conceptual layout of the potential stormwater park/detention facility located on the Town of Sellers property.

The second location for a potential stormwater park/detention facility is [redacted] that is currently owned by [redacted] and appears to currently contain an [redacted] that mainly operates in [redacted]. Figure B5 below from Marion County GIS details some parcel information.

[redacted]

Figure B5: [redacted]

An approximately 0.31 square mile area could potentially be routed through a stormwater park/detention facility located [redacted]. See Figure B6 below. As this property is not owned by the Town of Sellers there would be procurement costs, and as it is currently used for [redacted] there would be a change of land use associated with this potential project location.

It was determined that a similar footprint to what was presented above at the Town owned property is feasible and therefore similar storage capacity and reduction of peak flows could be possible via routing this drainage area through a stormwater park/detention facility.

Reducing the peak flow rates along either or both of these reaches of Upper Sellers Branch would have positive impacts to the function of the downstream crossings, improve the level of service of associated roadways, and likely reduce or eliminate flooding. After implementation of the railroad crossing improvements and reduction of the associated tailwater/backwater condition, it appears that achieving a flowrate of approximately 100-cfs would result in passage of flow through the Main Street double 48-inch RCP crossing according to our hydraulic model. Based on the preliminary and conceptual level stormwater park/detention facility design previously outlined, this level of flow reduction potentially feasible via implementation of both stormwater parks/detention facilities.

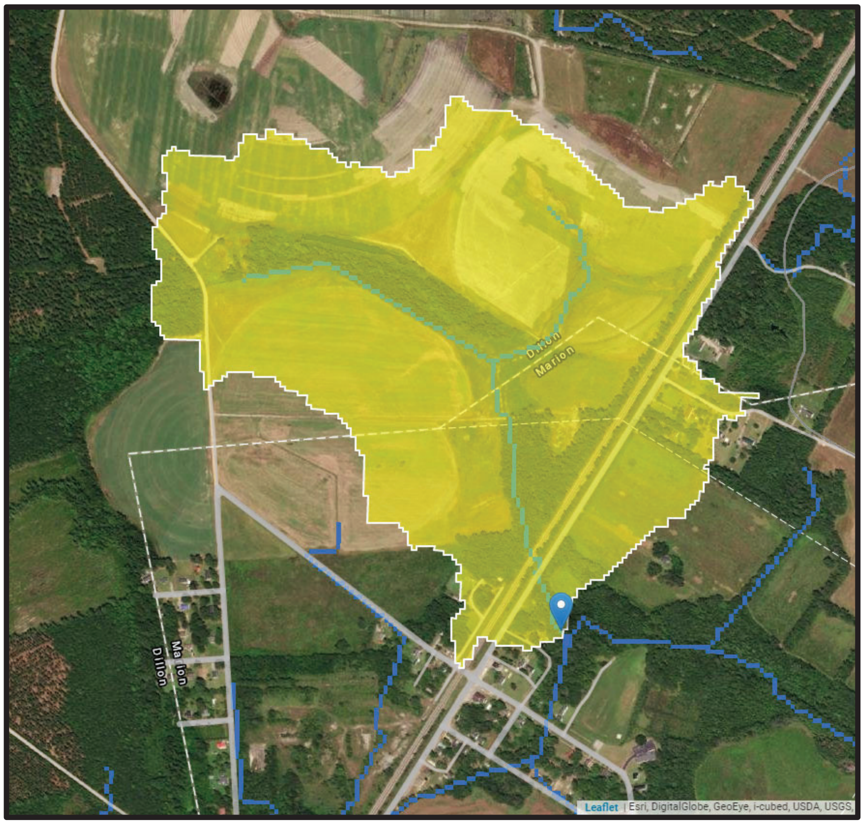


Figure B6: Drainage area of northwest tributary to Sellers Branch upstream of confluence, 0.31 square miles.

Additional Considerations

Sellers Branch is in a FEMA Zone AE without an established floodway. Any improvements/alterations to the normal stream flow, such as in-line or off-line storage will likely require FEMA coordination, but at a minimum will require coordination with the local floodplain manager.

Significant detailed survey, preliminary environmental information, and preliminary engineering design would need to be initiated to determine the most appropriate stormwater park configuration and fully assess the cost benefit relationship.

Environmental permitting could also be a significant hurdle for either potential project location, but specifically for the Sellers owned property as that option represents more off-line storage, and depending on detailed design, could dewater the contributing stream. Based on the design information currently available, the elevations/topography of the Sellers owned property would likely require diverting a significant flow from the stream as opposed to detaining/capturing runoff prior to entering the stream.

PROJECT BENEFITS

- ***Alleviate downstream flooding in the Town***
- ***Potential additional recreation opportunities***
- ***Improves level of service of Main Street and downstream crossings***
- ***Project is scalable based on funding/needs***

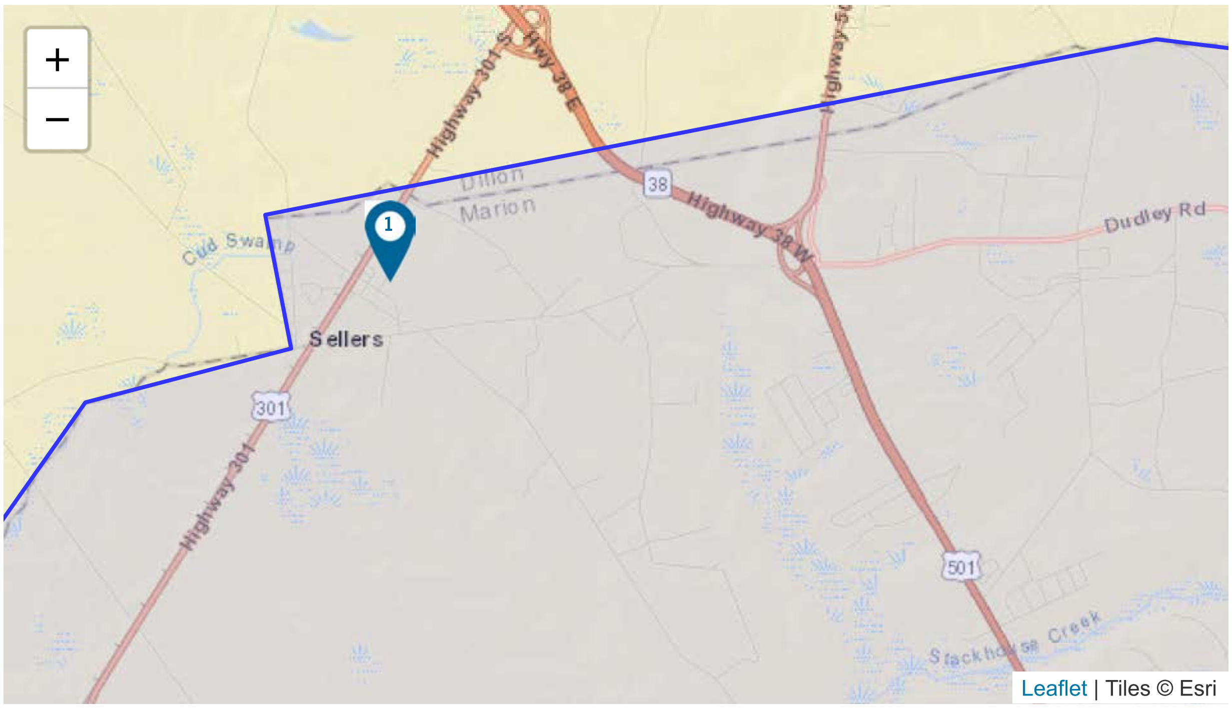
FEMA

Benefit-Cost Calculator

V.6.0 (Build 20221028.1600 | Release Notes)

Benefit-Cost Analysis

Project Name: B - Stormwater Parks - Sellers, SC



				Using 7% Discount Rate			Using 3% Discount Rate (For FY22 BRIC and FMA only)		
Map Marker ▲	Mitigation Title	Property Type	Hazard	Benefits (B)	Costs (C)	BCR (B/C)	Benefits (B)	Costs (C)	BCR (B/C)
1	Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"		DFA - Riverine Flood	$ 3,346,743	$ 2,829,539	1.18	$ 7,411,280	$ 2,864,198	2.59
TOTAL (SELECTED)				**$ 3,346,743**	**$ 2,829,539**	**1.18**	**$ 7,411,280**	**$ 2,864,198**	**2.59**
TOTAL				**$ 3,346,743**	**$ 2,829,539**	**1.18**	**$ 7,411,280**	**$ 2,864,198**	**2.59**

Property Configuration

Property Title:	Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"
Property Location:	29592, Marion, South Carolina
Property Coordinates:	34.2833333, -79.4699306
Hazard Type:	Riverine Flood
Mitigation Action Type:	Floodwater Diversion and Storage
Property Type:	Other
Analysis Method Type:	Professional Expected Damages

Cost Estimation

Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"

Project Useful Life (years):	100
Project Cost:	$2,801,000
Number of Maintenance Years:	100 Use Default:Yes
Annual Maintenance Cost:	$2,000

Damage Analysis Parameters - Damage Frequency Assessment

Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"

Year of Analysis was Conducted:	2022
Year Property was Built:	1960
Analysis Duration:	63 Use Default:Yes

Professional Expected Damages Before Mitigation

Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
10	0	2,000,000	0	0	0	0	2,000,000

Comments

-

Damages Before Mitigation:

Category 1 damages represent the value in additional runoff storage ($2/CF) added by the installation of the detention (approximately 1M CF), reference "The Economics of Low-Impact Development: A Literature Review" published in November 2007 by ECONorthwest.

Annualized Damages Before Mitigation

Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
10	2,000,000	200,000
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	2,000,000	200,000

Professional Expected Damages After Mitigation

Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
0	0	0	0	0	0	0	0

Annualized Damages After Mitigation

Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	0	0

Standard Benefits - Ecosystem Services

Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"

Total Project Area (acres):	5.3
Percentage of Urban Green Open Space:	0.00%
Percentage of Rural Green Open Space:	61.30%
Percentage of Riparian:	0.00%
Percentage of Coastal Wetlands:	0.00%
Percentage of Inland Wetlands:	0.00%
Percentage of Forests:	0.00%
Percentage of Coral Reefs:	0.00%
Percentage of Shellfish Reefs:	0.00%
Percentage of Beaches and Dunes:	0.00%
Expected Annual Ecosystem Services Benefits:	$34,542

Benefits-Costs Summary

Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"

Total Standard Mitigation Benefits:	$3,346,743
Total Social Benefits:	$0
Total Mitigation Project Benefits:	$3,346,743
Total Mitigation Project Cost:	$2,829,539
Benefit Cost Ratio - Standard:	1.18
Benefit Cost Ratio - Standard + Social:	1.18

BCA Cost Estimate - B - Stormwater Parks, Sellers SC

HARD COSTS

ITEM	IDESCR	IDESCRL	QUANTITY	UNITS	UNIT COST		COST
1031010	MOBILIZATION	MOBILIZATION		LS		5%	$ 82,611.30
1071000	TRAFFIC CONTROL	TRAFFIC CONTROL		LS		0%	$ -
2011000	CLEAR. & GRUB. WITHIN R/W	CLEARING & GRUBBING WITHIN RIGHT OF WAY		LS		3.5%	$ 57,827.91
2031000	UNCLASSIFIED EXCAVATION	UNCLASSIFIED EXCAVATION	37000	CY	$	40.00	$ 1,480,000.00
7141136	36" RC PIPE CUL.-CLASS V	36" RC PIPE CUL.-CLASS V	150	LF	$	200.00	$ 30,000.00
8041020	RIP-RAP (CLASS B)	RIP-RAP (CLASS B)	300	TON	$	98.38	$ 29,514.00
8048105	GEOTEX/EROS.CONT(CLASS1)TYPE B	GEOTEXTILE FOR EROSION CONTROL UNDER RIPRAP(CLASS 1)TYPE B	300	SY	$	4.14	$ 1,242.00
8063300	72" CHAIN LINK FENCE	72" CHAIN LINK FENCE 72" CHAIN-LINK FENCE	1500	LF	$	64.28	$ 96,420.00
8064300	4' CHAIN LNK FENCE GATE(72"HT)	4' WIDE - CHAIN LINK FENCE GATE (72"HT)	1	EA	$	800.00	$ 800.00
8101000	SEEDING (MULCHED)	SEEDING (MULCHED)	5	MSY	$	750.00	$ 3,750.00
8153000	SILT FENCE	SILT FENCE	3000	LF	$	3.50	$ 10,500.00
	CONTINGENCY	CONTINGENCY 25%	-	-			$ 448,166.30
					SUB-TOTAL:		$ 1,652,226.00
					HARD COST TOTAL:		$ 2,240,831.51

SOFT COSTS

DESIGN	SURVEY, STRUCTURAL DESIGN, HYDRO DESIGN, AND ENVIRO COMPLIANCE		$ 448,166.30
PERMITTING & FEES	LAND DISTURBANCE/NPDES PERMITTING, ENVIRO, SCDOT, ETC.		$ 112,041.58
		SOFT COST TOTAL:	$ 560,207.88
		GRAND TOTAL:	$ 2,801,039.39
		ROUNDED TOTAL:	$ 2,801,000.00

C - US-76 / Sheriff's Department / Detention Center Outfall Improvements - Marion, SC

C - US-76 / Sheriff's Department / Detention Center Outfall Improvements - Marion, SC			
Prioritization Category	**Sub-Category**	**Points**	**Maximum Point**
LMI % Served	*LMI % X 20 points*	10.8	20
Level of Flood Risk Reduction	Above a 25-year / 24-hour storm event level of protection	10	10
Quantity of Flood Risk Reduction	0-10 Structures	0	10
Benefit-Cost Ratio	0-25%	0	20
Leveraged Funding	No potential cost share identified	0	10
Permitting/Scheduling	Little-to-no challenges	10	10
Mobility Improvement	Significant mobility improvements	5	5
Phasing Considerations	Limited Contribution	3	5
Project Synergies	Limited cost savings	3	5
Environmental Impact	Neutral Impact	3	5
		44.8	100

US 76 / SHERIFF'S DEPARTMENT / DETENTION CENTER OUTFALL IMPROVEMENTS - REVISED

Marion, South Carolina

Category:
Fully Meets Design Standards

Purpose:
Upsize the existing US 76 crossing and additional crossing just upstream to reduce flooding in the upstream floodplain and meet SCDOT design criteria

Background

The two culvert locations shown in Figure C1 have a contributing watershed of 2.95 square miles. The existing culvert under US-76 is a 4'(W) x 4'(H) box culvert that appears to experience overtopping of US 76 based on our calculations for events greater than 2-year storm events. The existing upstream culvert is a 90" x 72" elliptical corrugated metal pipe. These locations were pointed out by County personnel as a potential constriction in the flow pattern. The hydraulic models developed also indicate these crossings as constrictions.

Figure C1: Aerial Image of Culvert Locations Based on Survey Data

Figure C2: Recent Photo of the 90" x 72" CMP – Upstream Face

Figure C3: Recent Phot of the 4'(W) x 4'(H) RCBC US 76 Crossing Culvert - Upstream Face

Potential Project

Remove and replace both culverts with a culvert sized to properly convey the 50-year storm event at each location. An 8'(W) x 5'(H) box culvert would be required at the US-76 crossing location to meet SCDOT requirements for the 50-year storm and also prevent overtopping of US 76 for the 100-year storm event.

Additional Considerations

Traffic control would be required to remove and install the US 76 crossing which may impact traffic patterns in Marion.

PROJECT BENEFITS

Prevent Overtopping of US-76 up to the 100-year storm event

Reduce localized flooding directly upstream of the crossings

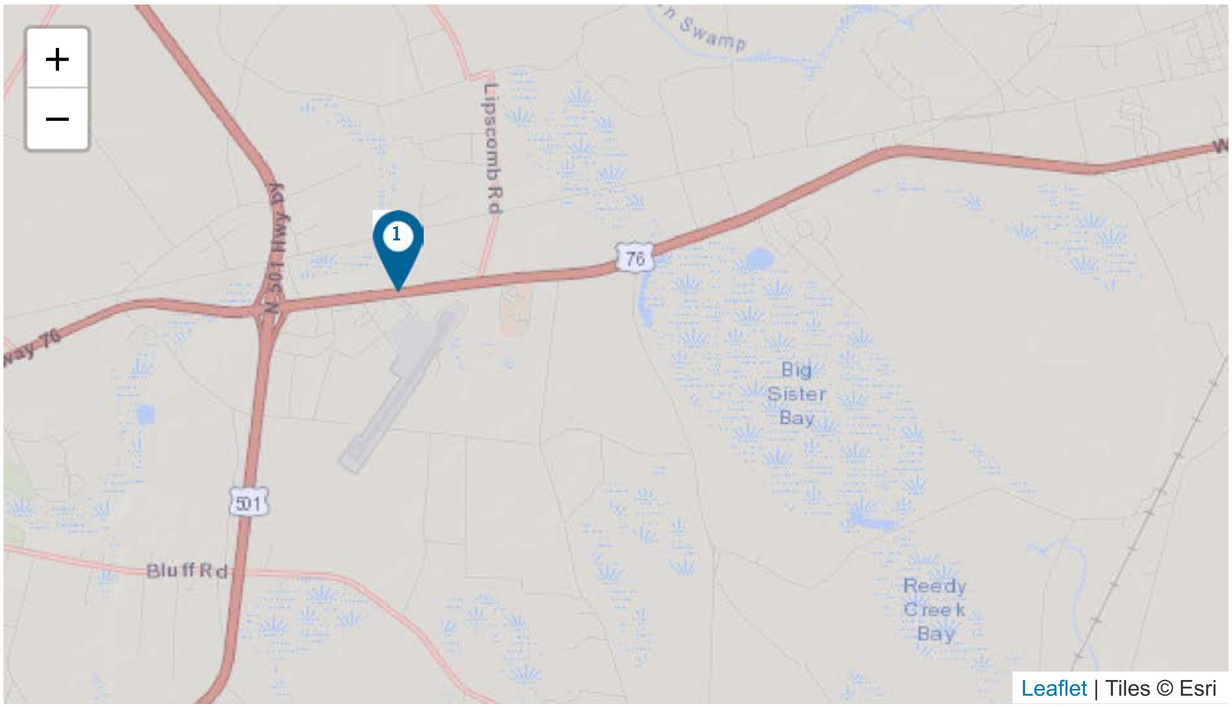
FEMA

Benefit-Cost Calculator

V.6.0 (Build 20221028.1600 | Release Notes)

Benefit-Cost Analysis

Project Name: C - US 76 / Sheriff's Department / Detention Center Outfall Improvements - Marion, SC



				Using 7% Discount Rate			Using 3% Discount Rate (For FY22 BRIC and FMA only)		
Map Marker ▲	Mitigation Title	Property Type	Hazard	Benefits (B)	Costs (C)	BCR (B/C)	Benefits (B)	Costs (C)	BCR (B/C)
1	Drainage Improvement @ 34.1879000; -79.3352083		DFA - Riverine Flood	$ 683,068	$ 746,801	0.91	$ 1,273,495	$ 758,730	1.68
TOTAL (SELECTED)				**$ 683,068**	**$ 746,801**	**0.91**	**$ 1,273,495**	**$ 758,730**	**1.68**
TOTAL				**$ 683,068**	**$ 746,801**	**0.91**	**$ 1,273,495**	**$ 758,730**	**1.68**

Property Configuration

Property Title:	Drainage Improvement @ 34.1879000; -79.3352083
Property Location:	29571, Marion, South Carolina
Property Coordinates:	34.1879000, -79.3352083
Hazard Type:	Riverine Flood
Mitigation Action Type:	Drainage Improvement
Property Type:	Roads & Bridges
Analysis Method Type:	Professional Expected Damages

Cost Estimation

Drainage Improvement @ 34.1879000; -79.3352083

Project Useful Life (years):	50
Project Cost:	$733,000
Number of Maintenance Years:	50 Use Default:Yes
Annual Maintenance Cost:	$1,000

Damage Analysis Parameters - Damage Frequency Assessment

Drainage Improvement @ 34.1879000; -79.3352083

Year of Analysis was Conducted:	2022
Year Property was Built:	1960
Analysis Duration:	63 Use Default:Yes

Roads and Bridges Properties

Drainage Improvement @ 34.1879000; -79.3352083

Estimated Number of One-Way Traffic Detour Trips per Day:	11,800
Additional Time per One-Way Detour Trip (minutes):	10
Number of Additional Miles:	1
Federal Rate ($):	0.625 Use Default:Yes
Economic Loss Per Day of Loss of Function ($):	77,388.33

Comments

-

Number of Trips:

AADT 2021 from SCDOT Street Finder

Professional Expected Damages Before Mitigation

Drainage Improvement @ 34.1879000; -79.3352083

	ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
25	1	605,200	554,800	0	0	0	1,237,388

Comments

-

Damages Before Mitigation:

When road overtops, hydroplaning accidents are likely. Assuming three potential accidents with 2 passengers per road overtopping event, due to the high volume of traffic. One of these potential accidents are assumed to be incapacitating due to the higher speed limit in this area. An injury crash is valued as $302,600 of damage per incident and an incapacitating level of injury is valued as $554,800 of damage per incident per Table A-1: Value of Reduced Fatalities and Injuries within the Benefit Cost Analysis Guidance for Discretionary Grant Programs, U.S. Department of Transportation, March 2022.

Annualized Damages Before Mitigation

Drainage Improvement @ 34.1879000; -79.3352083

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
25	1,237,388	49,495
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	1,237,388	49,495

Professional Expected Damages After Mitigation

Drainage Improvement @ 34.1879000; -79.3352083

	ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
0	0	0	0	0	0	0	0

Annualized Damages After Mitigation

Drainage Improvement @ 34.1879000; -79.3352083

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	0	0

Standard Benefits - Ecosystem Services

Drainage Improvement @ 34.1879000; -79.3352083

Total Project Area (acres):	0
Percentage of Urban Green Open Space:	0.00%
Percentage of Rural Green Open Space:	0.00%
Percentage of Riparian:	0.00%
Percentage of Coastal Wetlands:	0.00%
Percentage of Inland Wetlands:	0.00%
Percentage of Forests:	0.00%
Percentage of Coral Reefs:	0.00%
Percentage of Shellfish Reefs:	0.00%
Percentage of Beaches and Dunes:	0.00%
Expected Annual Ecosystem Services Benefits:	$0

Benefits-Costs Summary

Drainage Improvement @ 34.1879000; -79.3352083

Total Standard Mitigation Benefits:	$683,068
Total Social Benefits:	$0
Total Mitigation Project Benefits:	$683,068
Total Mitigation Project Cost:	$746,801
Benefit Cost Ratio - Standard:	0.91
Benefit Cost Ratio - Standard + Social:	0.91

BCA Cost Estimate - C - US-76 / Sheriff's Department / Detention Center Outfall Improvements, Marion SC

HARD COSTS

ITEM	IDESCR	IDESCRL	QUANTITY	UNITS	UNIT COST	COST
1031010	MOBILIZATION	MOBILIZATION		LS	5%	$ 18,775.20
1071000	TRAFFIC CONTROL	TRAFFIC CONTROL		LS	20%	$ 75,100.80
2011000	CLEAR. & GRUB. WITHIN R/W	CLEARING & GRUBBING WITHIN RIGHT OF WAY		LS	0.0%	$ -
2028500	REM&DISP.OF EX.CULV 4'X4'	REMOVAL & DISPOSAL OF EXISTING CULVERT 4'X4'	1	EA	$ 30,000.00	$ 30,000.00
4012120	FULL DEP.ASPH.PAV.PATCH-12"	FULL DEPTH ASPH. PAV. PATCHING 12"UNIF	500	SY	$ 120.00	$ 60,000.00
7221043	8'X5' PCBOX CULV.{M-273}FH<2	8'X 5' P.C. BOX CULVERT {AASHTO M-273} FH < 2 8'X 5'	130	LF	$ 2,000.00	$ 260,000.00
8041020	RIP-RAP (CLASS B)	RIP-RAP (CLASS B)	200	TON	$ 98.38	$ 19,676.00
8048105	GEOTEX/EROS.CONT(CLASS1)TYPE B	GEOTEXTILE FOR EROSION CONTROL UNDER RIPRAP(CLASS 1)TYPE B	200	SY	$ 4.14	$ 828.00
8101000	SEEDING (MULCHED)	SEEDING (MULCHED)	2	MSY	$ 750.00	$ 1,500.00
8153000	SILT FENCE	SILT FENCE	1000	LF	$ 3.50	$ 3,500.00
	CONTINGENCY	CONTINGENCY 25%	-	-		$ 117,345.00
					SUB-TOTAL:	$ 375,504.00
					HARD COST TOTAL:	$ 586,725.00

SOFT COSTS

DESIGN	SURVEY, STRUCTURAL DESIGN, HYDRO DESIGN, AND ENVIRO COMPLIANCE	$ 117,345.00
PERMITTING & FEES	LAND DISTURBANCE/NPDES PERMITTING, ENVIRO, SCDOT, ETC.	$ 29,336.25
	SOFT COST TOTAL:	$ 146,681.25
	GRAND TOTAL:	$ 733,406.25
	ROUNDED TOTAL:	$ 733,000.00

D - Catfish Creek Restoration - Marion, SC

D - Catfish Creek Restoration - Marion, SC			
Prioritization Category	**Sub-Category**	**Points**	**Maximum Point**
LMI % Served	*LMI % X 20 points*	8.2	20
Level of Flood Risk Reduction	Above a 25-year / 24-hour storm event level of protection	10	10
Quantity of Flood Risk Reduction	10-25 Structures	4	10
Benefit-Cost Ratio	75-100%	20	20
Leveraged Funding	Limited potential cost share identified	5	10
Permitting/Scheduling	Potential challenges	5	10
Mobility Improvement	Minimal mobility improvements	0	5
Phasing Considerations	No connection to larger scale project	0	5
Project Synergies	Limited cost savings	3	5
Environmental Impact	Green Infrastructure or Improved Impact	5	5
		60.2	100

CATFISH CREEK RESTORATION - REVISED

Marion, South Carolina

Category:
Stream/Wetland Restoration

Purpose:
To assess the potential of restoration on part or all of Catfish Swamp north of Marion, and/or the restoration on part or all of Catfish Canal west of Marion to a more naturalized stream.

Background

As part of the effort to evaluate stream and/or wetland restoration potential in the County, altered streams and wetlands upstream and adjacent to populated areas were assessed.

Catfish Creek west of the City of Marion was channelized into Catfish Canal sometime around the 1940's. The 1939 SC Highway County Map shows Catfish Creek, while the 1947 USACE Topographic Map portrays the canal in its current configuration. Just north of the City, Catfish Swamp is shown as a vegetated wetland in 1947, although the Canal runs through the middle of it. By 1954, Topographic Maps indicate that the western floodplain of Catfish Swamp had been cleared, and it has been in agricultural use for decades.

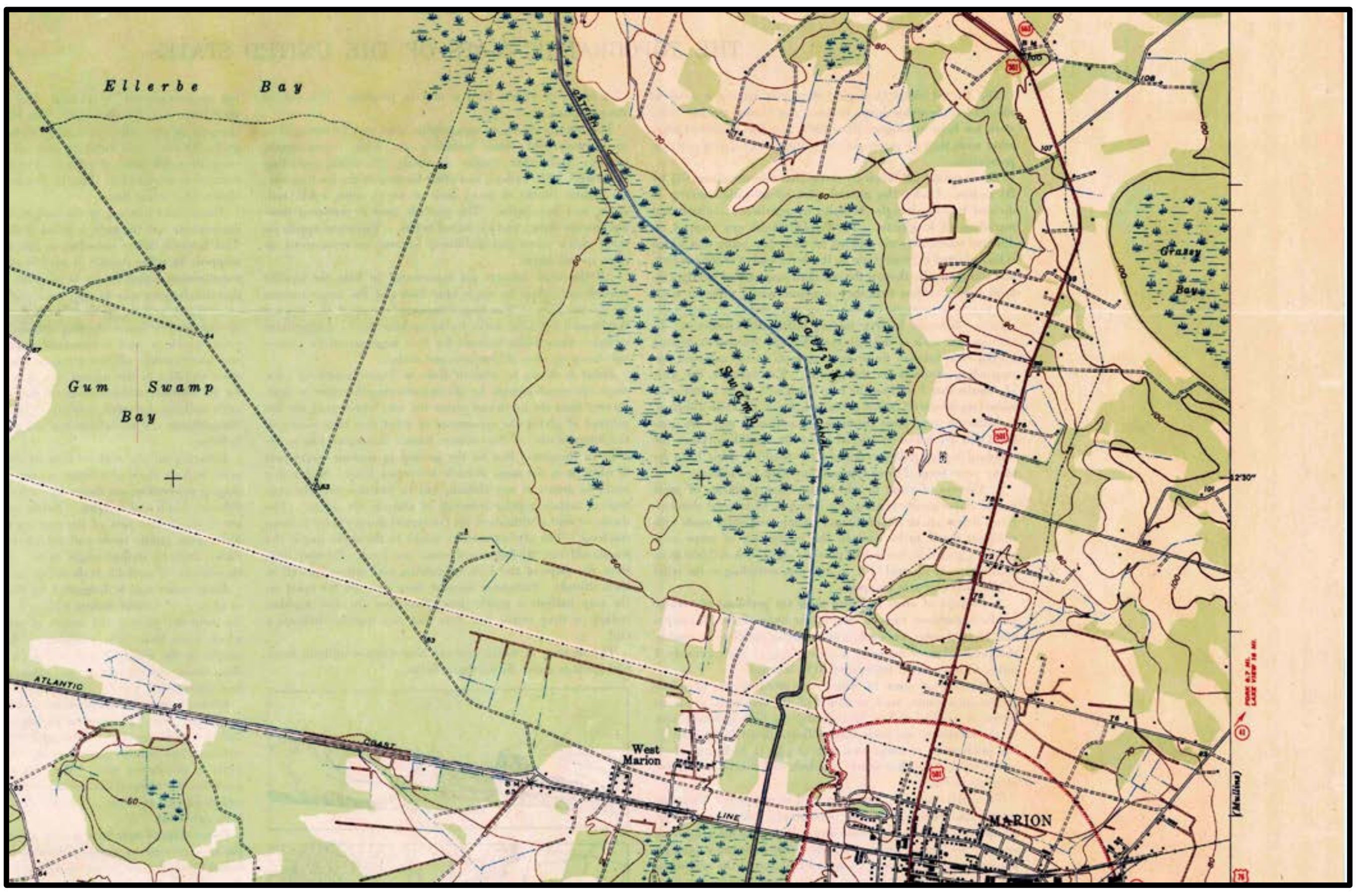


Figure D1: 1947 USACOE Topographic Map

Figure D2: Current Aerial of same area with property lines

Potential Project

The majority of Catfish Swamp that has been cleared and drained is included in one [redacted] parcel ([redacted]). The previous wetland could be restored by plugging the ditches that drained the land for farming and restoring the stream using natural channel design principals. Optional enhancements could be to plant native trees and vegetation in the restored wetland, add a multiuse path around the perimeter and possibly some boardwalks out over the wetland for public recreation.

Restoring the wetland would allow ponding and storage within the wetland that should reduce peak flows downstream in the canal. Further analysis will be required to quantify the benefits of flood storage. The drainage area to the downstream end of Catfish Swamp is approximately 59.6 square miles.

From a maintenance perspective, restoring the section of Catfish Canal through the swamp to a natural channel system would create a stable system that allows sediment transport and deposition in the overbank areas of the swamp. This would reduce siltation in the main channel and would allow the stream and its floodplain to function in a natural way.

There is another large agricultural parcel downstream from Catfish Swamp just west of the City that could potentially be used for a stream and wetland restoration of Catfish Canal as well. That parcel ([redacted]) is [redacted] of mostly former wetland according to the historical maps. At the Alternatives Analysis Presentation to SCOR and Marion County, the potential stream and wetland restoration of this parcel, which is [redacted] the City of Marion, was not deemed favorable by the City because of the perception that it may impeded water from draining from the City as fast. Therefore, restoration of [redacted] was not included in the final proposed project and associated BCA.

[redacted]

Figure D3: Parcel map of a portion of Catfish Canal proposed for potential wetland restoration

[redacted]

Figure D4: Parcel map of a portion of Catfish Canal assessed as a second possible restoration site (the proposed restoration on this parcel was not included in the final proposed project)

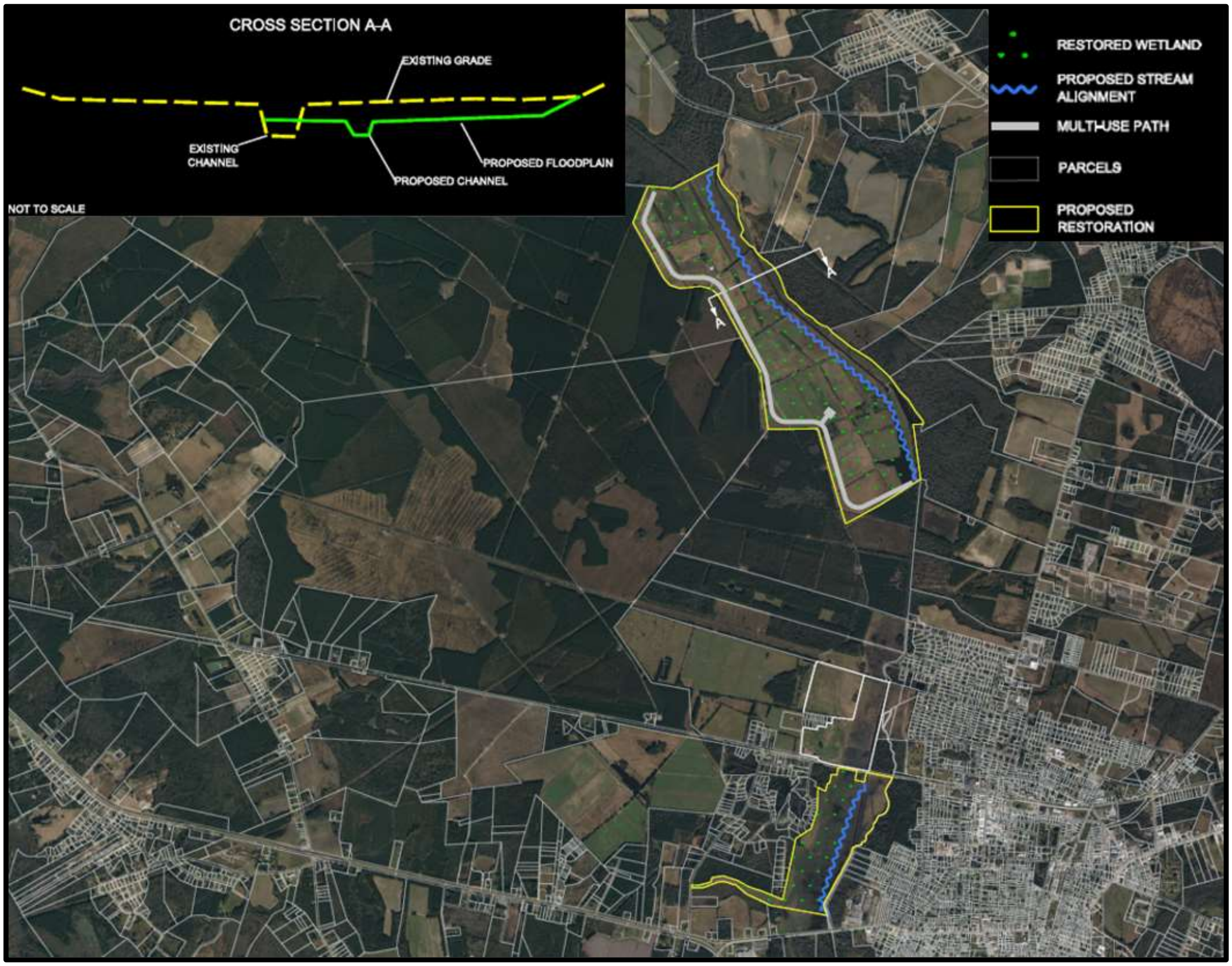


Figure D5: Conceptual sketch showing stream and wetland restoration on two potential sites along Catfish Canal

Additional Considerations

Catfish canal is in a detailed FEMA study zone with a floodway, so any impacts to the floodway would require a Letter of Map Revision.

Other funding options may be available. EPA and other federal agencies have various sources of funding that can be used for wetland restoration, such as NRCS Wetland Reserve Easements through the Agricultural Conservation Easement Program (ACEP).

PROJECT BENEFITS

Floodplain storage

Improved Water Quality

Self-sustaining stream with reduced maintenance

Public recreation potential

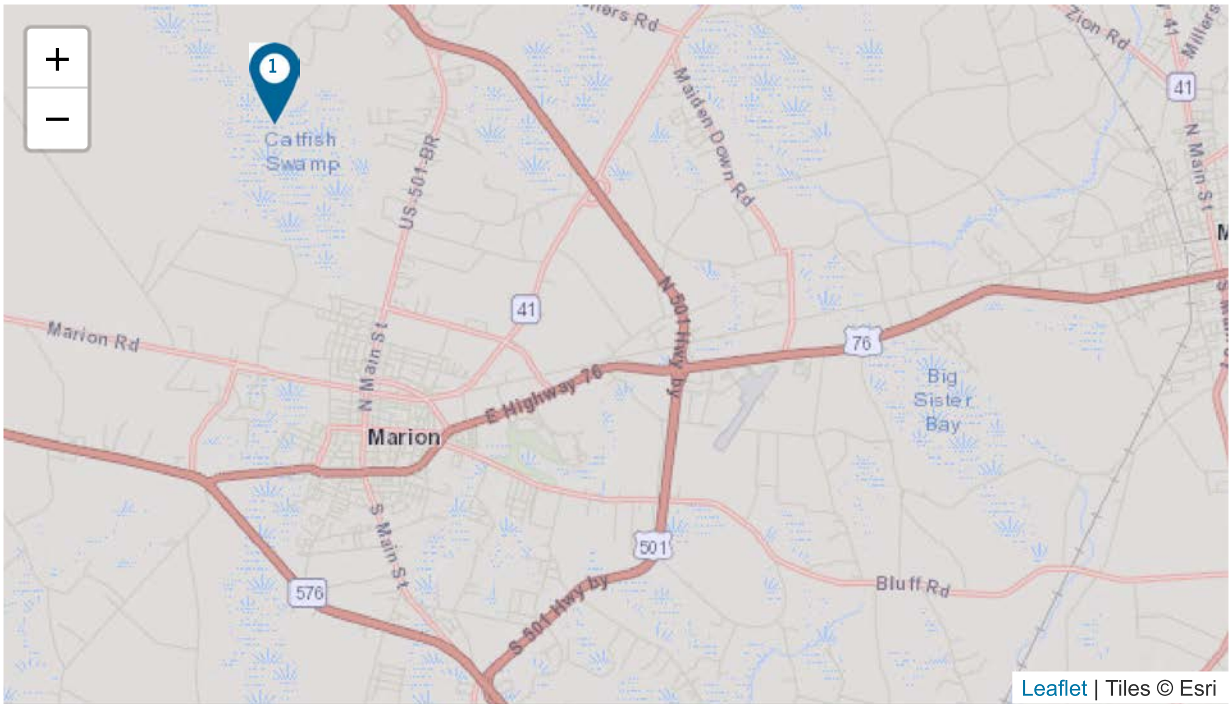
Project is scalable based on funding/needs

Benefit-Cost Calculator

V.6.0 (Build 20221001.0249 | Release Notes)

Benefit-Cost Analysis

Project Name: Catfish Creek Restoration - Marion County, SC



Map Marker ▲	Mitigation Title	Property Type	Hazard	Benefits (B)	Costs (C)	BCR (B/C)
1	Floodplain and Stream Restoration @ 34° 13' 18.8500800"; -79° -24' -58.5100800"	•••	DFA - Riverine Flood	$ 87,436,957	$ 11,426,925	7.65
TOTAL (SELECTED)				**$ 87,436,957**	**$ 11,426,925**	**7.65**
TOTAL				**$ 87,436,957**	**$ 11,426,925**	**7.65**

Property Configuration

Property Title:	Floodplain and Stream Restoration @ 34° 13' 18.8500800"; -79° -24' -58.5100800"
Property Location:	29571, Marion, South Carolina
Property Coordinates:	34.2213778, -79.4155917
Hazard Type:	Riverine Flood
Mitigation Action Type:	Floodplain and Stream Restoration
Property Type:	Other
Analysis Method Type:	Professional Expected Damages

Cost Estimation

Floodplain and Stream Restoration @ 34° 13' 18.8500800"; -79° -24' -58.5100800"

Project Useful Life (years):	100
Project Cost:	$10,000,000
Number of Maintenance Years:	100 Use Default: *No*
Annual Maintenance Cost:	$100,000

Damage Analysis Parameters - Damage Frequency Assessment

Floodplain and Stream Restoration @ 34° 13' 18.8500800"; -79° -24' -58.5100800"

Year of Analysis was Conducted:	2022
Year Property was Built:	1950
Analysis Duration:	73 Use Default:Yes

Professional Expected Damages Before Mitigation

Floodplain and Stream Restoration @ 34° 13' 18.8500800"; -79° -24' -58.5100800"

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
0	0	0	0	0	0	0	0

Annualized Damages Before Mitigation

Floodplain and Stream Restoration @ 34° 13' 18.8500800"; -79° -24' -58.5100800"

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	0	0

Professional Expected Damages After Mitigation

Floodplain and Stream Restoration @ 34° 13' 18.8500800"; -79° -24' -58.5100800"

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
0	0	0	0	0	0	0	0

Annualized Damages After Mitigation

Floodplain and Stream Restoration @ 34° 13' 18.8500800"; -79° -24' -58.5100800"

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	0	0

Standard Benefits - Ecosystem Services

Floodplain and Stream Restoration @ 34° 13' 18.8500800"; -79° -24' -58.5100800"

Total Project Area (acres):	728
Percentage of Urban Green Open Space:	0.00%
Percentage of Rural Green Open Space:	10.00%
Percentage of Riparian:	0.00%
Percentage of Coastal Wetlands:	0.00%
Percentage of Inland Wetlands:	90.00%
Percentage of Forests:	0.00%
Percentage of Coral Reefs:	0.00%
Percentage of Shellfish Reefs:	0.00%
Percentage of Beaches and Dunes:	0.00%
Expected Annual Ecosystem Services Benefits:	$6,127,649

Benefits-Costs Summary

Floodplain and Stream Restoration @ 34° 13' 18.8500800"; -79° -24' -58.5100800"

Total Standard Mitigation Benefits:	$87,436,957
Total Social Benefits:	$0
Total Mitigation Project Benefits:	$87,436,957
Total Mitigation Project Cost:	$11,426,925
Benefit Cost Ratio - Standard:	7.65
Benefit Cost Ratio - Standard + Social:	7.65

BCA Cost Estimate - D - Catfish Creek Restoration, Marion SC

HARD COSTS

ITEM	IDESCR	IDESCRL	QUANTITY	UNITS	UNIT COST	COST
2031000	UNCLASSIFIED EXCAVATION	UNCLASSIFIED EXCAVATION	37000	CY	$ 40.00	$ 1,480,000.00
	10' MULTIUSE PATH		11900	FT	$ 208.00	$ 2,475,200.00
	VEGETATION & TREES		700	AC	$ 1,000.00	$ 700,000.00
	CONTINGENCY	CONTINGENCY 25%	-	-		$ 988,800.00
					HARD COST TOTAL:	$ 5,644,000.00

SOFT COSTS

DESIGN	SURVEY, STRUCTURAL DESIGN, HYDRO DESIGN, AND ENVIRO COMPLIANCE		$ 1,128,800.00
PERMITTING & FEES	LAND DISTURBANCE/NPDES PERMITTING, ENVIRO, SCDOT, ETC.		$ 564,400.00
LAND ACQUISTION			$ 1,818,932.40
		SOFT COST TOTAL:	$ 3,512,132.40
		GRAND TOTAL:	$ 9,156,132.40
		ROUNDED TOTAL:	$ 10,000,000.00

E - Three Bridges Road Outfall Improvements - Mullins, SC

E - Three Bridges Road Outfall Improvements - Mullins, SC			
Prioritization Category	**Sub-Category**	**Points**	**Maximum Point**
LMI % Served	*LMI % X 20 points*	13	20
Level of Flood Risk Reduction	Above a 25-year / 24-hour storm event level of protection	10	10
Quantity of Flood Risk Reduction	0-10 Structures	0	10
Benefit-Cost Ratio	50-75%	13	20
Leveraged Funding	Limited potential cost share identified	5	10
Permitting/Scheduling	Little-to-no challenges	10	10
Mobility Improvement	Significant mobility improvements	5	5
Phasing Considerations	No connection to larger scale project	0	5
Project Synergies	Limited cost savings	3	5
Environmental Impact	Neutral Impact	3	5
		62	100

THREE BRIDGE ROAD CROSSING IMPROVEMENTS

Mullins, South Carolina

Category:
Fully Meets Design Standards

Purpose:
Improve the existing 48” RCP crossing under Three Bridge Road

Background

An unnamed stream downstream of Johnson Court crosses under Three Bridge Road through a 48-inch RCP and into a tributary to Maidendown Swamp. This location was pointed out by City personnel as a potential constriction in the flow pattern. This crossing was also identified as a major pinch point within our developed hydraulic models.

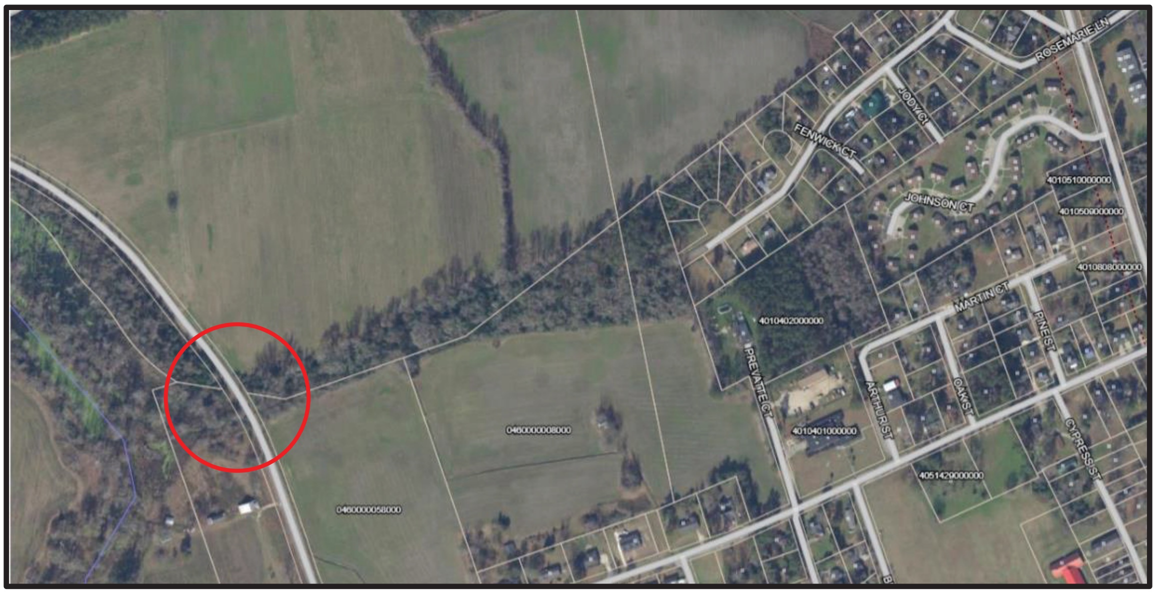


Figure E1: Unnamed stream under Three Bridge Road location.

Figure E2: Upstream of crossing (left) and downstream of crossing (right).

Potential Project

A hydraulic analysis was performed to see if the existing crossing is undersized. The culvert is in tailwater control due to the flat downstream topography. Several iterations were modeled to see what the optimal size culvert would be to pass the 50-year design flow without going into pressure flow. Double 8' (W) x 4'(H) box culverts meet SCDOT design criteria and are recommended for the crossing.

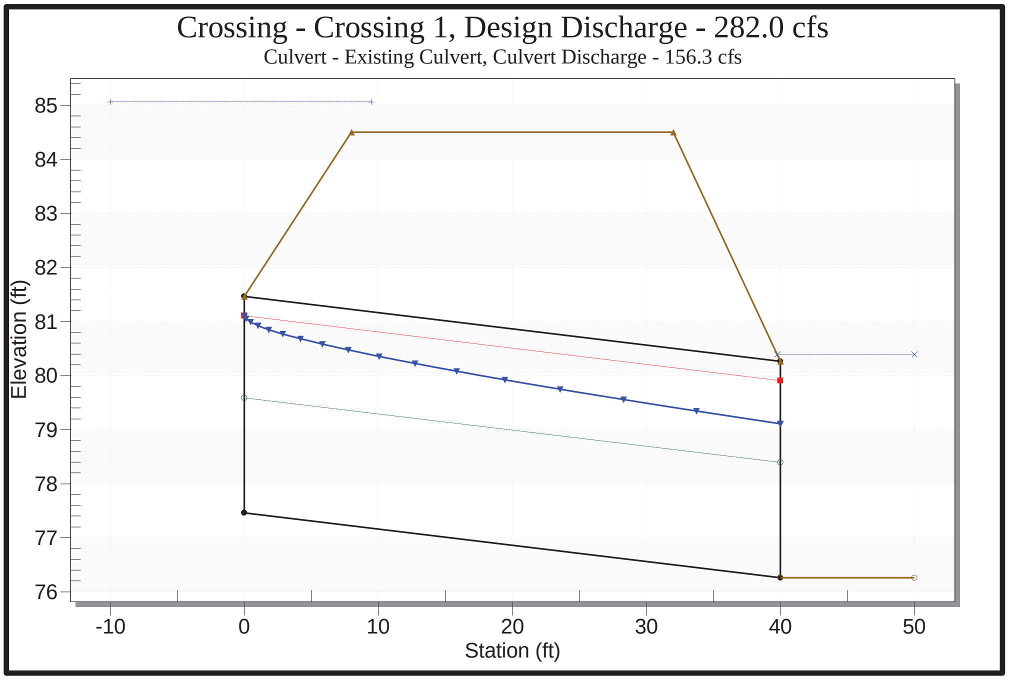


Figure E3: Blue line on the left represents the existing headwater elevation for the 50-year storm.

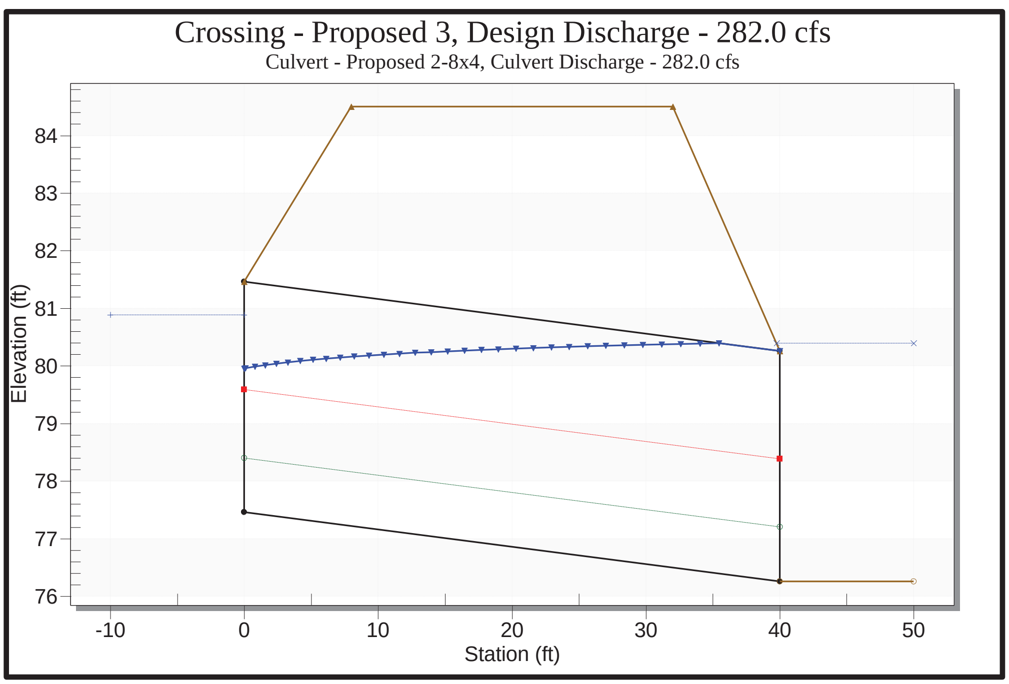


Figure E4: Blue line on the left represents the proposed headwater elevation for the 50-year storm.

Additional Considerations

Improvements to Three Bridge Road may be required to achieve necessary cover above the proposed culverts. Additionally, shoulder improvements and guardrail would likely be required to protect the traveling public from this roadside hazard.

PROJECT BENEFITS

Reduces backwater impacts to Johnson Court

Meets SCDOT design criteria

FEMA

Benefit-Cost Calculator

V.6.0 (Build 20221028.1600 | Release Notes)

Benefit-Cost Analysis

Project Name: E - Three Bridge Road Crossing Improvements - Mullins, SC

				Using 7% Discount Rate			Using 3% Discount Rate (For FY22 BRIC and FMA only)		
Map Marker ▲	Mitigation Title	Property Type	Hazard	Benefits (B)	Costs (C)	BCR (B/C)	Benefits (B)	Costs (C)	BCR (B/C)
1	Drainage Improvement @ Three Bridge Rd, Mullins, South Carolina, 29574		DFA - Riverine Flood	$ 523,103	$ 433,801	1.21	$ 975,261	$ 445,730	2.19
TOTAL (SELECTED)				**$ 523,103**	**$ 433,801**	**1.21**	**$ 975,261**	**$ 445,730**	**2.19**
TOTAL				**$ 523,103**	**$ 433,801**	**1.21**	**$ 975,261**	**$ 445,730**	**2.19**

Property Configuration

Property Title:	Drainage Improvement @ Three Bridge Rd, Mullins, South Carolina, 29574
Property Location:	29574, Marion, South Carolina
Property Coordinates:	34.2088111, -79.2720833
Hazard Type:	Riverine Flood
Mitigation Action Type:	Drainage Improvement
Property Type:	Roads & Bridges
Analysis Method Type:	Professional Expected Damages

Cost Estimation

Drainage Improvement @ Three Bridge Rd, Mullins, South Carolina, 29574

Project Useful Life (years):	50
Project Cost:	$420,000
Number of Maintenance Years:	50 Use Default:Yes
Annual Maintenance Cost:	$1,000

Damage Analysis Parameters - Damage Frequency Assessment

Drainage Improvement @ Three Bridge Rd, Mullins, South Carolina, 29574

Year of Analysis was Conducted:	2022
Year Property was Built:	1960
Analysis Duration:	63 Use Default:Yes

Roads and Bridges Properties

Drainage Improvement @ Three Bridge Rd, Mullins, South Carolina, 29574

Estimated Number of One-Way Traffic Detour Trips per Day:	350
Additional Time per One-Way Detour Trip (minutes):	2
Number of Additional Miles:	1
Federal Rate ($):	0.625 Use Default:Yes
Economic Loss Per Day of Loss of Function ($):	634.08

Comments

-

Number of Trips:

AADT 2021 from SCDOT Street Finder

Professional Expected Damages Before Mitigation

Drainage Improvement @ Three Bridge Rd, Mullins, South Carolina, 29574

	ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
8	1	302,600	0	0	0	0	303,234

Comments

•

Damages Before Mitigation:

When road overtops, hydroplaning accidents are likely. Assuming one potential accident per road overtopping event. An injury crash is valued as $302,600 of damage per incident per Table A-1: Value of Reduced Fatalities and Injuries within the Benefit Cost Analysis Guidance for Discretionary Grant Programs, U.S. Department of Transportation, March 2022. The roadway overtops between the 5-year and 10-year recurrence interval therefore a return period of 8-years was used.

Annualized Damages Before Mitigation

Drainage Improvement @ Three Bridge Rd, Mullins, South Carolina, 29574

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
8	303,234	37,904
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	303,234	37,904

Professional Expected Damages After Mitigation

Drainage Improvement @ Three Bridge Rd, Mullins, South Carolina, 29574

	ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
0	0	0	0	0	0	0	0

Annualized Damages After Mitigation

Drainage Improvement @ Three Bridge Rd, Mullins, South Carolina, 29574

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	0	0

Standard Benefits - Ecosystem Services

Drainage Improvement @ Three Bridge Rd, Mullins, South Carolina, 29574

Total Project Area (acres):	0
Percentage of Urban Green Open Space:	0.00%
Percentage of Rural Green Open Space:	0.00%
Percentage of Riparian:	0.00%
Percentage of Coastal Wetlands:	0.00%
Percentage of Inland Wetlands:	0.00%
Percentage of Forests:	0.00%
Percentage of Coral Reefs:	0.00%
Percentage of Shellfish Reefs:	0.00%
Percentage of Beaches and Dunes:	0.00%
Expected Annual Ecosystem Services Benefits:	$0

Benefits-Costs Summary

Drainage Improvement @ Three Bridge Rd, Mullins, South Carolina, 29574

Total Standard Mitigation Benefits:	$523,103
Total Social Benefits:	$0
Total Mitigation Project Benefits:	$523,103
Total Mitigation Project Cost:	$433,801
Benefit Cost Ratio - Standard:	1.21
Benefit Cost Ratio - Standard + Social:	1.21

BCA Cost Estimate - E - Three Bridges Road Crossing Improvements, Mullins SC

HARD COSTS

ITEM	IDESCR	IDESCRL	QUANTITY	UNITS	UNIT COST		COST
1031010	MOBILIZATION	MOBILIZATION		LS		5%	$ 11,397.60
1071000	TRAFFIC CONTROL	TRAFFIC CONTROL		LS		8%	$ 18,236.16
2011000	CLEAR. & GRUB. WITHIN R/W	CLEARING & GRUBBING WITHIN RIGHT OF WAY		LS		5.0%	$ 11,397.60
4012120	FULL DEP.ASPH.PAV.PATCH-12"	FULL DEPTH ASPH. PAV. PATCHING 12"UNIF	300	SY	$	120.00	$ 36,000.00
7221042	8'X4' PCBOX CULV.{M-273}FH<2	8'X 4' P.C. BOX CULVERT {AASHTO M-273} FH < 2 8'X 4'	80	LF	$	2,240.00	$ 179,200.00
8041020	RIP-RAP (CLASS B)	RIP-RAP (CLASS B)	100	TON	$	98.38	$ 9,838.00
8048105	GEOTEX/EROS.CONT(CLASS1)TYPE B	GEOTEXTILE FOR EROSION CONTROL UNDER RIPRAP(CLASS 1)TYPE B	100	SY	$	4.14	$ 414.00
8101000	SEEDING (MULCHED)	SEEDING (MULCHED)	1	MSY	$	750.00	$ 750.00
8153000	SILT FENCE	SILT FENCE	500	LF	$	3.50	$ 1,750.00
	CONTINGENCY	CONTINGENCY 25%	-	-			$ 67,245.84
					SUB-TOTAL:		$ 227,952.00
					HARD COST TOTAL:		$ 336,229.20

SOFT COSTS

DESIGN	SURVEY, STRUCTURAL DESIGN, HYDRO DESIGN, AND ENVIRO COMPLIANCE		$ 67,245.84
PERMITTING & FEES	LAND DISTURBANCE/NPDES PERMITTING, ENVIRO, SCDOT, ETC.		$ 16,811.46
		SOFT COST TOTAL:	$ 84,057.30
		GRAND TOTAL:	$ 420,286.50
		ROUNDED TOTAL:	$ 420,000.00

F - Housing Authority Flooding Alleviation - Mullins, SC

F - Housing Authority Flooding Alleviation - Mullins, SC			
Prioritization Category	**Sub-Category**	**Points**	**Maximum Point**
LMI % Served	*LMI % X 20 points*	10.2	20
Level of Flood Risk Reduction	Above a 25-year / 24-hour storm event level of protection	10	10
Quantity of Flood Risk Reduction	10-25 Structures	4	10
Benefit-Cost Ratio	0-25%	0	20
Leveraged Funding	Limited potential cost share identified	5	10
Permitting/Scheduling	Little-to-no challenges	10	10
Mobility Improvement	Significant mobility improvements	5	5
Phasing Considerations	Limited Contribution	3	5
Project Synergies	Limited cost savings	3	5
Environmental Impact	Green Infrastructure or Improved Impact	5	5
		55.2	100

HOUSING AUHTORITY FLOODING ALLEVIATION

Mullins, South Carolina

Category:
Low Impact Design and/or Retrofit

Purpose:
To assess the potential of a stormwater park/detention facility to alleviate flooding near the Blanton Court Mullins Housing Authority

Background

The Blanton Court Mullins Housing Authority is located adjacent to the State Road S-34-60 (Figure F1). The existing condition analyses denoted high flooding potential for this area as the localized (XPSWMM) model resulted in flooding for multiple different storm events. The results of this model coincide with documented flooding in the area according to City personnel. Runoff from the area upstream of Academy Street is collected by a closed drainage system. At the end of this system, a 48-inch HDPE (High Density Polyethylene) pipe drains into two 48-inch reinforced concrete pipes at State Road S-34-60 (Figure F2). The closed drainage system exceeds its capacity due to excess runoff which causes flooding to the neighboring areas.

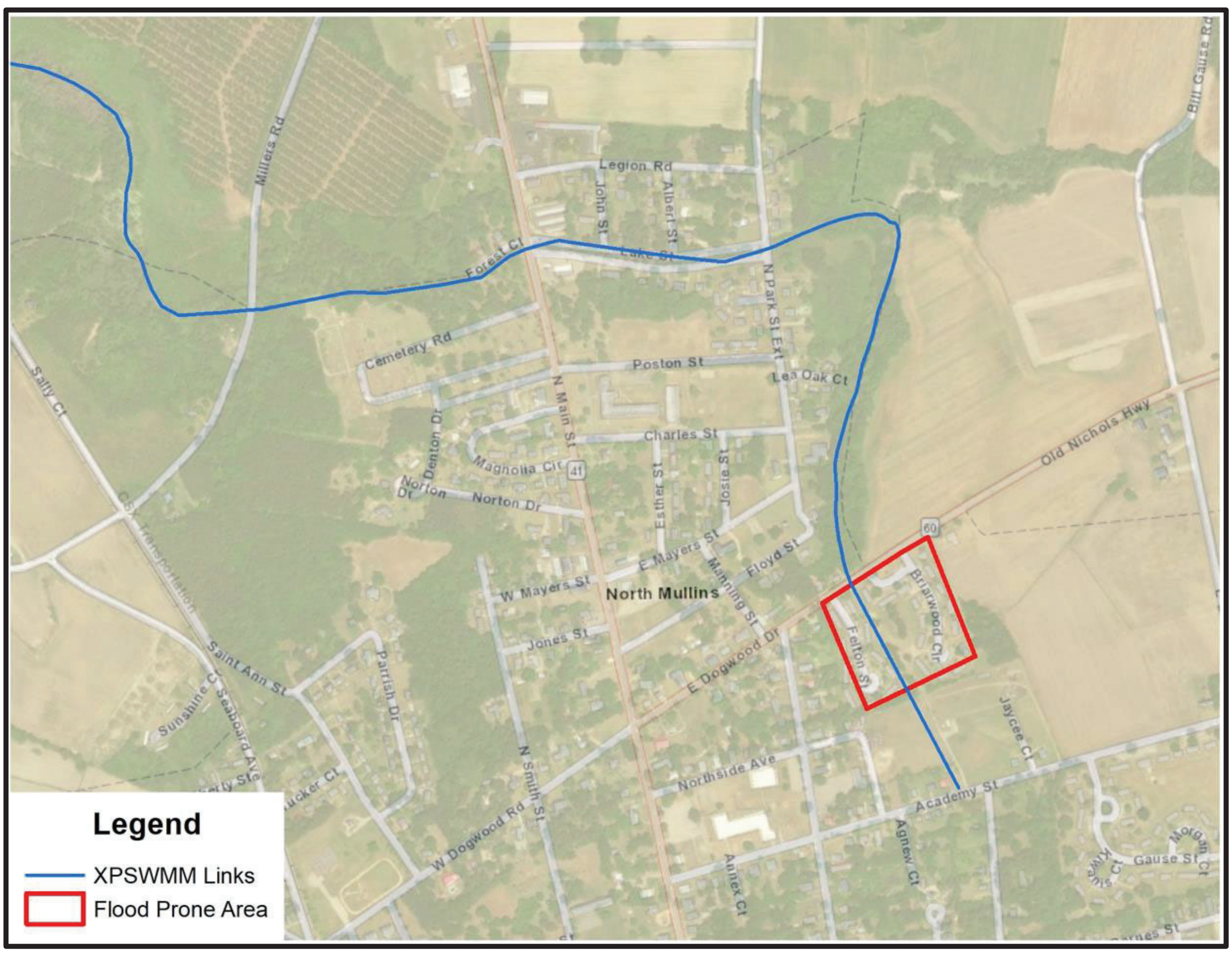


Figure F1: Blanton Court Mullins Housing Authority area and the adjacent stormwater conveyance system

Figure F2: Downstream end of the closed drainage system running parallel to the Blanton Court Mullins Housing Authority Area

Potential Project

A stormwater park/detention facility located upstream of the Blanton Court Housing Authority was modeled to determine what size facility would be required to alleviate flooding in the downstream area. It was determined that the required storage volume to properly control stormwater runoff for the 50-year storm event would be approximately 1.3 million ft^3. Using this volume, a parcel [redacted] of the Blanton Court Housing Authority was identified that is approximately [redacted] acres in size ([redacted]) that could provide the necessary storage volume for this facility, see Figure F3 below.

The stormwater facility will act as temporary storage to detain and release runoff in a controlled manner. The flowrate leaving the pond will be controlled through a multi-stage outlet control structure. The outlet structure will consist of a combination of orifices and weirs. The pond will also be equipped with an emergency spillway which will prevent the pond from breaching when it exceeds its storage capacity during an extreme event. The controlled runoff leaving the pond will be conveyed by a culvert which will tie into the closed drainage system running between Academy Street and East Dogwood Drive. The proposed stormwater facility will reduce the 50-year peak flowrate at the closed drainage system by approximately 50%. This reduction in peak flow will alleviate flooding in the Blanton Court Mullins Housing Authority as well as the surrounding area.

Figure F3: Location of the proposed stormwater detention pond

Additional Considerations

The outlet control structure should be regularly monitored to prevent clogging. A fence can be installed around the limits of the pond as a safety precaution to the public.

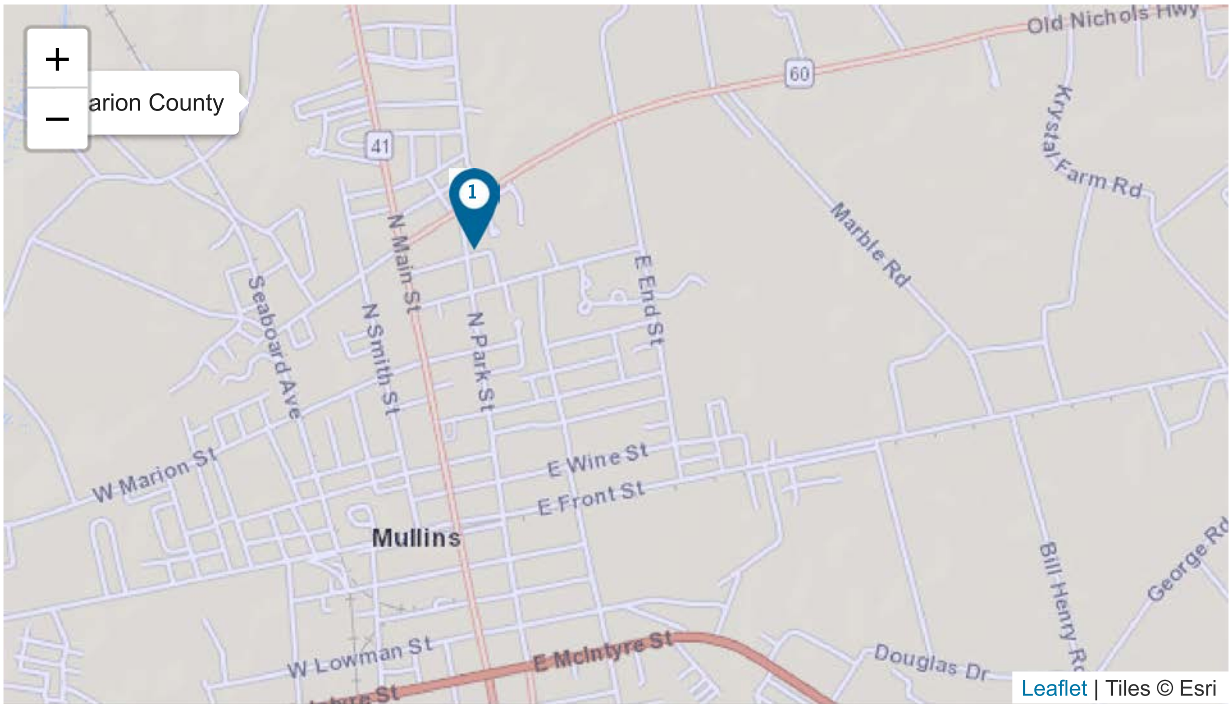
PROJECT BENEFITS	
	Reduced flooding risks at the Blanton Court Mullins Housing Authority and the neighboring area
	Potential additional recreation opportunities
	Project is scalable based on funding/needs

Benefit-Cost Calculator

V.6.0 (Build 20221028.1600 | Release Notes)

Benefit-Cost Analysis

Project Name: F - Housing Authority Flooding Alleviation - Mullins, SC



				Using 7% Discount Rate			Using 3% Discount Rate (For FY22 BRIC and FMA only)		
Map Marker ▲	Mitigation Title	Property Type	Hazard	Benefits (B)	Costs (C)	BCR (B/C)	Benefits (B)	Costs (C)	BCR (B/C)
1	Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"		DFA - Riverine Flood	$ 969,918	$ 2,683,269	0.36	$ 2,147,861	$ 2,700,599	0.80
TOTAL (SELECTED)				**$ 969,918**	**$ 2,683,269**	**0.36**	**$ 2,147,861**	**$ 2,700,599**	**0.80**
TOTAL				**$ 969,918**	**$ 2,683,269**	**0.36**	**$ 2,147,861**	**$ 2,700,599**	**0.80**

Property Configuration

Property Title:	Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"
Property Location:	29574, Marion, South Carolina
Property Coordinates:	34.2152778, -79.2537361
Hazard Type:	Riverine Flood
Mitigation Action Type:	Floodwater Diversion and Storage
Property Type:	Other
Analysis Method Type:	Professional Expected Damages

Cost Estimation

Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"

Project Useful Life (years):	100
Project Cost:	$2,669,000
Number of Maintenance Years:	100 Use Default:Yes
Annual Maintenance Cost:	$1,000

Damage Analysis Parameters - Damage Frequency Assessment

Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"

Year of Analysis was Conducted:	2022
Year Property was Built:	1960
Analysis Duration:	63 Use Default:Yes

Professional Expected Damages Before Mitigation

Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
50	0	873,260	0	0	0	0	873,260

Comments

-

Damages Before Mitigation:

Using the FEMA Flood Damage Calculator, and that approximately 10-structures are removed from the 50-year flooded area via these proposed improvements, a 2-foot of flood damage cost value of $87,326 per impacted 2.5K SF structure was used. Category 1 damages represent this flood reduction value.

Annualized Damages Before Mitigation

Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
50	873,260	17,465
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	873,260	17,465

Professional Expected Damages After Mitigation

Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
0	0	0	0	0	0	0	0

Annualized Damages After Mitigation

Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	0	0

Standard Benefits - Ecosystem Services

Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"

Total Project Area (acres):	6.36
Percentage of Urban Green Open Space:	51.10%
Percentage of Rural Green Open Space:	0.00%
Percentage of Riparian:	0.00%
Percentage of Coastal Wetlands:	0.00%
Percentage of Inland Wetlands:	0.00%
Percentage of Forests:	0.00%
Percentage of Coral Reefs:	0.00%
Percentage of Shellfish Reefs:	0.00%
Percentage of Beaches and Dunes:	0.00%
Expected Annual Ecosystem Services Benefits:	$50,508

Benefits-Costs Summary

Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"

Total Standard Mitigation Benefits:	$969,918
Total Social Benefits:	$0
Total Mitigation Project Benefits:	$969,918
Total Mitigation Project Cost:	$2,683,269
Benefit Cost Ratio - Standard:	0.36
Benefit Cost Ratio - Standard + Social:	0.36

BCA Cost Estimate - F/K - Housing Authority Flooding Alleviation & Seaboard Avenue Outfall Systems Improvements, Mullins SC

HARD COSTS

ITEM	IDESCR	IDESCRL	QUANTITY	UNITS	UNIT COST	COST
1031010	MOBILIZATION	MOBILIZATION		LS	5%	$ 81,342.40
1071000	TRAFFIC CONTROL	TRAFFIC CONTROL		LS	0%	$ -
2011000	CLEAR. & GRUB. WITHIN R/W	CLEARING & GRUBBING WITHIN RIGHT OF WAY		LS	0.0%	$ -
2031000	UNCLASSIFIED EXCAVATION	UNCLASSIFIED EXCAVATION	37000	CY	$ 40.00	$ 1,480,000.00
7141136	36" RC PIPE CUL.-CLASS V	36" RC PIPE CUL.-CLASS V	100	LF	$ 200.00	$ 20,000.00
8041020	RIP-RAP (CLASS B)	RIP-RAP (CLASS B)	150	TON	$ 98.38	$ 14,757.00
8048105	GEOTEX/EROS.CONT(CLASS1)TYPE B	GEOTEXTILE FOR EROSION CONTROL UNDER RIPRAP(CLASS 1)TYPE B	150	SY	$ 4.14	$ 621.00
8063300	72" CHAIN LINK FENCE	72" CHAIN LINK FENCE 72" CHAIN-LINK FENCE	1500	LF	$ 64.28	$ 96,420.00
8064300	4' CHAIN LNK FENCE GATE(72"HT)	4' WIDE - CHAIN LINK FENCE GATE (72"HT)	1	EA	$ 800.00	$ 800.00
8101000	SEEDING (MULCHED)	SEEDING (MULCHED)	5	MSY	$ 750.00	$ 3,750.00
8153000	SILT FENCE	SILT FENCE	3000	LF	$ 3.50	$ 10,500.00
	CONTINGENCY	CONTINGENCY 25%	-	-		$ 427,047.60
					SUB-TOTAL:	$ 1,626,848.00
					HARD COST TOTAL:	$ 2,135,238.00

SOFT COSTS

DESIGN	SURVEY, STRUCTURAL DESIGN, HYDRO DESIGN, AND ENVIRO COMPLIANCE		$ 427,047.60
PERMITTING & FEES	LAND DISTURBANCE/NPDES PERMITTING, ENVIRO, SCDOT, ETC.		$ 106,761.90
		SOFT COST TOTAL:	$ 533,809.50
		GRAND TOTAL:	$ 2,669,047.50
		ROUNDED TOTAL:	$ 2,669,000.00

G - East Front Street Road & Railroad Crossing Improvements - Mullins, SC

G - East Front Street Road & Railroad Crossing Improvements			
Prioritization Category	**Sub-Category**	**Points**	**Maximum Point**
LMI % Served	*LMI % X 20 points*	9.4	20
Level of Flood Risk Reduction	Above a 25-year / 24-hour storm event level of protection	10	10
Quantity of Flood Risk Reduction	10-25 Structures	4	10
Benefit-Cost Ratio	0-25%	0	20
Leveraged Funding	No potential cost share identified	0	10
Permitting/Scheduling	Significant challenges	0	10
Mobility Improvement	Significant mobility improvements	5	5
Phasing Considerations	No connection to larger scale project	0	5
Project Synergies	Limited cost savings	3	5
Environmental Impact	Neutral Impact	3	5
		34.4	100

EAST FRONT STREET ROAD & RAILROAD CROSSING IMPROVEMENTS

Mullins, South Carolina

Category:
Fully Meets Design Standards

Purpose:
To reduce and/or alleviate flooding upstream of the railroad and East Front Street in Mullins

Background

White Oak Creek flows from north to south and borders the eastern boundary of the City of Mullins as shown in Figure G1. The area upstream of East Front Street adjacent to White Oak Creek frequently floods according to City officials. The existing crossing along White Oak Creek under East Front Street and the railroad has a complex configuration. The upstream area is collected by a series of pipes connected by a drop inlet before discharging into a 36” pipe before transitioning to a 48” pipe under the railroad as shown in Figure G2. The 48” pipe under the railroad ultimately drains into double 48” pipes immediately downstream of the railroad. Figure G3 depicts the existing configuration just downstream of the railroad crossing.

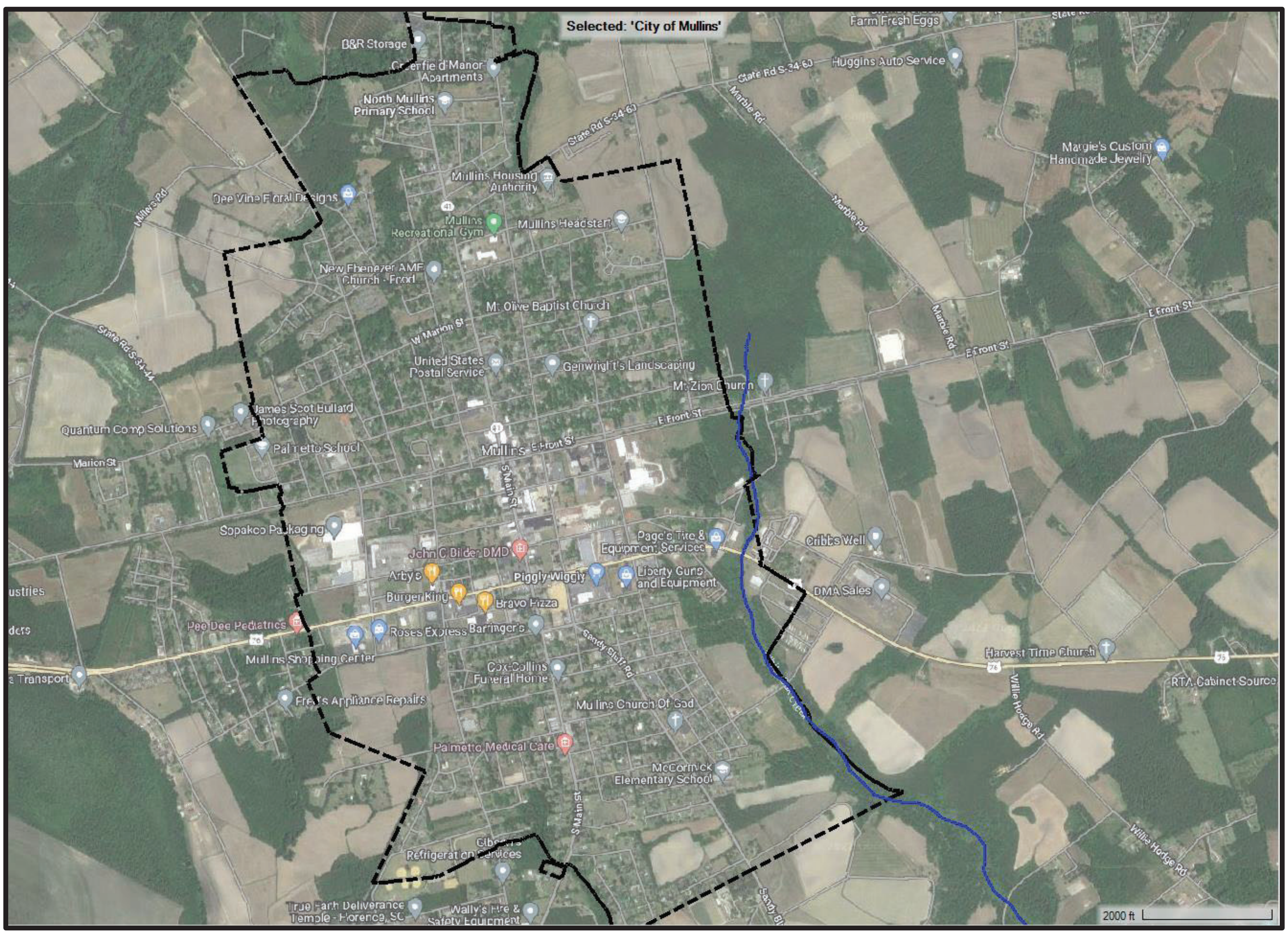


Figure G1: White Oak Creek centerline with City of Mullins limits

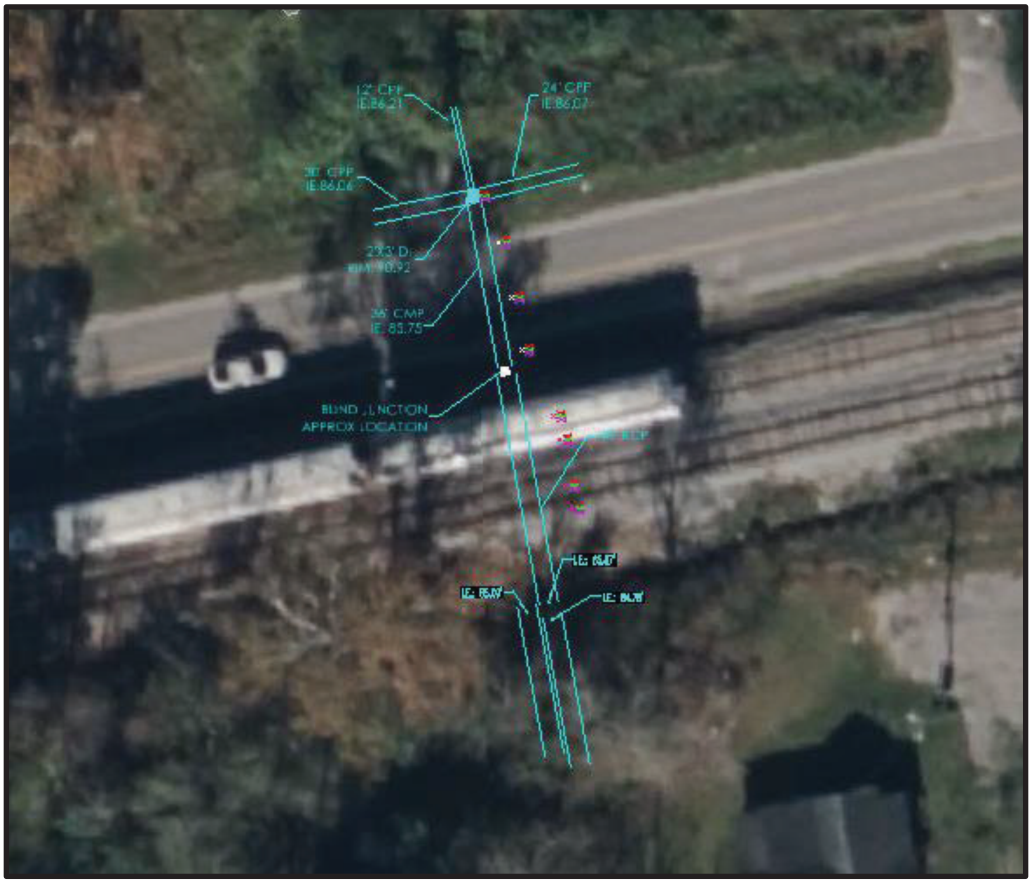


Figure G2: East Front Street and railroad crossing pipe configuration

Figure G3: 48" concrete pipe from under the railroad draining to double 48" pipes immediately downstream

Potential Project

A hydraulic analysis was performed to see if the existing crossing at East Front Street is undersized. Reviewing the water surface profile, it was evident the crossing under East Front Street and the railroad was substandard as water was backing up behind the roadway until the road eventually overtopped. Several iterations were performed to select a structure size that alleviates the flooding upstream. Eventually, double 48" pipes were selected as this sizing resulted in little to no headwater buildup upstream of the crossing. Figure G4 below shows a comparison of the 100-year existing condition (red) with the 100-year proposed condition (blue) utilizing the upsized crossing. From this comparison, one can see that flooding upstream is reduced by several feet. Figure G5 shows the 100-year flood depths along White Oak Creek with the existing infrastructure in place and shows significant flooding upstream of East Front Street. This flooding encroaches on several structures which are depicted as red polygons in the figure. Figure G6 shows the 100-year flood depths with the proposed double 48" pipes constructed under East Front Street and the railroad. The flooding in this figure is greatly reduced and removes all structures that were previously in the 100-year floodplain.

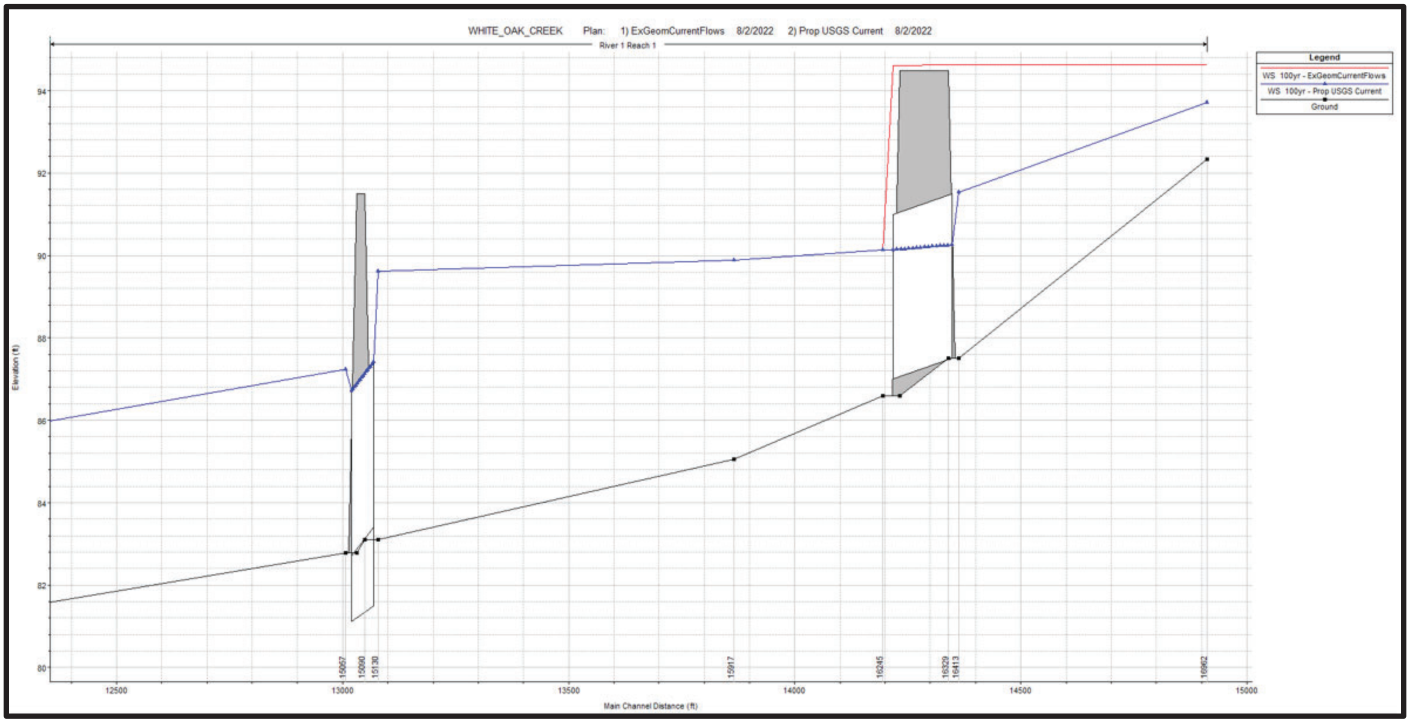


Figure G4: 100-yr water surface profile along White Oak Creek showing existing condition (red) and proposed improvements (blue)

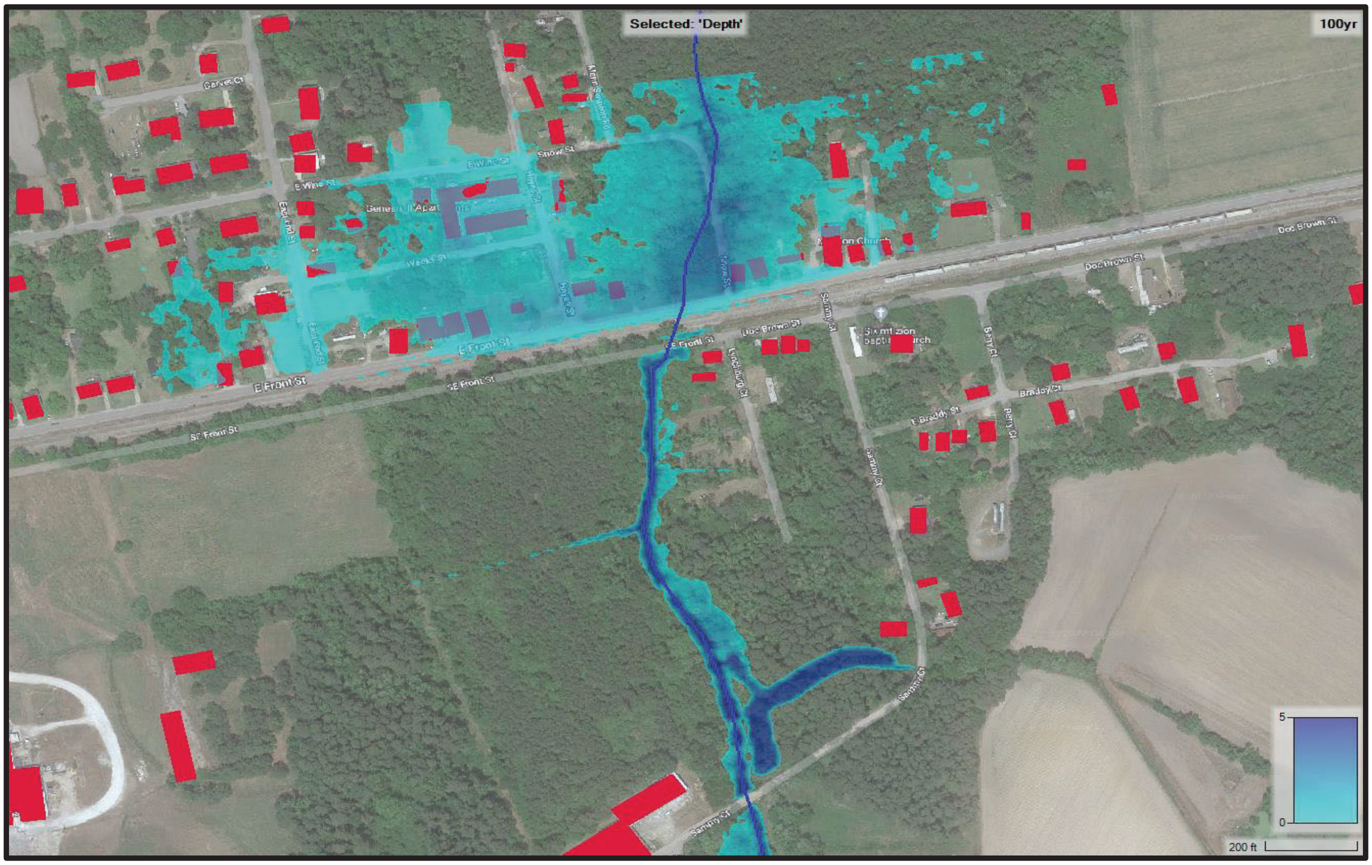


Figure G5: 100-yr flood depth with existing East Front Street and railroad infrastructure in place

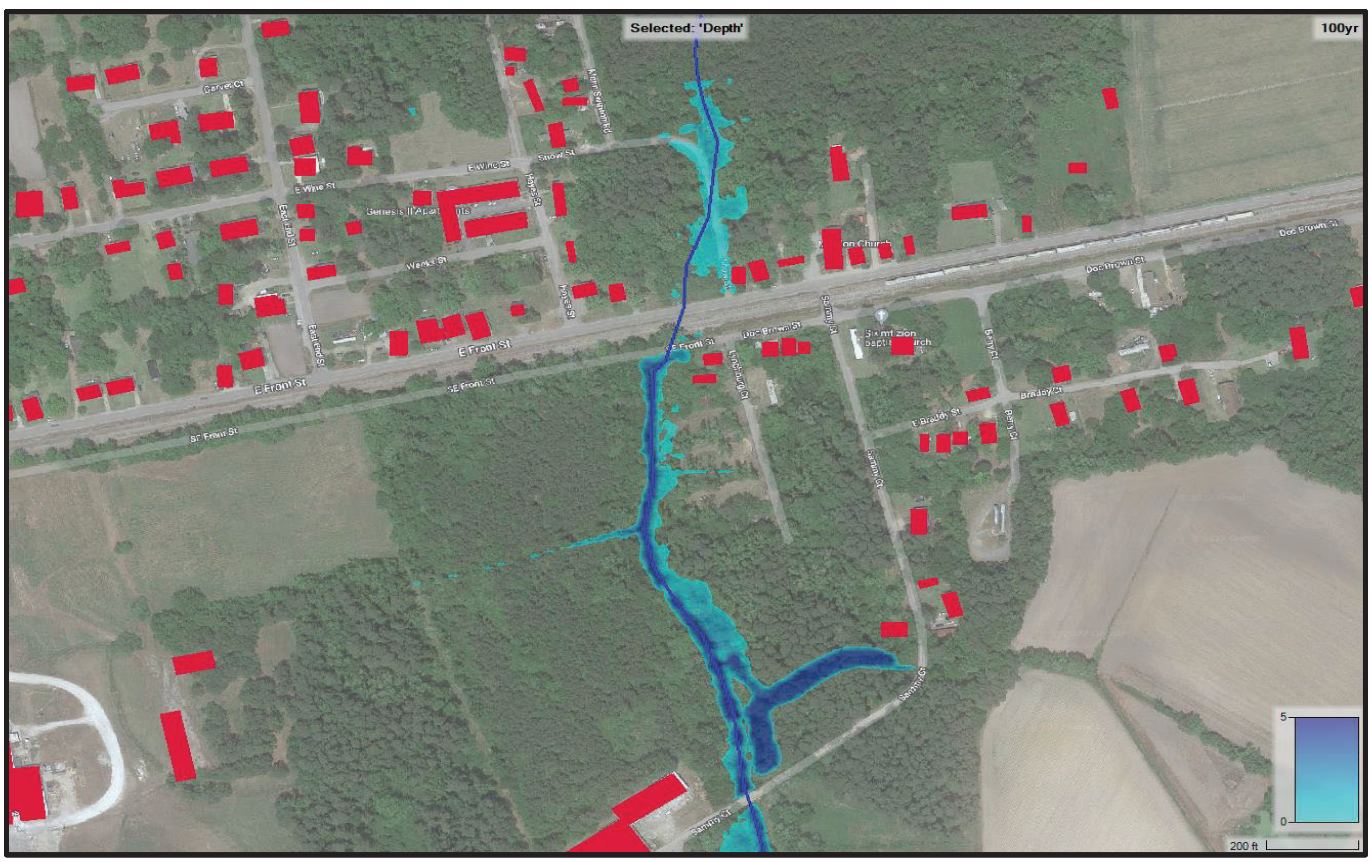


Figure G6: 100-yr flood depth with upsized East Front Street and railroad crossing

Additional Considerations

The East Front Street and railroad crossing is not located within a FEMA designated flood zone. However, immediately downstream of this crossing, is a FEMA designated Zone AE with an established floodway. Any improvements may require coordination with the local floodplain manager and/or FEMA coordination.

Updated topographic information may be required to better define the floodplain inundation limits as the existing LiDAR is from 2008.

Finished floor elevations on structures within the floodplain will be required to ensure structures are above the floodplain.

Existing closed storm drainage system upstream will need to be reviewed to ensure the upstream system is sized appropriately to convey localized runoff

PROJECT BENEFITS

Eliminates flooding upstream of East Front Street

Improves levels of service of East Front Street

Meets SCDOT design criteria

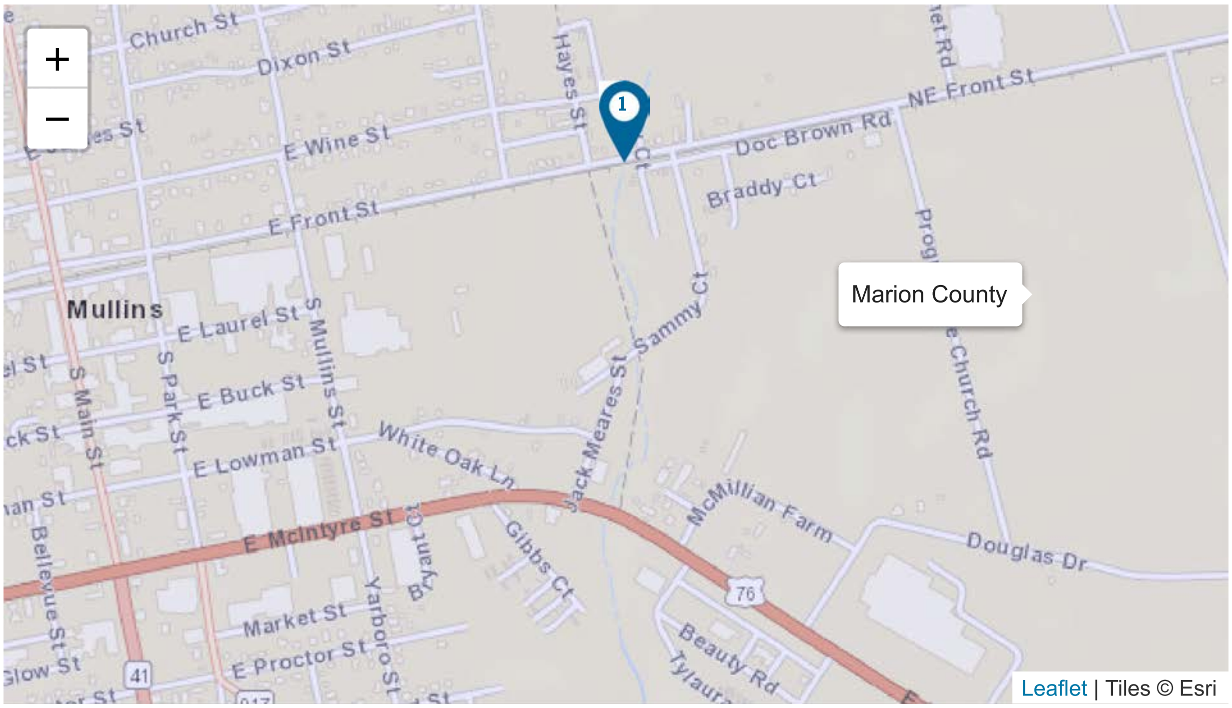
All structures previously within the 100-year floodplain are now outside the limits

FEMA Benefit-Cost Calculator

V.6.0 (Build 20221028.1600 | Release Notes)

Benefit-Cost Analysis

Project Name: G - East Front Street & Railroad Crossing - Mullins, SC



				Using 7% Discount Rate			Using 3% Discount Rate (For FY22 BRIC and FMA only)		
Map Marker ▲	Mitigation Title	Property Type	Hazard	Benefits (B)	Costs (C)	BCR (B/C)	Benefits (B)	Costs (C)	BCR (B/C)
1	Drainage Improvement @ 34° 16' 51.8199600"; -79° -28' -31.5699600"		DFA - Riverine Flood	$ 170,729	$ 543,801	0.31	$ 318,303	$ 555,730	0.57
TOTAL (SELECTED)				**$ 170,729**	**$ 543,801**	**0.31**	**$ 318,303**	**$ 555,730**	**0.57**
TOTAL				**$ 170,729**	**$ 543,801**	**0.31**	**$ 318,303**	**$ 555,730**	**0.57**

Property Configuration

Property Title:	Drainage Improvement @ 34° 16' 51.8199600"; -79° -28' -31.5699600"
Property Location:	29594, Marion, South Carolina
Property Coordinates:	34.2074694, -79.2423194
Hazard Type:	Riverine Flood
Mitigation Action Type:	Drainage Improvement
Property Type:	Roads & Bridges
Analysis Method Type:	Professional Expected Damages

Cost Estimation

Drainage Improvement @ 34° 16' 51.8199600"; -79° -28' -31.5699600"

Project Useful Life (years):	50
Project Cost:	$530,000
Number of Maintenance Years:	50 Use Default:Yes
Annual Maintenance Cost:	$1,000

Damage Analysis Parameters - Damage Frequency Assessment

Drainage Improvement @ 34° 16' 51.8199600"; -79° -28' -31.5699600"

Year of Analysis was Conducted:	2022
Year Property was Built:	1960
Analysis Duration:	63 Use Default:Yes

Roads and Bridges Properties

Drainage Improvement @ 34° 16' 51.8199600"; -79° -28' -31.5699600"

Estimated Number of One-Way Traffic Detour Trips per Day:	1,350
Additional Time per One-Way Detour Trip (minutes):	5
Number of Additional Miles:	1
Federal Rate ($):	0.625 Use Default:Yes
Economic Loss Per Day of Loss of Function ($):	4,848.75

Comments

-

Number of Trips:

Railroad crossing not roadway crossing.

Professional Expected Damages Before Mitigation

Drainage Improvement @ 34° 16' 51.8199600"; -79° -28' -31.5699600"

	ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
100	1	616,560	0	0	0	0	621,409
50	1	0	605,200	0	0	0	610,049

Comments

-

Damages Before Mitigation:

Approximately 21-structures are removed from the 100-year floodplain (based on hydraulic modeling) and the structures (1,000-SF) are relieved of approximately 1-foot of flooding, the FEMA Flood Damage Calculator values this flood reduction at $29,360 per impacted structure (21). This value was used for the 100-year event and are depicted in Category 1 damages. Based on hydraulic modeling, the roadway overtops during the 50-year event. When roadways overtop, hydroplaning accidents are likely. Two (2) potential accidents are assumed per overtopping event. An injury crash is valued at $302,600 of damage per incident via Table A-1: Value of Reduced Fatalities and Injuries within the Benefit Cost Analysis Guidance for Discretionary Grant Programs, U.S. Department of Transportation, March 2022. This value was used for the 50-year event and are depicted in Category 2 damages.

Annualized Damages Before Mitigation

Drainage Improvement @ 34° 16' 51.8199600"; -79° -28' -31.5699600"

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
50	610,049	6,157
100	621,409	6,214
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	1,231,458	12,371

Professional Expected Damages After Mitigation

Drainage Improvement @ 34° 16' 51.8199600"; -79° -28' -31.5699600"

	ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
0	0	0	0	0	0	0	0

Annualized Damages After Mitigation

Drainage Improvement @ 34° 16' 51.8199600"; -79° -28' -31.5699600"

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	0	0

Standard Benefits - Ecosystem Services

Drainage Improvement @ 34° 16' 51.8199600"; -79° -28' -31.5699600"

Total Project Area (acres):	0
Percentage of Urban Green Open Space:	0.00%
Percentage of Rural Green Open Space:	0.00%
Percentage of Riparian:	0.00%
Percentage of Coastal Wetlands:	0.00%
Percentage of Inland Wetlands:	0.00%
Percentage of Forests:	0.00%
Percentage of Coral Reefs:	0.00%
Percentage of Shellfish Reefs:	0.00%
Percentage of Beaches and Dunes:	0.00%
Expected Annual Ecosystem Services Benefits:	$0

Benefits-Costs Summary

Drainage Improvement @ 34° 16' 51.8199600"; -79° -28' -31.5699600"

Total Standard Mitigation Benefits:	$170,729
Total Social Benefits:	$0
Total Mitigation Project Benefits:	$170,729
Total Mitigation Project Cost:	$543,801
Benefit Cost Ratio - Standard:	0.31
Benefit Cost Ratio - Standard + Social:	0.31

BCA Cost Estimate - G - East Front Street & Railroad Crossing Improvements, Mullins SC

HARD COSTS

ITEM	IDESCR	IDESCRL	QUANTITY	UNITS	UNIT COST	COST
1031010	MOBILIZATION	MOBILIZATION		LS	5%	$ 11,319.60
1071000	TRAFFIC CONTROL	TRAFFIC CONTROL		LS	8%	$ 18,111.36
2011000	CLEAR. & GRUB. WITHIN R/W	CLEARING & GRUBBING WITHIN RIGHT OF WAY		LS	3.5%	$ 7,923.72
2028500	REM&DISP.OF EX.CULV 48" CULVERT (& VARIOUS OTHERS)	REM&DISP.OF EX.CULV 48" CULVERT (& VARIOUS OTHERS)		LS	$ 40,000.00	$ 40,000.00
4012120	FULL DEP.ASPH.PAV.PATCH-12"	FULL DEPTH ASPH. PAV. PATCHING 12"UNIF	200	SY	$ 120.00	$ 24,000.00
7141136	36" RC PIPE CUL.-CLASS V	36" RC PIPE CUL.-CLASS V	100	LF	$ 240.00	$ 24,000.00
7141138	48" RC PIPE CUL.-CLASS V	48" RC PIPE CUL.-CLASS V	244	LF	$ 310.00	$ 75,640.00
8041020	RIP-RAP (CLASS B)	RIP-RAP (CLASS B)	100	TON	$ 98.38	$ 9,838.00
8048105	GEOTEX/EROS.CONT(CLASS1)TYPE B	GEOTEXTILE FOR EROSION CONTROL UNDER RIPRAP(CLASS 1)TYPE B	100	SY	$ 4.14	$ 414.00
8101000	SEEDING (MULCHED)	SEEDING (MULCHED)	1	MSY	$ 750.00	$ 750.00
8153000	SILT FENCE	SILT FENCE	500	LF	$ 3.50	$ 1,750.00
	RAILROAD TRACK/BALLAST REBUILD	RAILROAD TRACK/BALLAST REBUILD	100	LF	$ 500.00	$ 50,000.00
	RAIL SHOOFLY (DESIGN AND CONSTRUCTION)	RAIL SHOOFLY (DESIGN AND CONSTRUCTION)		LS		$ -
	CONTINGENCY	CONTINGENCY 35% (ADDITIONAL CONTINGENCY FOR RAIL PROJECTS)	-	-		$ 92,311.34
					SUB-TOTAL:	$ 226,392.00
					HARD COST TOTAL:	$ 356,058.02

SOFT COSTS

RAILROAD CONSTRUCTION OBSERVATION	RAILROAD CONSTRUCTION OBSERVATION		$ 60,000.00
RAILROAD ENGINEERING REVIEW	RAILROAD CONSULTANT DESIGN REVIEW		$ 25,000.00
DESIGN	SURVEY, STRUCTURAL DESIGN, HYDRO DESIGN, AND ENVIRO COMPLIANCE		$ 71,211.60
PERMITTING & FEES	LAND DISTURBANCE/NPDES PERMITTING, ENVIRO, SCDOT, ETC.		$ 17,802.90
		SOFT COST TOTAL:	$ 174,014.50
		GRAND TOTAL:	$ 530,072.52
		ROUNDED TOTAL:	$ 530,000.00

H - East McIntyre Street Crossing Improvements - Mullins, SC

H - East McIntyre Street Crossing Improvements			
Prioritization Category	**Sub-Category**	**Points**	**Maximum Point**
LMI % Served	*LMI % X 20 points*	9.4	20
Level of Flood Risk Reduction	Above a 25-year / 24-hour storm event level of protection	10	10
Quantity of Flood Risk Reduction	10-25 Structures	4	10
Benefit-Cost Ratio	75-100%	20	20
Leveraged Funding	Limited potential cost share identified	5	10
Permitting/Scheduling	Little-to-no challenges	10	10
Mobility Improvement	Significant mobility improvements	5	5
Phasing Considerations	No connection to larger scale project	0	5
Project Synergies	Limited cost savings	3	5
Environmental Impact	Neutral Impact	3	5
		69.4	100

EAST MCINTYRE STREET CROSSING IMPROVEMENTS

Mullins, South Carolina

Category:
Fully Meets Design Standards

Purpose:
To reduce and/or alleviate flooding upstream of East McIntyre Street in Mullins

Background

White Oak Creek Tributary 1-1 flows from north to south as shown in Figure H1 below. This tributary ultimately drains to White Oak Creek approximately 500 feet downstream of the limits of the effective FEMA model. The area upstream of East McIntyre Street frequently floods according to City officials and numerous news articles. The existing crossing along White Oak Creek Tributary 1-1 under East McIntyre Street is a single 4'(W) x 4'(H) reinforced concrete box culvert. At the downstream outlet of the existing box culvert is also a 48" reinforced concrete pipe which carries stormwater runoff from the closed system along East McIntyre Street. This 48" culvert does not actually carry stream flow and was not included in the HEC-RAS model. Figures H2 and H3 below show pictures at the upstream and downstream faces of these structures.

Figure H1: White Oak Creek Tributary 1-1 centerline with parcel boundaries

Figure H2: Upstream face of existing box culvert under East McIntyre Street

Figure H3: Downstream face of existing box culvert and 48" RCP under East McIntyre Street

Potential Project

A hydraulic analysis was performed to investigate the major cause behind the flooding upstream of East McIntyre Street. Reviewing the water surface profile along White Oak Creek Tributary 1-1 shows that the existing crossing under East McIntyre Street is severely undersized as the current crossing is inadequate for even the 2-year storm event. The constriction caused by this undersized crossing results in flooding the area upstream of East McIntyre Street. Given the flat nature of the upstream floodplain in this area, the flooding extents caused by this restriction extend east and west of the stream impacting several structures. To alleviate flooding upstream, a proposed 6'(W) x 6'(H) reinforced concrete box culvert was selected as a replacement structure to reassess upstream impacts. This culvert size was chosen as this sizing would not result in any major modifications to the existing stream or the need to make major roadway improvements along East McIntyre Street. The flood reduction upstream of this crossing in the proposed condition is evident by reviewing the water surface profile as shown in Figure H4 below. The red line corresponds to 100-year water surface profile with the current 4'(W) x 4'(H) box culvert in place. The blue line corresponds to the 100-year water surface profile with the proposed 6'(W) x 6'(H) replacement structure in place. Figure H5 depicts the 100-year flood depths along White Oak Creek Tributary 1-1 with the existing infrastructure in place and shows significant flooding upstream of East McIntyre Street which corresponds with documented flooding. This flooding encroaches on several structures which are depicted as red polygons in the figures. Figure G6 shows the 100-year flood depths with the proposed box culvert constructed. The flooding depicted in this figure is greatly reduced and removes all structures that were previously in the 100-year floodplain.

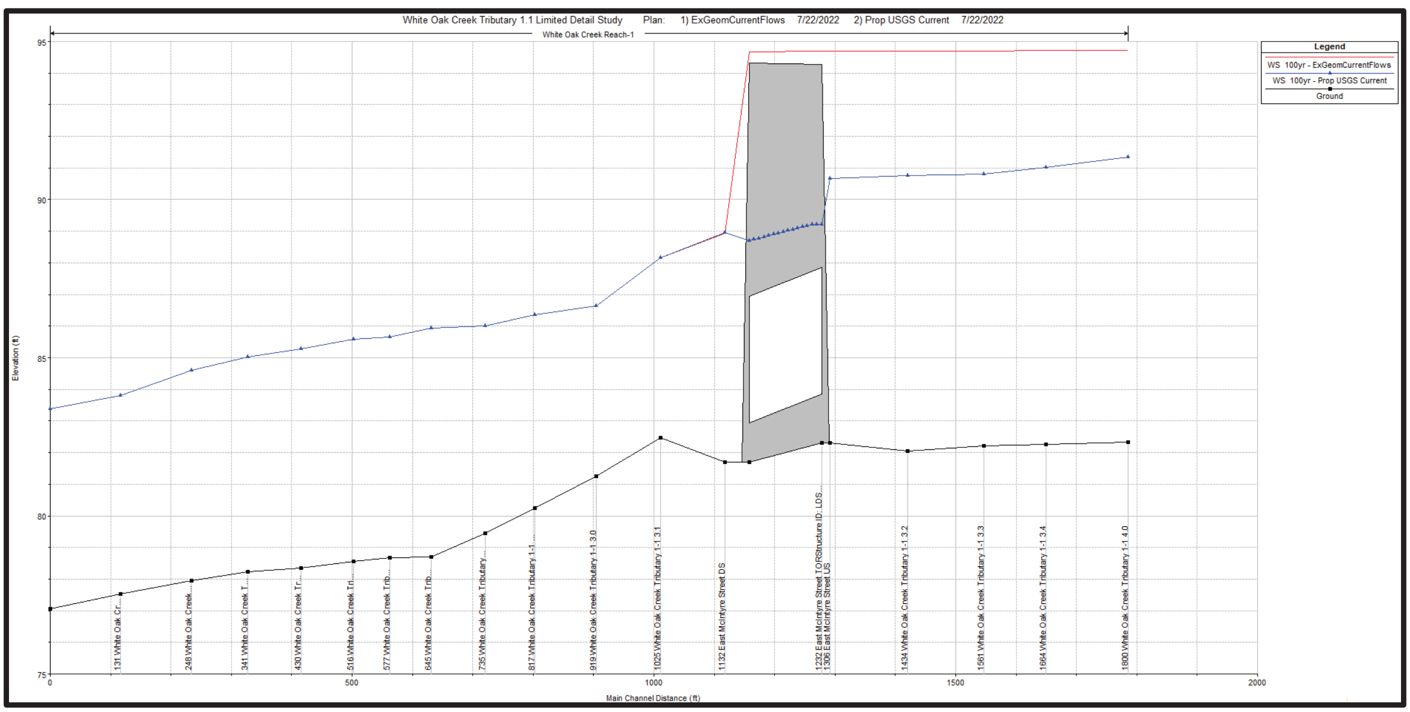


Figure H4: 100-yr water surface profile along White Oak Creek Tributary 1-1 showing existing condition (red) and proposed improvements (blue)

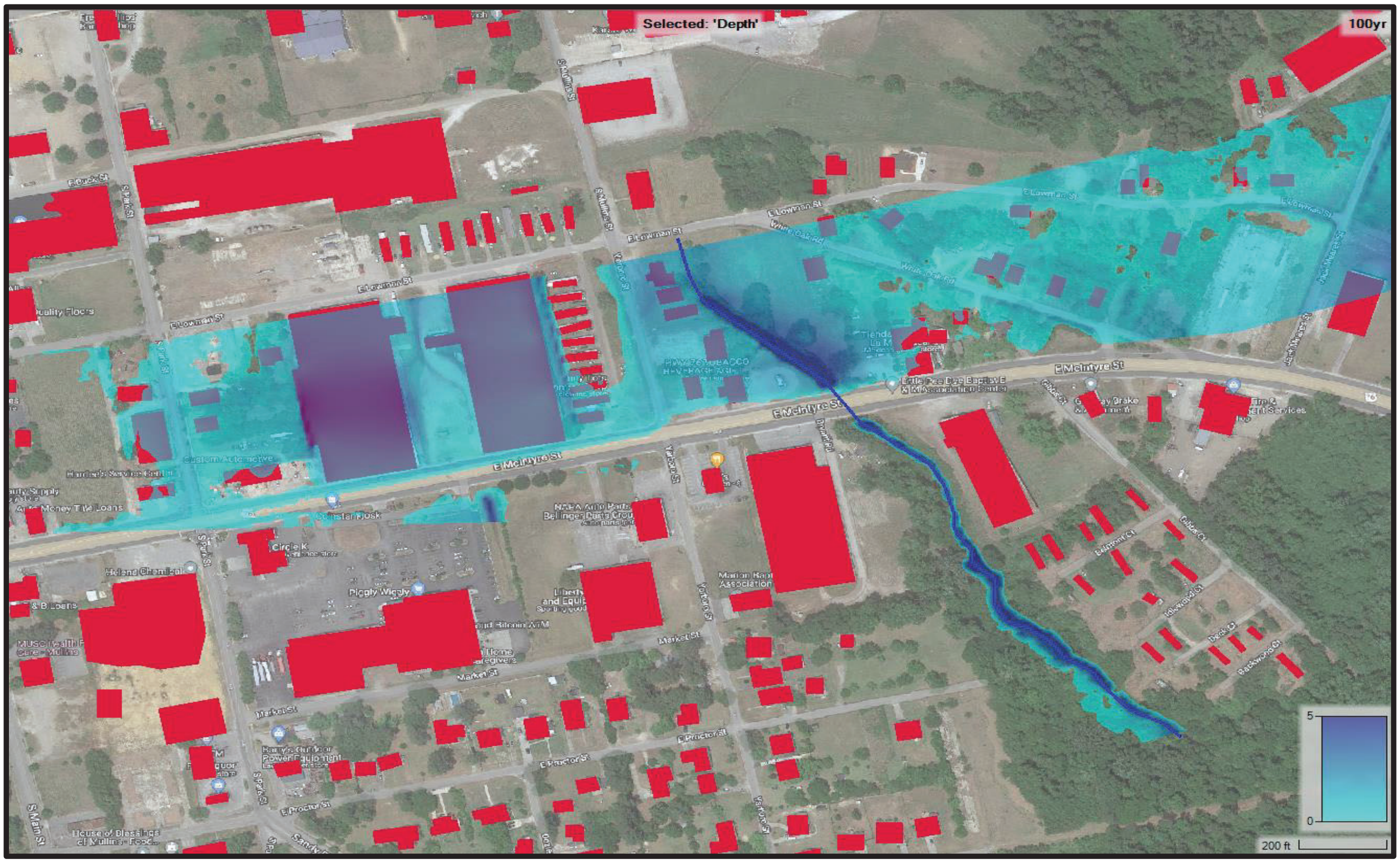


Figure H5: 100-yr flood depth with existing East McIntyre Street infrastructure in place

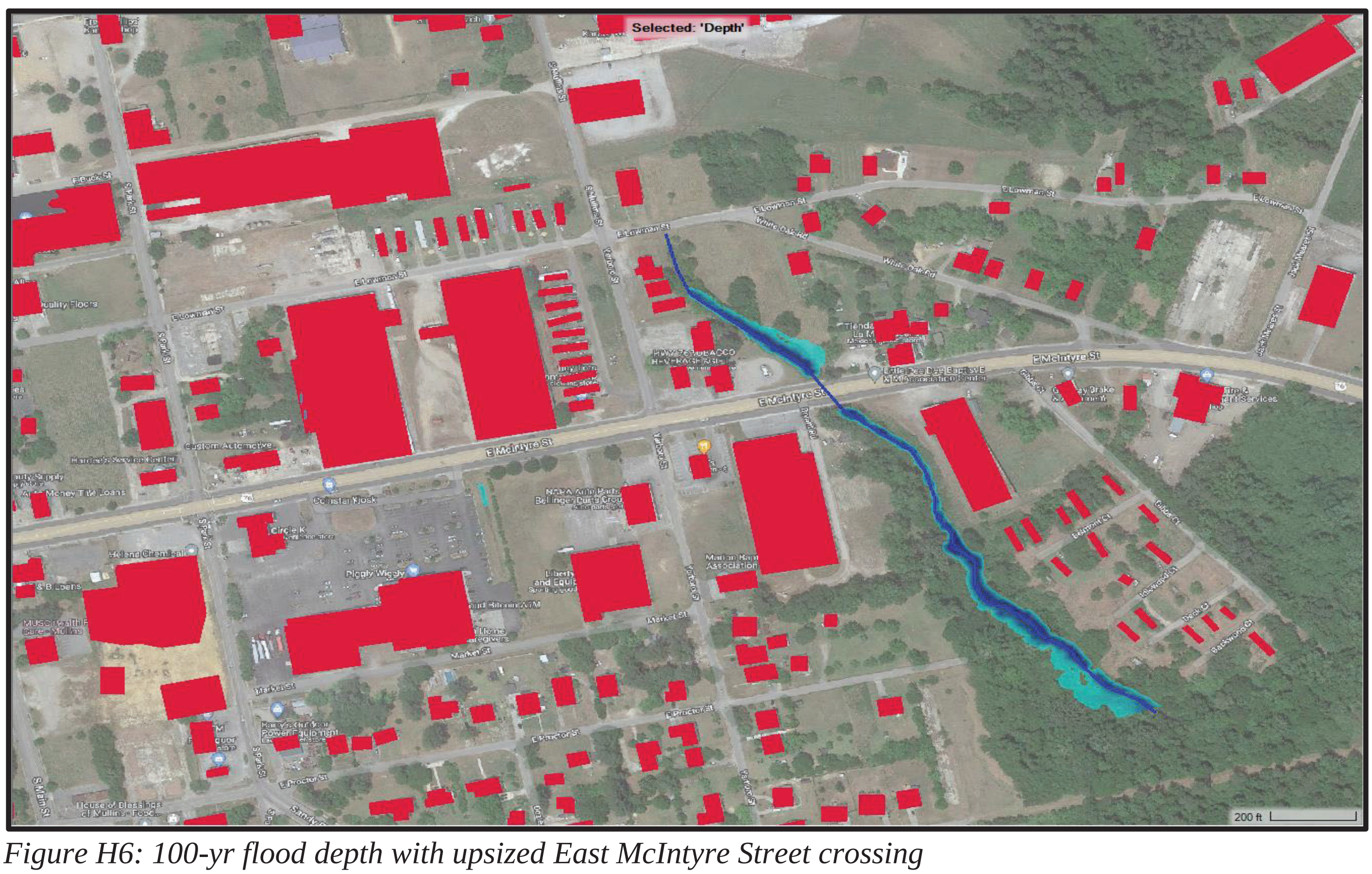


Figure H6: 100-yr flood depth with upsized East McIntyre Street crossing

Additional Considerations

White Oak Creek Tributary 1-1 is in a detailed FEMA Zone AE without an established floodway. Any improvements may require FEMA coordination, but at a minimum will require coordination with the local floodplain manager.

Updated topographic information may be required to better define the floodplain inundation limits as the existing LiDAR is from 2008.

PROJECT BENEFITS

Eliminates flooding upstream of East McIntyre Street

Improves level of service of East Front Street significantly

Meets SCDOT design criteria

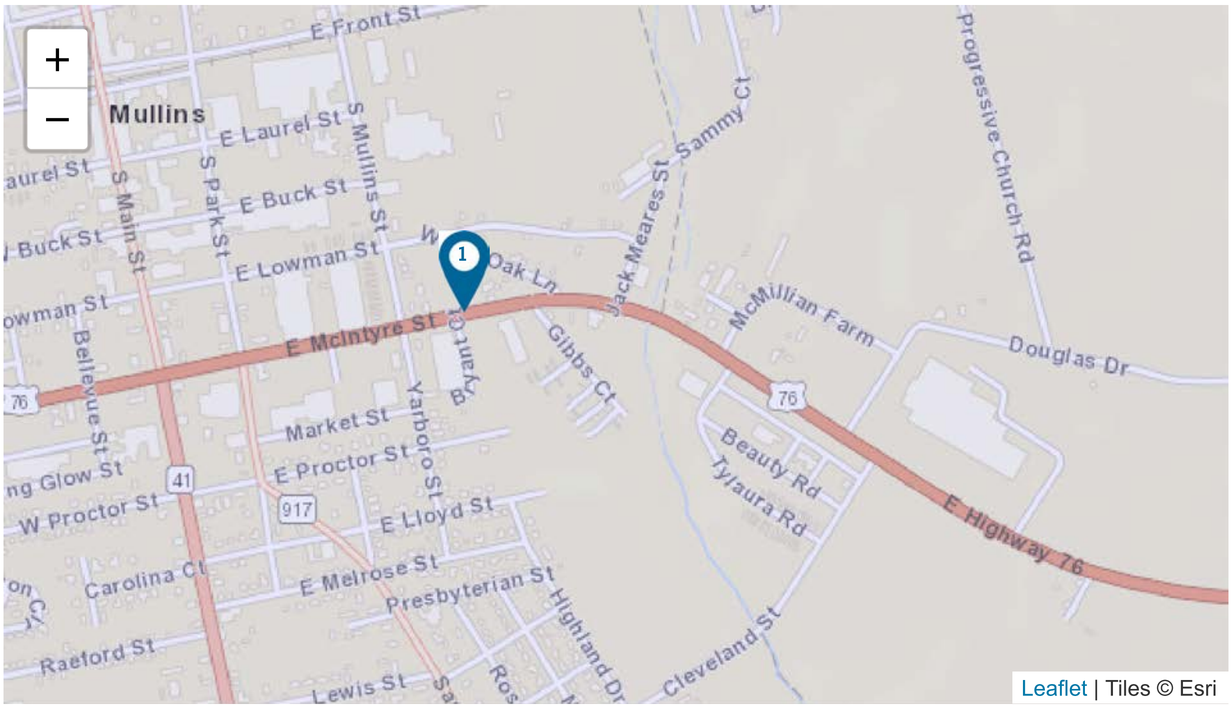
All structures previously within the 100-year floodplain are now outside the limits

Provides flood relief for both high frequency and low frequency storm events

Benefit-Cost Calculator
V.6.0 (Build 20221028.1600 | Release Notes)

Benefit-Cost Analysis

Project Name: H - East McIntyre Street Crossing Improvements - Mullins, SC



				Using 7% Discount Rate			Using 3% Discount Rate (For FY22 BRIC and FMA only)		
Map Marker ▲	Mitigation Title	Property Type	Hazard	Benefits (B)	Costs (C)	BCR (B/C)	Benefits (B)	Costs (C)	BCR (B/C)
1	Drainage Improvement @ 34.2013250; -79.2466639		DFA - Riverine Flood	$ 871,766	$ 684,801	1.27	$ 1,625,298	$ 696,730	2.33
TOTAL (SELECTED)				**$ 871,766**	**$ 684,801**	**1.27**	**$ 1,625,298**	**$ 696,730**	**2.33**
TOTAL				**$ 871,766**	**$ 684,801**	**1.27**	**$ 1,625,298**	**$ 696,730**	**2.33**

Property Configuration

Property Title:	Drainage Improvement @ 34.2013250; -79.2466639
Property Location:	29574, Marion, South Carolina
Property Coordinates:	34.2013250, -79.2466639
Hazard Type:	Riverine Flood
Mitigation Action Type:	Drainage Improvement
Property Type:	Roads & Bridges
Analysis Method Type:	Professional Expected Damages

Cost Estimation

Drainage Improvement @ 34.2013250; -79.2466639

Project Useful Life (years):	50
Project Cost:	$671,000
Number of Maintenance Years:	50 Use Default:Yes
Annual Maintenance Cost:	$1,000

Damage Analysis Parameters - Damage Frequency Assessment

Drainage Improvement @ 34.2013250; -79.2466639

Year of Analysis was Conducted:	2022
Year Property was Built:	1960
Analysis Duration:	63 Use Default:Yes

Roads and Bridges Properties

Drainage Improvement @ 34.2013250; -79.2466639

Estimated Number of One-Way Traffic Detour Trips per Day:	4,000
Additional Time per One-Way Detour Trip (minutes):	2
Number of Additional Miles:	1
Federal Rate ($):	0.625 Use Default:Yes
Economic Loss Per Day of Loss of Function ($):	7,246.67

Comments

-

Number of Trips:

AADT 2021 from SCDOT Street Finder

Professional Expected Damages Before Mitigation
Drainage Improvement @ 34.2013250; -79.2466639

	ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	0Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
10	5	605,200	0	0	0	0	641,433
100	1	0	616,560	0	0	0	623,807

Comments

-

Damages Before Mitigation:
When road overtops, hydroplaning accidents are likely. Assuming two potential accidents with 2 passengers per road overtopping event. An injury crash is valued as $302,600 of damage per incident per Table A-1: Value of Reduced Fatalities and Injuries within the Benefit Cost Analysis Guidance for Discretionary Grant Programs, U.S. Department of Transportation, March 2022. Category 1 damages represent this injury crash value. Also, using the FEMA Flood Damage Calculator, and that approximately 21-structures are removed from the 100-year flooded area via these proposed improvements, a 1-foot of flood damage cost value of $29,360 per impacted structure was used. Category 2 damages represent this flood reduction value.

Annualized Damages Before Mitigation
Drainage Improvement @ 34.2013250; -79.2466639

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
10	641,433	56,930
100	623,807	6,238
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	1,265,240	63,168

Professional Expected Damages After Mitigation
Drainage Improvement @ 34.2013250; -79.2466639

	ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	0Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
0	0	0	0	0	0	0	0

Annualized Damages After Mitigation
Drainage Improvement @ 34.2013250; -79.2466639

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	0	0

Standard Benefits - Ecosystem Services

Drainage Improvement @ 34.2013250; -79.2466639

Total Project Area (acres):	0
Percentage of Urban Green Open Space:	0.00%
Percentage of Rural Green Open Space:	0.00%
Percentage of Riparian:	0.00%
Percentage of Coastal Wetlands:	0.00%
Percentage of Inland Wetlands:	0.00%
Percentage of Forests:	0.00%
Percentage of Coral Reefs:	0.00%
Percentage of Shellfish Reefs:	0.00%
Percentage of Beaches and Dunes:	0.00%
Expected Annual Ecosystem Services Benefits:	$0

Benefits-Costs Summary

Drainage Improvement @ 34.2013250; -79.2466639

Total Standard Mitigation Benefits:	$871,766
Total Social Benefits:	$0
Total Mitigation Project Benefits:	$871,766
Total Mitigation Project Cost:	$684,801
Benefit Cost Ratio - Standard:	1.27
Benefit Cost Ratio - Standard + Social:	1.27

BCA Cost Estimate - H - East McIntyre Street Crossing Improvements, Mullins SC

HARD COSTS

ITEM	IDESCR	IDESCRL	QUANTITY	UNITS	UNIT COST		COST
1031010	MOBILIZATION	MOBILIZATION		LS		5%	$ 18,427.60
1071000	TRAFFIC CONTROL	TRAFFIC CONTROL		LS		8%	$ 29,484.16
2011000	CLEAR. & GRUB. WITHIN R/W	CLEARING & GRUBBING WITHIN RIGHT OF WAY		LS		3.5%	$ 12,899.32
2028500	REM&DISP.OF EX.CULV 4'X4'	REMOVAL & DISPOSAL OF EXISTING CULVERT 4'X4'	1	EA	$	15,000.00	$ 15,000.00
4012120	FULL DEP.ASPH.PAV.PATCH-12"	FULL DEPTH ASPH. PAV. PATCHING 12"UNIF	500	SY	$	120.00	$ 60,000.00
7221024	6'X6' PCBOX CULV.{M-273}FH<2	6'X 6' P.C. BOX CULVERT {AASHTO M-273} FH < 2 6'X 6'	117	LF	$	2,400.00	$ 280,800.00
8041020	RIP-RAP (CLASS B)	RIP-RAP (CLASS B)	100	TON	$	98.38	$ 9,838.00
8048105	GEOTEX/EROS.CONT(CLASS1)TYPE B	GEOTEXTILE FOR EROSION CONTROL UNDER RIPRAP(CLASS 1)TYPE B	100	SY	$	4.14	$ 414.00
8101000	SEEDING (MULCHED)	SEEDING (MULCHED)	1	MSY	$	750.00	$ 750.00
8153000	SILT FENCE	SILT FENCE	500	LF	$	3.50	$ 1,750.00
	CONTINGENCY	CONTINGENCY 25%	-	-			$ 107,340.77
					SUB-TOTAL:		$ 368,552.00
					HARD COST TOTAL:		$ 536,703.85

SOFT COSTS

DESIGN	SURVEY, STRUCTURAL DESIGN, HYDRO DESIGN, AND ENVIRO COMPLIANCE		$ 107,340.77
PERMITTING & FEES	LAND DISTURBANCE/NPDES PERMITTING, ENVIRO, SCDOT, ETC.		$ 26,835.19
		SOFT COST TOTAL:	$ 134,175.96
		GRAND TOTAL:	$ 670,879.81
		ROUNDED TOTAL:	$ 671,000.00

I - West McIntyre Street Crossing Improvements - Mullins, SC

I - West McIntyre Street Crossing Improvements - Mullins, SC			
Prioritization Category	**Sub-Category**	**Points**	**Maximum Point**
LMI % Served	*LMI % X 20 points*	10.2	20
Level of Flood Risk Reduction	Above a 25-year / 24-hour storm event level of protection	10	10
Quantity of Flood Risk Reduction	10-25 Structures	4	10
Benefit-Cost Ratio	25-50%	7	20
Leveraged Funding	Limited potential cost share identified	5	10
Permitting/Scheduling	Little-to-no challenges	10	10
Mobility Improvement	Significant mobility improvements	5	5
Phasing Considerations	No connection to larger scale project	0	5
Project Synergies	Limited cost savings	3	5
Environmental Impact	Neutral Impact	3	5
		57.2	100

WEST MCINTYRE STREET CROSSING IMPROVEMENTS

Mullins, South Carolina

Category:
Fully Meets Design Standards

Purpose:
Replace the existing 6’(W) x 4’(H) reinforced concrete box culvert (RCBC) and 3’ diameter reinforced concrete pipe (RCP) with a 9’(W) x 6’(H) RCBC. Achieves approximately 0.75’ reduction in 100-year water surface elevations and 1.10’ reduction in the 50-year water surface elevations immediately upstream.

Background

Maidendown Swamp Tributary crosses West McIntyre Street (US-76) to the west and just outside of the City of Mullins limits. The area upstream of this crossing, south of the roadway, has historically experienced flooding during high-flow storm events. Specifically, the Milton Troy neighborhood has been impacted by these flooding issues for several decades.

It is Michael Baker International’s understanding that a number of projects have been initiated in an effort to alleviate flooding issues in this specific area including a CDBG Block Grant for drainage improvements (approximately 2014/2015) and an SCDOT project (2020/2021) to install the 36” RCP culvert that is currently in place with the 6'(W) x 4'(H) RCBC.

Figure I1: View of approximate existing 100-YR inundation depth upstream of West McIntyre Street (US-76).

Potential Project

The proposed project would remove and replace the existing 6'(W) x 4'(H) Reinforced Concrete Box Culvert (RCBC) and 3' diameter reinforced concrete pipe (RCP) with a 9'(W) x 6'(H) RCBC of similar length and slope.

Figure I2: Recent photograph of the West McIntyre Street (US-76) crossing showing existing configuration.

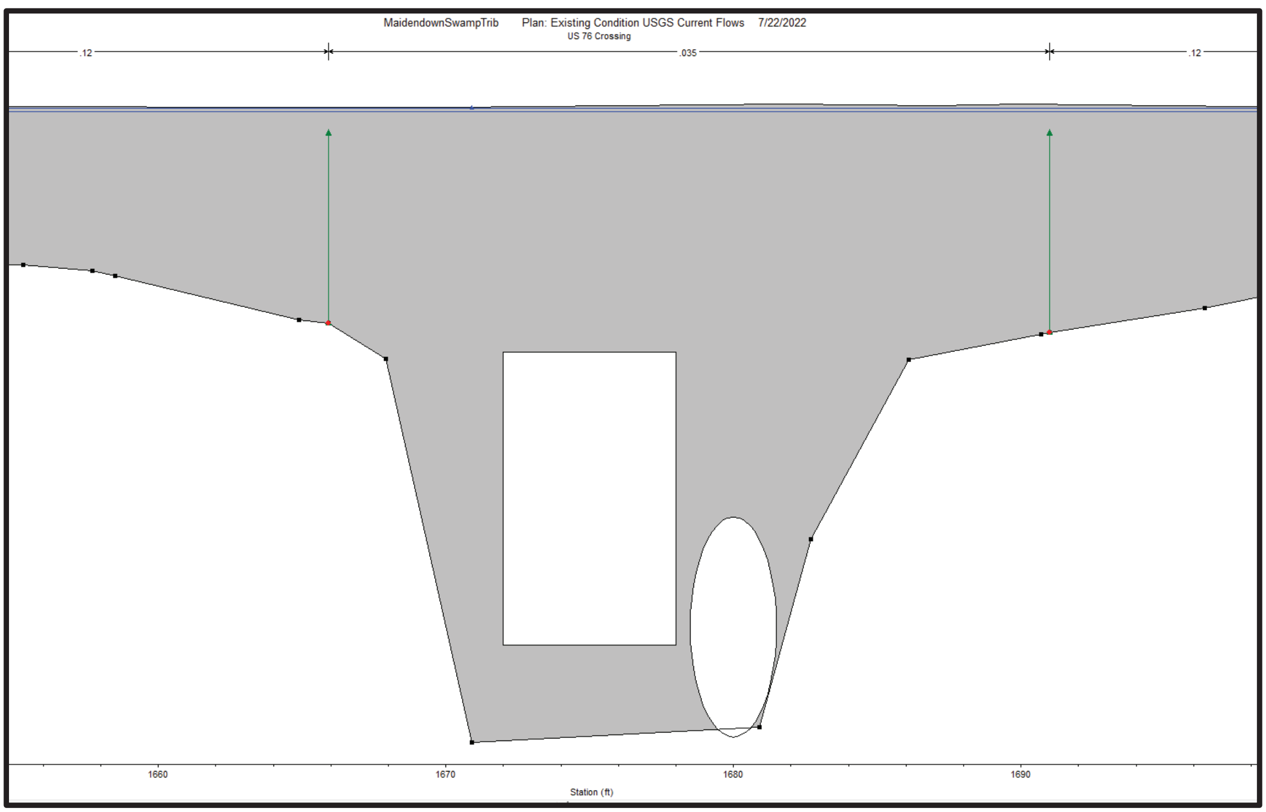


Figure I3: View of HEC-RAS model at the West McIntyre Street (US-76) crossing showing existing configuration.

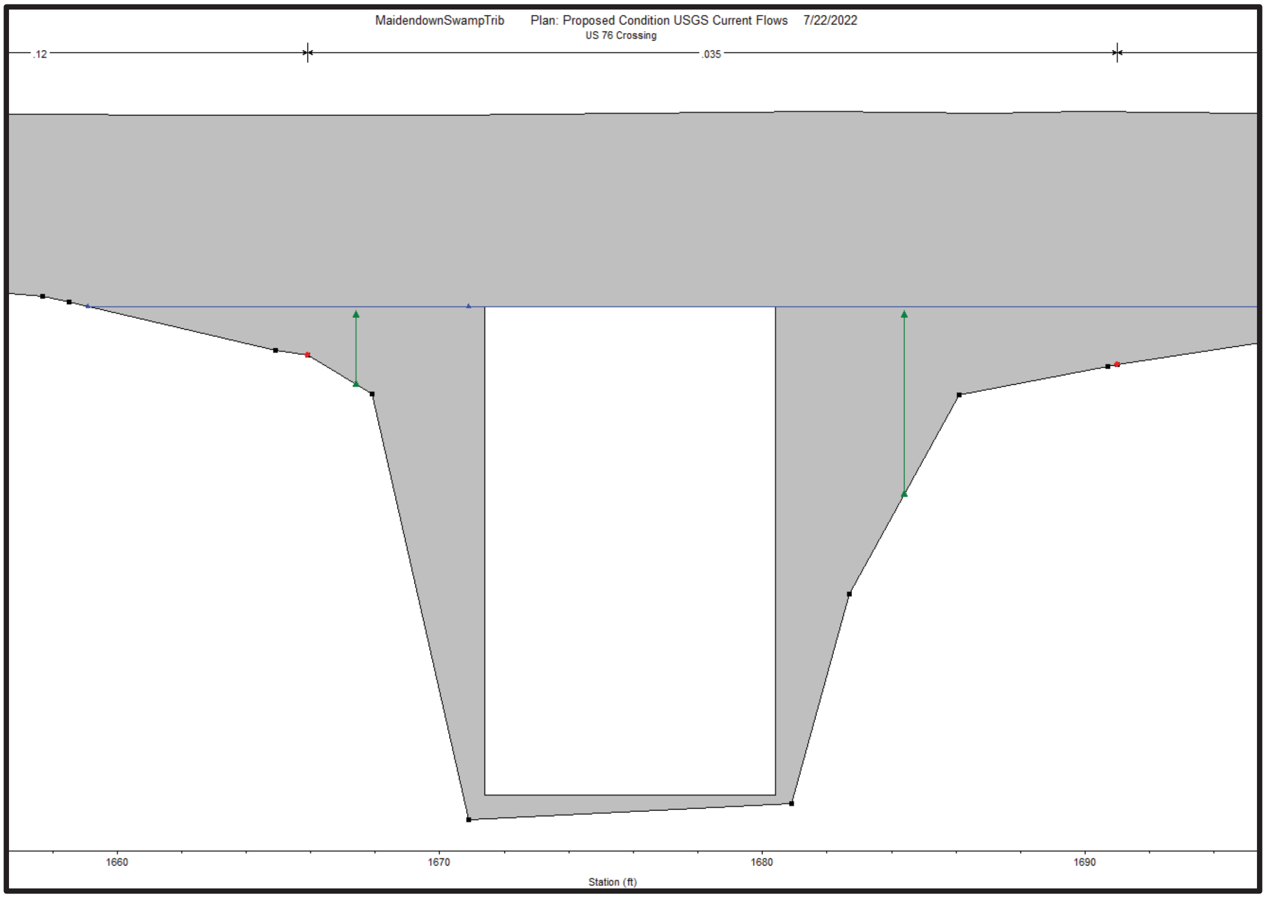


Figure I4: View of HEC-RAS model at the West McIntyre Street (US-76) crossing showing proposed configuration.

Due to the low-lying topography of the surrounding area upstream, the Milton Troy neighborhood, the observed limits of flooding between existing and proposed conditions do not appear significant. However, when comparing the flooding depths between Figures I1 and I4, there is a reduction of 0.75’ and 1.10’ of flood depth for the 100-year and 50-year storm events respectively.

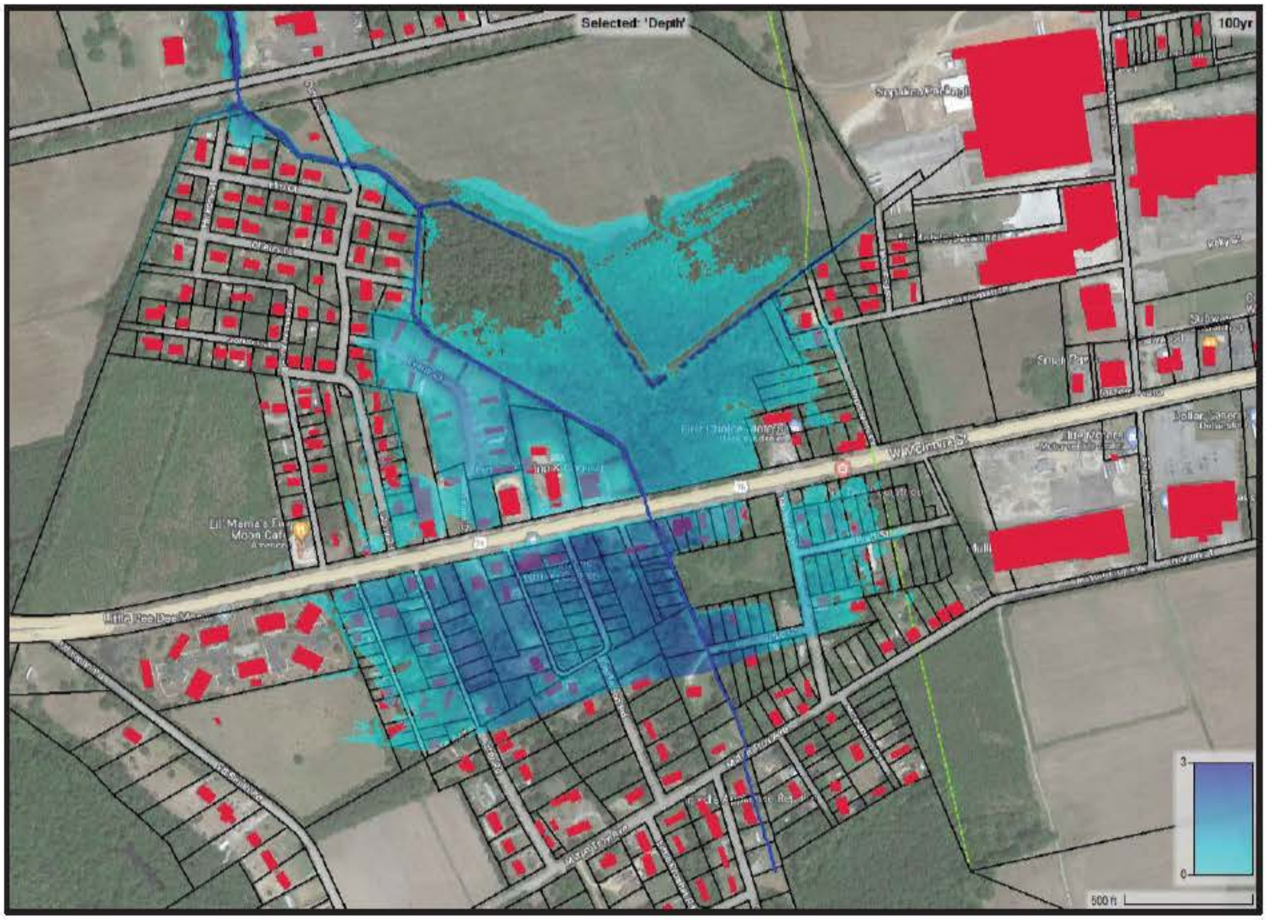


Figure I5: View of approximate existing inundation area upstream of West McIntyre Street (US-76).

Additional Considerations

The recent history of proposed drainage improvement efforts in this area should be considered when assessing if this potential project should be selected. With the CDBG Block Grant project seeming to have stopped mid-project in 2014/2015 due to apparent threatened or actual litigation from [redacted], [redacted], and SCDOT's drainage improvements being completed in 2020/2021 this location may be difficult to get concurrence from other stakeholders/property owners. Early stakeholders' meetings and further, more detailed, feasibility studies should be conducted prior to initiation.

PROJECT BENEFITS

Upstream flooding reduction

Improvements within Public/SCDOT Right of Way

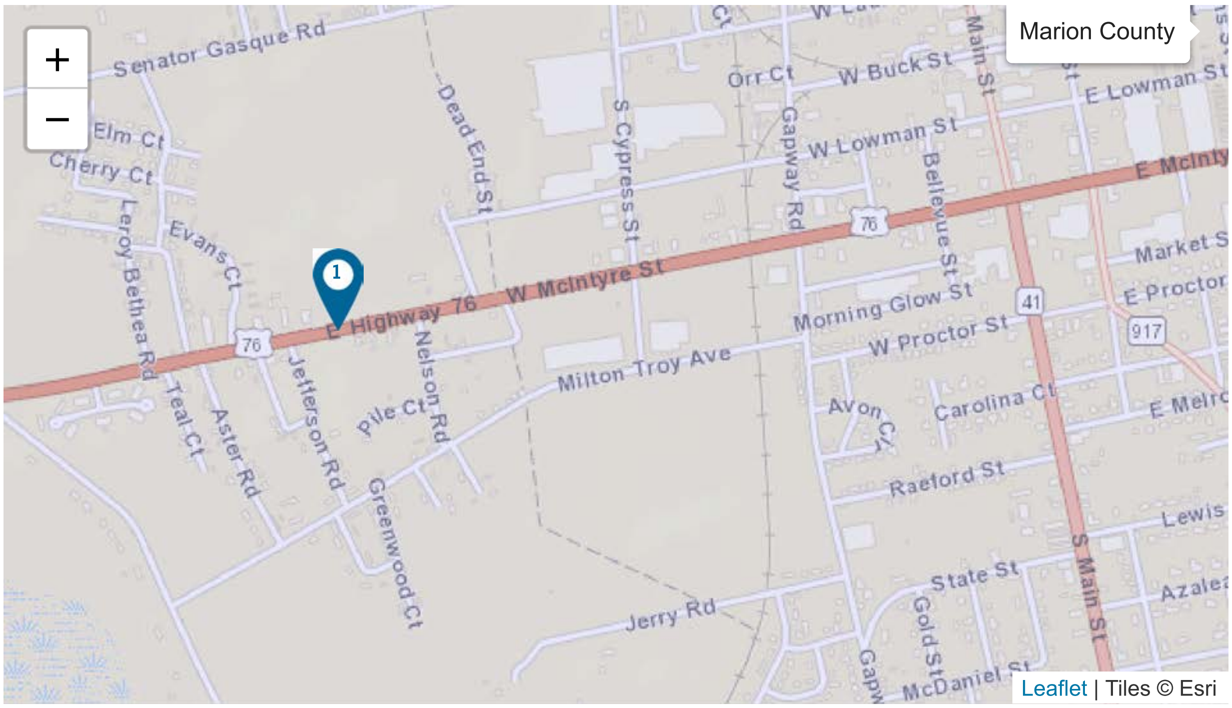
Increase level of service for West McIntyre Street (US-76)

Benefit-Cost Calculator

V.6.0 (Build 20221028.1600 | Release Notes)

Benefit-Cost Analysis

Project Name: I - West McIntyre Street Crossing Improvements - Mullins, SC



Map Marker ▲	Mitigation Title	Property Type	Hazard	Using 7% Discount Rate: Benefits (B)	Costs (C)	BCR (B/C)	Using 3% Discount Rate (For FY22 BRIC and FMA only): Benefits (B)	Costs (C)	BCR (B/C)
1	Drainage Improvement @ 34° 11' 52.3298400"; -79° -16' -3.3301200"		DFA - Riverine Flood	$ 977,617	$ 836,801	1.17	$ 1,822,645	$ 848,730	2.15
TOTAL (SELECTED)				**$ 977,617**	**$ 836,801**	**1.17**	**$ 1,822,645**	**$ 848,730**	**2.15**
TOTAL				**$ 977,617**	**$ 836,801**	**1.17**	**$ 1,822,645**	**$ 848,730**	**2.15**

Property Configuration

Property Title:	Drainage Improvement @ 34° 11' 52.3298400"; -79° -16' -3.3301200"
Property Location:	29574, Marion, South Carolina
Property Coordinates:	34.1978694, -79.2675917
Hazard Type:	Riverine Flood
Mitigation Action Type:	Drainage Improvement
Property Type:	Roads & Bridges
Analysis Method Type:	Professional Expected Damages

Cost Estimation

Drainage Improvement @ 34° 11' 52.3298400"; -79° -16' -3.3301200"

Project Useful Life (years):	50
Project Cost:	$823,000
Number of Maintenance Years:	50 Use Default:Yes
Annual Maintenance Cost:	$1,000

Damage Analysis Parameters - Damage Frequency Assessment

Drainage Improvement @ 34° 11' 52.3298400"; -79° -16' -3.3301200"

Year of Analysis was Conducted:	2022
Year Property was Built:	1960
Analysis Duration:	63 Use Default:Yes

Roads and Bridges Properties

Drainage Improvement @ 34° 11' 52.3298400"; -79° -16' -3.3301200"

Estimated Number of One-Way Traffic Detour Trips per Day:	8,100
Additional Time per One-Way Detour Trip (minutes):	10
Number of Additional Miles:	1
Federal Rate ($):	0.625 Use Default:Yes
Economic Loss Per Day of Loss of Function ($):	53,122.5

Comments

-

Number of Trips:

AADT 2021 from SCDOT Street Finder

Professional Expected Damages Before Mitigation

Drainage Improvement @ 34° 11' 52.3298400"; -79° -16' -3.3301200"

	ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
25	1	605,200	554,800	557,840	0	0	1,770,963

Comments

•

Damages Before Mitigation:

When road overtops, hydroplaning accidents are likely. Assuming three (3) potential accidents with 2 passengers per road overtopping event, due to the high volume of traffic. One of these potential accidents are assumed to be incapacitating due to the higher speed limit in this area. An injury crash is valued as $302,600 of damage per incident (Category 1 damages) and an incapacitating level of injury is valued as $554,800 (Category 2 damages) of damage per incident per Table A-1: Value of Reduced Fatalities and Injuries within the Benefit Cost Analysis Guidance for Discretionary Grant Programs, U.S. Department of Transportation, March 2022. Also, using the FEMA Flood Damage Calculator, and that approximately 19-structures are removed from the 25-year flooded area via these proposed improvements, a 1-foot of flood damage cost value of $29,360 per impacted structure was used. Category 3 damages represent this flood reduction value.

Annualized Damages Before Mitigation

Drainage Improvement @ 34° 11' 52.3298400"; -79° -16' -3.3301200"

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
25	1,770,963	70,838
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	1,770,963	70,838

Professional Expected Damages After Mitigation

Drainage Improvement @ 34° 11' 52.3298400"; -79° -16' -3.3301200"

	ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
0	0	0	0	0	0	0	0

Annualized Damages After Mitigation

Drainage Improvement @ 34° 11' 52.3298400"; -79° -16' -3.3301200"

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	0	0

Standard Benefits - Ecosystem Services

Drainage Improvement @ 34° 11' 52.3298400"; -79° -16' -3.3301200"

Total Project Area (acres):	0
Percentage of Urban Green Open Space:	0.00%
Percentage of Rural Green Open Space:	0.00%
Percentage of Riparian:	0.00%
Percentage of Coastal Wetlands:	0.00%
Percentage of Inland Wetlands:	0.00%
Percentage of Forests:	0.00%
Percentage of Coral Reefs:	0.00%
Percentage of Shellfish Reefs:	0.00%
Percentage of Beaches and Dunes:	0.00%
Expected Annual Ecosystem Services Benefits:	$0

Benefits-Costs Summary

Drainage Improvement @ 34° 11' 52.3298400"; -79° -16' -3.3301200"

Total Standard Mitigation Benefits:	$977,617
Total Social Benefits:	$0
Total Mitigation Project Benefits:	$977,617
Total Mitigation Project Cost:	$836,801
Benefit Cost Ratio - Standard:	1.17
Benefit Cost Ratio - Standard + Social:	1.17

BCA Cost Estimate - I - West McIntyre Street Crossing Improvements, Mullins SC

HARD COSTS

ITEM	IDESCR	IDESCRL	QUANTITY	UNITS	UNIT COST		COST
1031010	MOBILIZATION	MOBILIZATION		LS		5%	$ 21,065.20
1071000	TRAFFIC CONTROL	TRAFFIC CONTROL		LS		20%	$ 84,260.80
2011000	CLEAR. & GRUB. WITHIN R/W	CLEARING & GRUBBING WITHIN RIGHT OF WAY		LS		0.0%	$ -
2028500	REM&DISP.OF EX.CULV 6'X4'	REMOVAL & DISPOSAL OF EXISTING CULVERT 6'X4'	1	EA	$	35,000.00	$ 35,000.00
4012120	FULL DEP.ASPH.PAV.PATCH-12"	FULL DEPTH ASPH. PAV. PATCHING 12"UNIF	500	SY	$	120.00	$ 60,000.00
7221054	9'X6' PCBOX CULV.{M-273}FH<2	9'X 6' P.C. BOX CULVERT {AASHTO M-273} FH < 2 9'X 6'	94	LF	$	3,200.00	$ 300,800.00
8041020	RIP-RAP (CLASS B)	RIP-RAP (CLASS B)	200	TON	$	98.38	$ 19,676.00
8048105	GEOTEX/EROS.CONT(CLASS1)TYPE B	GEOTEXTILE FOR EROSION CONTROL UNDER RIPRAP(CLASS 1)TYPE B	200	SY	$	4.14	$ 828.00
8101000	SEEDING (MULCHED)	SEEDING (MULCHED)	2	MSY	$	750.00	$ 1,500.00
8153000	SILT FENCE	SILT FENCE	1000	LF	$	3.50	$ 3,500.00
	CONTINGENCY	CONTINGENCY 25%	-	-			$ 131,657.50
					SUB-TOTAL:		$ 421,304.00
					HARD COST TOTAL:		$ 658,287.50

SOFT COSTS

DESIGN	SURVEY, STRUCTURAL DESIGN, HYDRO DESIGN, AND ENVIRO COMPLIANCE		$ 131,657.50
PERMITTING & FEES	LAND DISTURBANCE/NPDES PERMITTING, ENVIRO, SCDOT, ETC.		$ 32,914.38
		SOFT COST TOTAL:	$ 164,571.88
		GRAND TOTAL:	$ 822,859.38
		ROUNDED TOTAL:	$ 823,000.00

J - Southeast Mullins Drainage Conveyance Improvements - Mullins SC

J - Southeast Mullins Drainage Conveyance Improvements - Mullins SC			
Prioritization Category	**Sub-Category**	**Points**	**Maximum Point**
LMI % Served	*LMI % X 20 points*	9.4	20
Level of Flood Risk Reduction	Above a 25-year / 24-hour storm event level of protection	10	10
Quantity of Flood Risk Reduction	0-10 Structures	0	10
Benefit-Cost Ratio	25-50%	7	20
Leveraged Funding	Limited potential cost share identified	5	10
Permitting/Scheduling	Potential challenges	5	10
Mobility Improvement	Limited mobility improvements	3	5
Phasing Considerations	No connection to larger scale project	0	5
Project Synergies	Limited cost savings	3	5
Environmental Impact	Neutral Impact	3	5
		45.4	100

SOUTHEAST MULLINS DRAINAGE CONVEYANCE IMPROVEMENTS

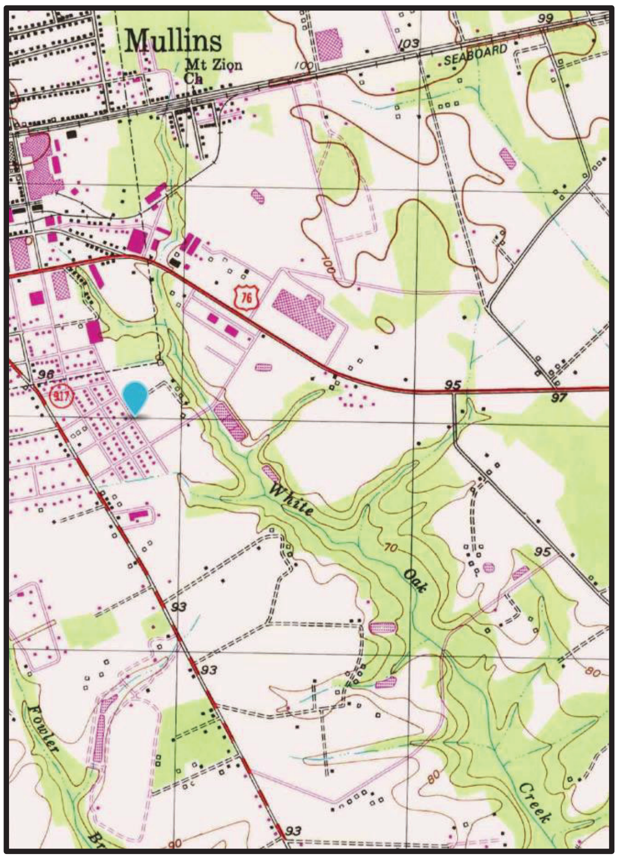
Mullins, South Carolina

Category:
Fully Meets Design Standards

Purpose:
To design an open channel and closed drainage system that will provide adequate capacity to relieve flooding from higher frequency storm events

Background

The drainage infrastructure in the area bound within Sandy Bluff Road, East Proctor Street, Highland Drive and Crestwood Street was designed and implemented mostly in the 1950s and 1960s. Since then, development, impervious area and rainfall intensities have increased. Based on our model of the existing drainage system, the existing infrastructure appears significantly undersized given the current conditions today. Insufficient sizing, limited vertical grade, and lack of maintenance have led to sediment buildup within culverts causing standing water within residential properties and adjacent roadways.



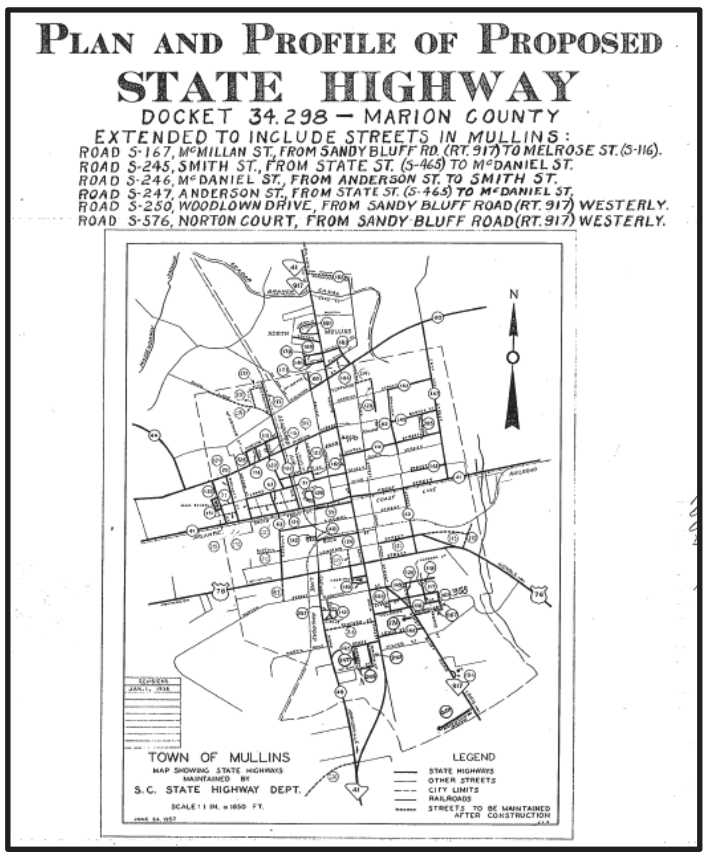


Figure J1 and J2: USGS 1948 Topographic Map, 1958 SCDOT Highway Plans

Potential Project

Additional closed drainage infrastructure with properly sized and sloped pipes would be placed to prevent localized flooding in the area within Sandy Bluff Road, East Proctor Street, Highland Drive and Crestwood Street. Ditches, pipes, and inlets would be reconfigured to adequately convey runoff to the existing outfall locations.

Figure J3: Area of Proposed Drainage Improvements

Additional Considerations

Grading will be required to create ditches with adequate depth and capacity. This could have significant right-of-way impacts on properties due to the area being densely residential. Right-of-way will likely have to be purchased to construct ditches, place structures and pipes for the closed drainage system.

PROJECT BENEFITS

Reduced localized flooding

Improved conveyance of water to outfalls

Reduced maintenance

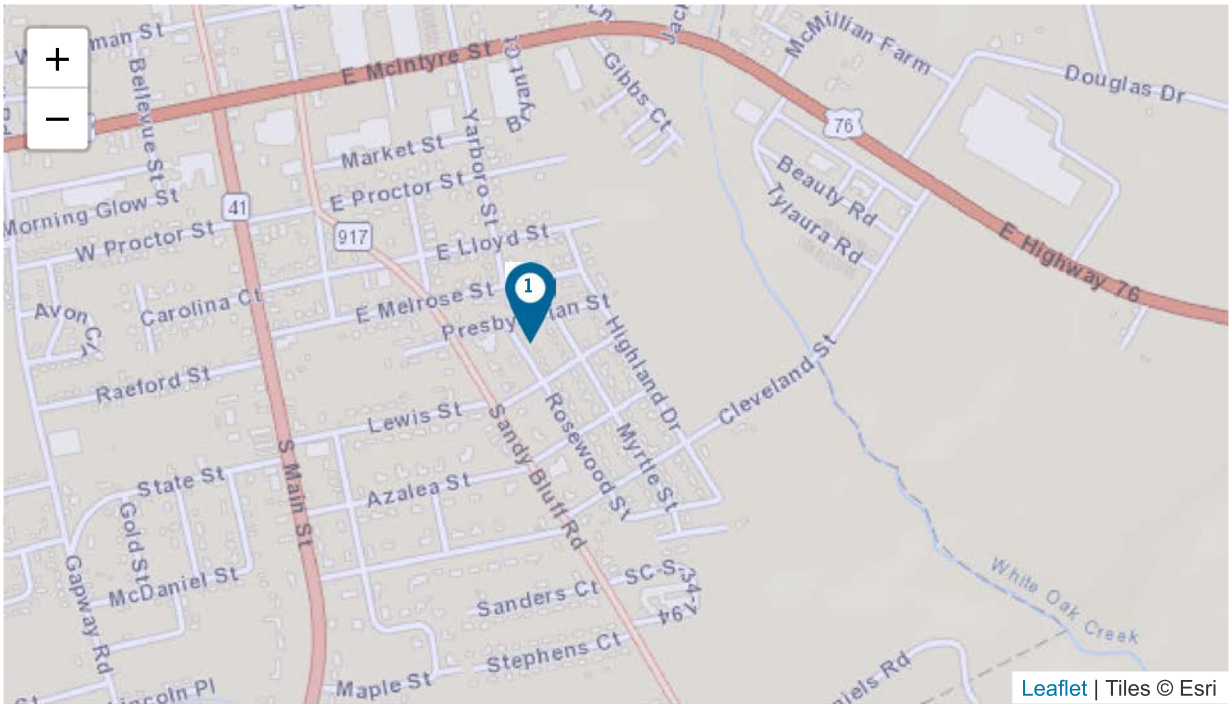
Project is scalable based on funding/needs

Benefit-Cost Calculator

V.6.0 (Build 20221028.1600 | Release Notes)

Benefit-Cost Analysis

Project Name: J - Southeast Mullins Drainage Conveyance Improvements - Mullins, SC



				Using 7% Discount Rate			Using 3% Discount Rate (For FY22 BRIC and FMA only)		
Map Marker ▲	Mitigation Title	Property Type	Hazard	Benefits (B)	Costs (C)	BCR (B/C)	Benefits (B)	Costs (C)	BCR (B/C)
1	Drainage Improvement @ 34° 12' 4.7700000"; -79° -14' -47.9900400"		DFA - Riverine Flood	$ 1,710,451	$ 1,412,900	1.21	$ 3,188,921	$ 1,418,865	2.25
TOTAL (SELECTED)				**$ 1,710,451**	**$ 1,412,900**	**1.21**	**$ 3,188,921**	**$ 1,418,865**	**2.25**
TOTAL				**$ 1,710,451**	**$ 1,412,900**	**1.21**	**$ 3,188,921**	**$ 1,418,865**	**2.25**

Property Configuration

Property Title:	Drainage Improvement @ 34° 12' 4.7700000"; -79° -14' -47.9900400"
Property Location:	29574, Marion, South Carolina
Property Coordinates:	34.1959444, -79.2464250
Hazard Type:	Riverine Flood
Mitigation Action Type:	Drainage Improvement
Property Type:	Roads & Bridges
Analysis Method Type:	Professional Expected Damages

Cost Estimation

Drainage Improvement @ 34° 12' 4.7700000"; -79° -14' -47.9900400"

Project Useful Life (years):	50
Project Cost:	$1,406,000
Number of Maintenance Years:	50 Use Default:Yes
Annual Maintenance Cost:	$500

Damage Analysis Parameters - Damage Frequency Assessment

Drainage Improvement @ 34° 12' 4.7700000"; -79° -14' -47.9900400"

Year of Analysis was Conducted:	2022
Year Property was Built:	1960
Analysis Duration:	63 Use Default:Yes

Roads and Bridges Properties

Drainage Improvement @ 34° 12' 4.7700000"; -79° -14' -47.9900400"

Estimated Number of One-Way Traffic Detour Trips per Day:	4,000
Additional Time per One-Way Detour Trip (minutes):	2
Number of Additional Miles:	1
Federal Rate ($):	0.625 Use Default:Yes
Economic Loss Per Day of Loss of Function ($):	7,246.67

Comments

-

Number of Trips:

AADT 2021 from SCDOT Street Finder

Professional Expected Damages Before Mitigation
Drainage Improvement @ 34° 12' 4.7700000"; -79° -14' -47.9900400"

	ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
5	2	605,200	0	0	0	0	619,693

Comments

-

Damages Before Mitigation:
When road overtops, hydroplaning accidents are likely. Assuming a potential accident with 2 passengers per flooding event. An injury crash is valued as $302,600 of damage per incident per Table A-1: Value of Reduced Fatalities and Injuries within the Benefit Cost Analysis Guidance for Discretionary Grant Programs, U.S. Department of Transportation, March 2022.

Annualized Damages Before Mitigation
Drainage Improvement @ 34° 12' 4.7700000"; -79° -14' -47.9900400"

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
5	619,693	123,939
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	619,693	123,939

Professional Expected Damages After Mitigation
Drainage Improvement @ 34° 12' 4.7700000"; -79° -14' -47.9900400"

	ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
0	0	0	0	0	0	0	0

Annualized Damages After Mitigation
Drainage Improvement @ 34° 12' 4.7700000"; -79° -14' -47.9900400"

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	0	0

Standard Benefits - Ecosystem Services

Drainage Improvement @ 34° 12' 4.7700000"; -79° -14' -47.9900400"

Total Project Area (acres):	0
Percentage of Urban Green Open Space:	0.00%
Percentage of Rural Green Open Space:	0.00%
Percentage of Riparian:	0.00%
Percentage of Coastal Wetlands:	0.00%
Percentage of Inland Wetlands:	0.00%
Percentage of Forests:	0.00%
Percentage of Coral Reefs:	0.00%
Percentage of Shellfish Reefs:	0.00%
Percentage of Beaches and Dunes:	0.00%
Expected Annual Ecosystem Services Benefits:	$0

Benefits-Costs Summary

Drainage Improvement @ 34° 12' 4.7700000"; -79° -14' -47.9900400"

Total Standard Mitigation Benefits:	$1,710,451
Total Social Benefits:	$0
Total Mitigation Project Benefits:	$1,710,451
Total Mitigation Project Cost:	$1,412,900
Benefit Cost Ratio - Standard:	1.21
Benefit Cost Ratio - Standard + Social:	1.21

BCA Cost Estimate - J - Southeast Mullins Drainage Conveyance Improvements, Mullins SC

HARD COSTS

ITEM	IDESCR	IDESCRL	QUANTITY	UNITS	UNIT COST	COST
1031010	MOBILIZATION	MOBILIZATION		LS	5%	$ 36,295.80
1071000	TRAFFIC CONTROL	TRAFFIC CONTROL		LS	8%	$ 58,073.28
2011000	CLEAR. & GRUB. WITHIN R/W	CLEARING & GRUBBING WITHIN RIGHT OF WAY		LS	3.5%	$ 25,407.06
2028500	REM&DISP.OF EX.CULV 24" CULVERT (& VARIOUS OTHERS)	REM&DISP.OF EX.CULV 24" CULVERT (& VARIOUS OTHERS)		LS	$ 35,000.00	$ 35,000.00
4012120	FULL DEP.ASPH.PAV.PATCH-12"	FULL DEPTH ASPH. PAV. PATCHING 12"UNIF	300	SY	$ 120.00	$ 36,000.00
7141133	18" RC PIPE CUL.-CLASS V	18" RC PIPE CUL.-CLASS V	2500	LF	$ 72.40	$ 181,000.00
7141134	24" RC PIPE CUL.-CLASS V	24" RC PIPE CUL.-CLASS V	2000	LF	$ 84.57	$ 169,140.00
7141135	30" RC PIPE CUL.-CLASS V	30" RC PIPE CUL.-CLASS V	500	LF	$ 110.00	$ 55,000.00
7192020	DROP INLET(24" X 36")	DROP INLET (24" X 36")	50	EA	$ 4,468.00	$ 223,400.00
8041020	RIP-RAP (CLASS B)	RIP-RAP (CLASS B)	50	TON	$ 98.38	$ 4,919.00
8048105	GEOTEX/EROS.CONT(CLASS1)TYPE B	GEOTEXTILE FOR EROSION CONTROL UNDER RIPRAP(CLASS 1)TYPE B	50	SY	$ 4.14	$ 207.00
8101000	SEEDING (MULCHED)	SEEDING (MULCHED)	5	MSY	$ 750.00	$ 3,750.00
8153000	SILT FENCE	SILT FENCE	5000	LF	$ 3.50	$ 17,500.00
	CONTINGENCY	CONTINGENCY 25%	-	-		$ 211,423.04
					SUB-TOTAL:	$ 725,916.00
					HARD COST TOTAL:	$ 1,057,115.18

SOFT COSTS

RAILROAD CONSTRUCTION OBSERVATION	RAILROAD CONSTRUCTION OBSERVATION		$ 60,000.00
RAILROAD ENGINEERING REVIEW	RAILROAD CONSULTANT DESIGN REVIEW		$ 25,000.00
DESIGN	SURVEY, STRUCTURAL DESIGN, HYDRO DESIGN, AND ENVIRO COMPLIANCE		$ 211,423.04
PERMITTING & FEES	LAND DISTURBANCE/NPDES PERMITTING, ENVIRO, SCDOT, ETC.		$ 52,855.76
		SOFT COST TOTAL:	$ 349,278.79
		GRAND TOTAL:	$ 1,406,393.97
		ROUNDED TOTAL:	$ 1,406,000.00

K - Seaboard Avenue Outfall Systems Improvements - Mullins, SC

K - Seaboard Avenue Outfall Systems Improvements - Mullins, SC			
Prioritization Category	**Sub-Category**	**Points**	**Maximum Point**
LMI % Served	*LMI % X 20 points*	13	20
Level of Flood Risk Reduction	Above a 25-year / 24-hour storm event level of protection	10	10
Quantity of Flood Risk Reduction	10-25 Structures	4	10
Benefit-Cost Ratio	0-25%	0	20
Leveraged Funding	Limited potential cost share identified	5	10
Permitting/Scheduling	Little-to-no challenges	10	10
Mobility Improvement	Significant mobility improvements	5	5
Phasing Considerations	Limited Contribution	3	5
Project Synergies	Limited cost savings	3	5
Environmental Impact	Green Infrastructure or Improved Impact	5	5
		58	100

SEABOARD AVENUE OUTFALL SYSTEM IMPROVEMENTS

Mullins, South Carolina

Category:
Low Impact Design and/or Retrofit

Purpose:
To reduce peak flow rates observed downstream of Seaboard Avenue, including Johnson Street

Background

The residential area downstream of Seaboard Avenue was identified by City personnel as an area subject to frequent flooding. Johnson Street in particular was identified as a major area of concern, see Figure K1 below. The XPSWMM model the project team created confirms this documented flooding. Runoff from the upstream watershed flows from east to west underneath Seaboard Avenue via an existing 36-inch reinforced concrete pipe (RCP). The closed pipe system extends downstream and runs adjacent to Johnson Street before ultimately draining to Maidendown Swamp Tributary.

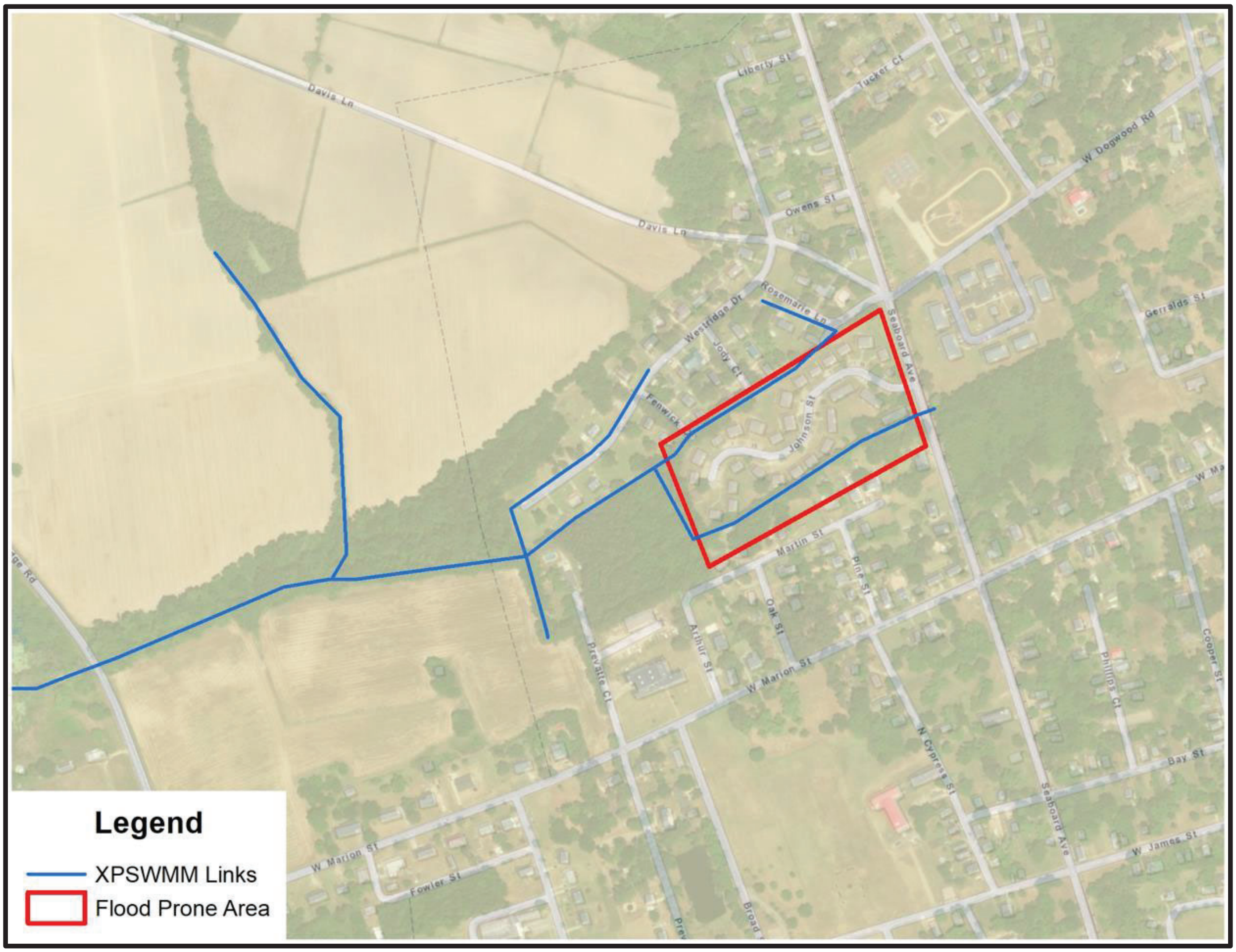


Figure K1: Seaboard Avenue outfall system and flood prone area identified by the City

Potential Project

A stormwater park/detention facility upstream of the existing Seaboard Avenue crossing can supply the necessary storage to successfully reduce the peak flowrates in the downstream system and thus alleviating flooding in the adjacent neighborhoods. Figure K2 below shows the proposed location of a potential stormwater park/detention facility. Given the site limitations, several different pond sizings were analyzed based on expected level of service. Table K1 below provides the required volume and number of parcels impacted to construct a pond in order to eliminate downstream flooding for the 10-, 25-, and 50-year storm events.

Table K1: Stormwater park/detention facility alternatives design summary table

Level of Service	Approximate Required Storage Volume (million ft^3)	Number of Parcels Impacted
10-year	1.5	4
25-year	2.0	5
50-year	2.5	6

The stormwater facility will act as temporary storage to release runoff in a controlled manner. The flowrate leaving the pond will be controlled through a multi-stage outlet control structure. The outlet structure will consist of a combination of orifices and weirs. The pond will also be equipped with an emergency spillway which will prevent the pond from breaching when it exceeds its storage capacity during an extreme event. The proposed stormwater park/detention facility once constructed will reduce the peak flowrate to the downstream closed drainage system to alleviate flooding downstream of Seaboard Avenue.

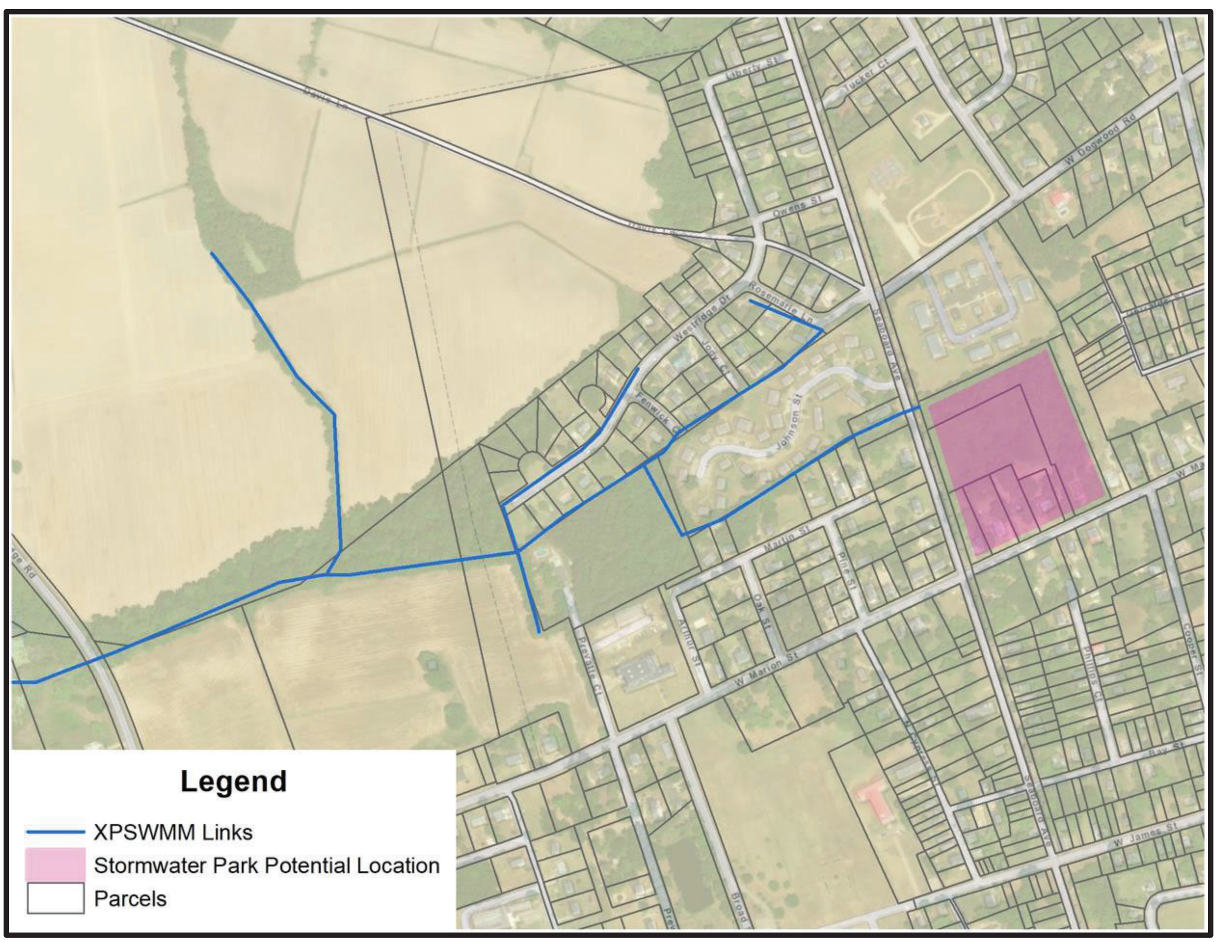


Figure K2: Proposed stormwater park/detention facility location and potential property impacts

Additional Considerations

The outlet control structure should be regularly monitored to prevent clogging. A fence can be installed around the limits of the pond as a safety precaution to the public.

Additional improvements to the downstream closed system adjacent to Johnson Street may also be required to help alleviate flooding

PROJECT BENEFITS

Reduce flooding downstream of Seaboard Avenue

Improves level of service of the Seaboard Avenue and railroad crossings

Potential additional recreation opportunities

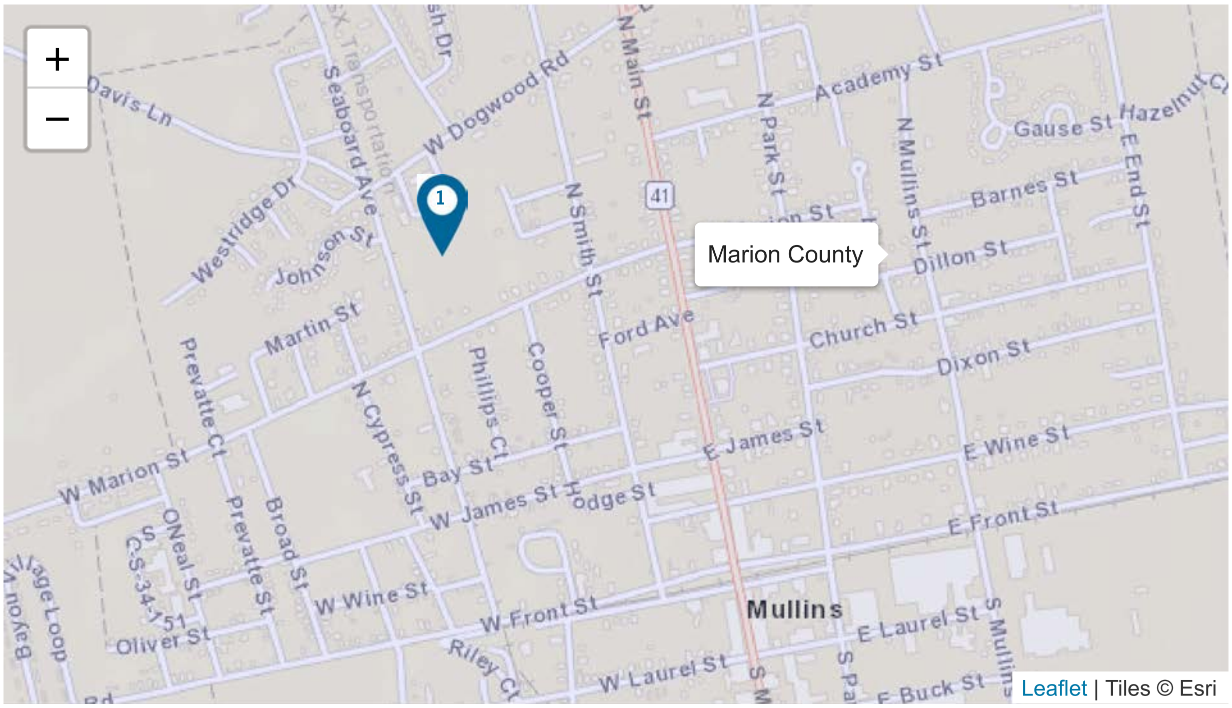
Project is scalable based on funding/needs

Benefit-Cost Calculator

V.6.0 (Build 20221028.1600 | Release Notes)

Benefit-Cost Analysis

Project Name: K - Seaboard Avenue Outfall System Improvements - Mullins, SC



				Using 7% Discount Rate			Using 3% Discount Rate (For FY22 BRIC and FMA only)		
Map Marker ▲	Mitigation Title	Property Type	Hazard	Benefits (B)	Costs (C)	BCR (B/C)	Benefits (B)	Costs (C)	BCR (B/C)
1	Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"	•••	DFA - Riverine Flood	$ 1,799,790	$ 2,683,269	0.67	$ 3,985,590	$ 2,700,599	1.48
TOTAL (SELECTED)				**$ 1,799,790**	**$ 2,683,269**	**0.67**	**$ 3,985,590**	**$ 2,700,599**	**1.48**
TOTAL				**$ 1,799,790**	**$ 2,683,269**	**0.67**	**$ 3,985,590**	**$ 2,700,599**	**1.48**

Property Configuration

Property Title:	Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"
Property Location:	29574, Marion, South Carolina
Property Coordinates:	34.2111111, -79.2608333
Hazard Type:	Riverine Flood
Mitigation Action Type:	Floodwater Diversion and Storage
Property Type:	Other
Analysis Method Type:	Professional Expected Damages

Cost Estimation

Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"

Project Useful Life (years):	100
Project Cost:	$2,669,000
Number of Maintenance Years:	100 Use Default:Yes
Annual Maintenance Cost:	$1,000

Damage Analysis Parameters - Damage Frequency Assessment

Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"

Year of Analysis was Conducted:	2022
Year Property was Built:	1960
Analysis Duration:	63 Use Default:Yes

Professional Expected Damages Before Mitigation

Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
10	0	605,200	0	0	0	0	605,200
50	0	0	873,260	0	0	0	873,260

Comments

-

Damages Before Mitigation:
When road overtops, hydroplaning accidents are likely. Assuming two potential accidents with 2 passengers per road overtopping event. An injury crash is valued as $302,600 of damage per incident per Table A-1: Value of Reduced Fatalities and Injuries within the Benefit Cost Analysis Guidance for Discretionary Grant Programs, U.S. Department of Transportation, March 2022. Category 1 damages represent this injury crash value. Also, using the FEMA Flood Damage Calculator, and that approximately 10-structures are removed from the 50-year flooded area via these proposed improvements, a 2-foot of flood damage cost value of $87,326 per impacted 2.5K SF structure was used. Category 2 damages represent this flood reduction value.

Annualized Damages Before Mitigation
Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
10	605,200	58,158
50	873,260	17,465
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	1,478,460	75,623

Professional Expected Damages After Mitigation
Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
0	0	0	0	0	0	0	0

Annualized Damages After Mitigation
Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	0	0

Standard Benefits - Ecosystem Services

Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"

Total Project Area (acres):	4.38
Percentage of Urban Green Open Space:	74.20%
Percentage of Rural Green Open Space:	0.00%
Percentage of Riparian:	0.00%
Percentage of Coastal Wetlands:	0.00%
Percentage of Inland Wetlands:	0.00%
Percentage of Forests:	0.00%
Percentage of Coral Reefs:	0.00%
Percentage of Shellfish Reefs:	0.00%
Percentage of Beaches and Dunes:	0.00%
Expected Annual Ecosystem Services Benefits:	$50,508

Benefits-Costs Summary

Floodwater Diversion and Storage @ 34° 17' 0.0000000"; -79° -28' -11.75"

Total Standard Mitigation Benefits:	$1,799,790
Total Social Benefits:	$0
Total Mitigation Project Benefits:	$1,799,790
Total Mitigation Project Cost:	$2,683,269
Benefit Cost Ratio - Standard:	0.67
Benefit Cost Ratio - Standard + Social:	0.67

L - Awt Road Crossing Improvements - Nichols, SC

L - Awt Road Crossing Improvements - Nichols, SC			
Prioritization Category	**Sub-Category**	**Points**	**Maximum Point**
LMI % Served	*LMI % X 20 points*	7.2	20
Level of Flood Risk Reduction	Above a 25-year / 24-hour storm event level of protection	10	10
Quantity of Flood Risk Reduction	0-10 Structures	0	10
Benefit-Cost Ratio	25-50%	7	20
Leveraged Funding	Limited potential cost share identified	5	10
Permitting/Scheduling	Little-to-no challenges	10	10
Mobility Improvement	Significant mobility improvements	5	5
Phasing Considerations	No connection to larger scale project	0	5
Project Synergies	Limited cost savings	3	5
Environmental Impact	Neutral Impact	3	5
		50.2	100

AWT ROAD CROSSING IMPROVEMENTS

Nichols, South Carolina

Category:
Improves Level of Service

Purpose:
Upsize the existing Awt Road crossing to reduce flooding in the upstream floodplain and meet current design criteria

Background

The culvert crossing under Awt Road is conveying water from an unnamed tributary southwest towards Little Pee Dee River. The two closest upstream crossings draining to Awt Road consist of a single 48-inch culvert while the other is a double 48-inch culvert. Currently there are two 24-inch pipes at the crossing receiving water from a drainage area of approximately 500 acres. These culverts are inadequately sized per our modeling and cause the road to overtop for the 2-year storm and greater.

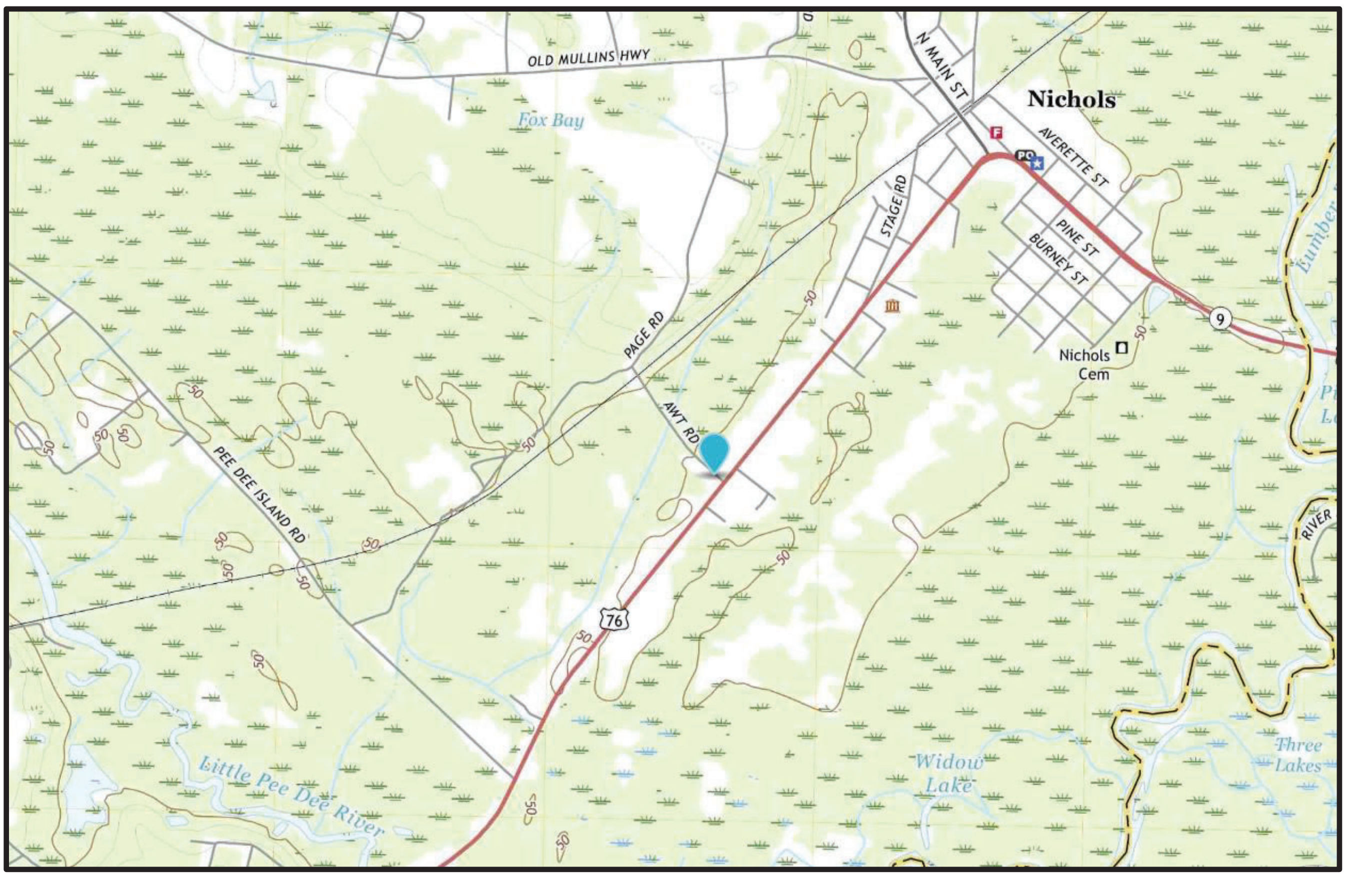


Figure L1: 2020 US Topographic Map


Figures L2 and L3: Awt Road Crossing – Downstream Channel (left), Upstream face of double 24-inch culverts (right)

Potential Project

Remove and replace the existing double 24” culverts with a 12’(W) x 4’(H) box culvert. This project would prevent the road from being overtopped up to a 50-year storm event by providing adequate capacity to convey the flow reaching the crossing.

Table L1: Proposed Awt Road Culvert Crossings

Storm Event	Required Culvert
2-year	Double 48” Culvert
5-year	Double 48” Culvert
10-year	8’(W) x 4’(H) Box Culvert
25-year	12’(W) x 4’(H) Box Culvert
50-year	12’(W) x 4’(H) Box Culvert

Additional Considerations

The grade of Awt Road does not currently allow for a culvert with a rise of 42 inches or greater to be placed without raising the grade of Awt Road to provide necessary cover for the culvert. All proposed culverts have a rise of 48 inches. This would require raising the grade 6-12 inches and likely paving approximately .33 miles of Awt Road. Additional Right of way would be required to be obtained from up to five parcels ([redacted]). Further analysis would be required of downstream culverts to ensure they are adequately sized, one of which is within private property ([redacted]).

PROJECT BENEFITS

Improved conveyance of water under Awt Road

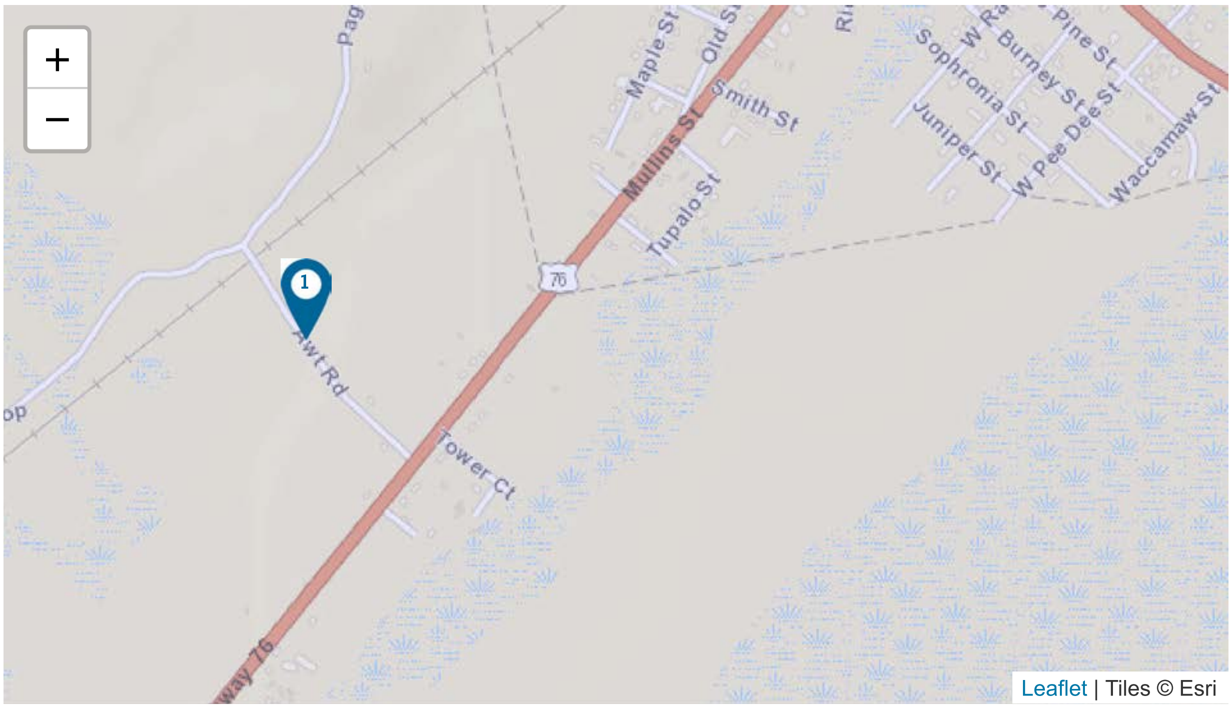
Increased level of service of Awt Road to convey the 50-year event without overtopping

Benefit-Cost Calculator

V.6.0 (Build 20221028.1600 | Release Notes)

Benefit-Cost Analysis

Project Name: L - Awt Road Crossing Improvements - Nichols, SC



				Using 7% Discount Rate			Using 3% Discount Rate (For FY22 BRIC and FMA only)		
Map Marker ▲	Mitigation Title	Property Type	Hazard	Benefits (B)	Costs (C)	BCR (B/C)	Benefits (B)	Costs (C)	BCR (B/C)
1	Drainage Improvement @ 34° 13' 24.9999600"; -79° -9' -38.2701600"		DFA - Riverine Flood	$ 421,323	$ 391,801	1.08	$ 785,504	$ 403,730	1.95
TOTAL (SELECTED)				**$ 421,323**	**$ 391,801**	**1.08**	**$ 785,504**	**$ 403,730**	**1.95**
TOTAL				**$ 421,323**	**$ 391,801**	**1.08**	**$ 785,504**	**$ 403,730**	**1.95**

Property Configuration

Property Title:	Drainage Improvement @ 34° 13' 24.9999600"; -79° -9' -38.2701600"
Property Location:	29581, Marion, South Carolina
Property Coordinates:	34.2236111, -79.1606306
Hazard Type:	Riverine Flood
Mitigation Action Type:	Drainage Improvement
Property Type:	Roads & Bridges
Analysis Method Type:	Professional Expected Damages

Cost Estimation

Drainage Improvement @ 34° 13' 24.9999600"; -79° -9' -38.2701600"

Project Useful Life (years):	50
Project Cost:	$378,000
Number of Maintenance Years:	50 Use Default:Yes
Annual Maintenance Cost:	$1,000

Damage Analysis Parameters - Damage Frequency Assessment

Drainage Improvement @ 34° 13' 24.9999600"; -79° -9' -38.2701600"

Year of Analysis was Conducted:	2022
Year Property was Built:	1960
Analysis Duration:	63 Use Default:Yes

Roads and Bridges Properties

Drainage Improvement @ 34° 13' 24.9999600"; -79° -9' -38.2701600"

Estimated Number of One-Way Traffic Detour Trips per Day:	10
Additional Time per One-Way Detour Trip (minutes):	5
Number of Additional Miles:	1
Federal Rate ($):	0.625 Use Default:Yes
Economic Loss Per Day of Loss of Function ($):	35.92

Comments

-

Number of Trips:

AADT 2021 is estimated via engineering judgement and population of the area.

Professional Expected Damages Before Mitigation

Drainage Improvement @ 34° 13' 24.9999600"; -79° -9' -38.2701600"

	ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
2	15	60,520	0	0	0	0	61,059

Comments

-

Damages Before Mitigation:
When road overtops, hydroplaning accidents are likely. Overtopping occurs during a 2-year return period storm. Assuming one potential accident for every five (5) road overtopping events (due to low daily traffic). An injury crash is valued as $302,600 of damage per incident per Table A-1: Value of Reduced Fatalities and Injuries within the Benefit Cost Analysis Guidance for Discretionary Grant Programs, U.S. Department of Transportation, March 2022. To factor in the every 5th storm portion of this the $302,600 was divided by five (5) resulting in $60,520.

Annualized Damages Before Mitigation

Drainage Improvement @ 34° 13' 24.9999600"; -79° -9' -38.2701600"

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
2	61,059	30,529
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	61,059	30,529

Professional Expected Damages After Mitigation

Drainage Improvement @ 34° 13' 24.9999600"; -79° -9' -38.2701600"

	ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
0	0	0	0	0	0	0	0

Annualized Damages After Mitigation

Drainage Improvement @ 34° 13' 24.9999600"; -79° -9' -38.2701600"

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	0	0

Standard Benefits - Ecosystem Services

Drainage Improvement @ 34° 13' 24.9999600"; -79° -9' -38.2701600"

Total Project Area (acres):	0
Percentage of Urban Green Open Space:	0.00%
Percentage of Rural Green Open Space:	0.00%
Percentage of Riparian:	0.00%
Percentage of Coastal Wetlands:	0.00%
Percentage of Inland Wetlands:	0.00%
Percentage of Forests:	0.00%
Percentage of Coral Reefs:	0.00%
Percentage of Shellfish Reefs:	0.00%
Percentage of Beaches and Dunes:	0.00%
Expected Annual Ecosystem Services Benefits:	$0

Benefits-Costs Summary

Drainage Improvement @ 34° 13' 24.9999600"; -79° -9' -38.2701600"

Total Standard Mitigation Benefits:	$421,323
Total Social Benefits:	$0
Total Mitigation Project Benefits:	$421,323
Total Mitigation Project Cost:	$391,801
Benefit Cost Ratio - Standard:	1.08
Benefit Cost Ratio - Standard + Social:	1.08

BCA Cost Estimate - M - Awt Road Crossing Improvements, Nichols SC

HARD COSTS

ITEM	IDESCR	IDESCRL	QUANTITY	UNITS	UNIT COST	COST
1031010	MOBILIZATION	MOBILIZATION		LS	5%	$ 10,237.60
1071000	TRAFFIC CONTROL	TRAFFIC CONTROL		LS	8%	$ 16,380.16
2011000	CLEAR. & GRUB. WITHIN R/W	CLEARING & GRUBBING WITHIN RIGHT OF WAY		LS	5.0%	$ 10,237.60
2028500	REM&DISP.OF EX.CULV 24"	REMOVAL & DISPOSAL OF EXISTING CULVERT 24"	2	EA	$ 5,000.00	$ 10,000.00
4012120	FULL DEP.ASPH.PAV.PATCH-12"	FULL DEPTH ASPH. PAV. PATCHING 12"UNIF	300	SY	$ 120.00	$ 36,000.00
7221082	12'X4'PCBOX CULV.{M-273}FH<2	12'X 4' P.C. BOX CULVERT {AASHTO M-273} FH < 2	50	LF	$ 2,920.00	$ 146,000.00
8041020	RIP-RAP (CLASS B)	RIP-RAP (CLASS B)	100	TON	$ 98.38	$ 9,838.00
8048105	GEOTEX/EROS.CONT(CLASS1)TYPE B	GEOTEXTILE FOR EROSION CONTROL UNDER RIPRAP(CLASS 1)TYPE B	100	SY	$ 4.14	$ 414.00
8101000	SEEDING (MULCHED)	SEEDING (MULCHED)	1	MSY	$ 750.00	$ 750.00
8153000	SILT FENCE	SILT FENCE	500	LF	$ 3.50	$ 1,750.00
	CONTINGENCY	CONTINGENCY 25%	-	-		$ 60,401.84
					SUB-TOTAL:	$ 204,752.00
					HARD COST TOTAL:	$ 302,009.20

SOFT COSTS

DESIGN	SURVEY, STRUCTURAL DESIGN, HYDRO DESIGN, AND ENVIRO COMPLIANCE		$ 60,401.84
PERMITTING & FEES	LAND DISTURBANCE/NPDES PERMITTING, ENVIRO, SCDOT, ETC.		$ 15,100.46
		SOFT COST TOTAL:	$ 75,502.30
		GRAND TOTAL:	$ 377,511.50
		ROUNDED TOTAL:	$ 378,000.00

M - Airport Annexation - Nichols, SC

M - Airport Annexation - Nichols, SC			
Prioritization Category	**Sub-Category**	**Points**	**Maximum Point**
LMI % Served	*LMI % X 20 points*	7.2	20
Level of Flood Risk Reduction	Above a 25-year / 24-hour storm event level of protection	10	10
Quantity of Flood Risk Reduction	25-50 Structures	7	10
Benefit-Cost Ratio	50-75%	13	20
Leveraged Funding	Limited potential cost share identified	5	10
Permitting/Scheduling	Little-to-no challenges	10	10
Mobility Improvement	Significant mobility improvements	5	5
Phasing Considerations	Limited Contribution	3	5
Project Synergies	Limited cost savings	3	5
Environmental Impact	Neutral Impact	3	5
		66.2	100

AIRPORT ANNEXATION

Nichols, South Carolina

Category:
Potential Buyouts

Purpose:
To assess the potential of annexing property adjacent to the current Town limits for potential relocations and potentially incorporating public recreation benefits

Background

South of the Town of Nichols and adjacent to Town limits is the site of a previous private airport. The airport was constructed prior to 1950. From the 1950 USGS quadrangle map, the original access to the airport appears to have been from W Raft Street to a taxiway. At some point after 1950 and prior to 1980, the residential area was expanded to extend over the taxiway and down to the end of the runway.

Figure M1: 1950 Topographic Map

Figure M2: 1980 Topographic Map

The site of the former runway is currently extended over two parcels, a 60.35 acre tract and a 785.98 acre tract that also includes a large area of Lumber River floodplain. Both parcels are owned by the same owner.

Potential Project

Because the two parcels that encompass the former airport site are contiguous to Town limits, the viability of annexing the property for potential relocations and/or recreation opportunities was assessed.

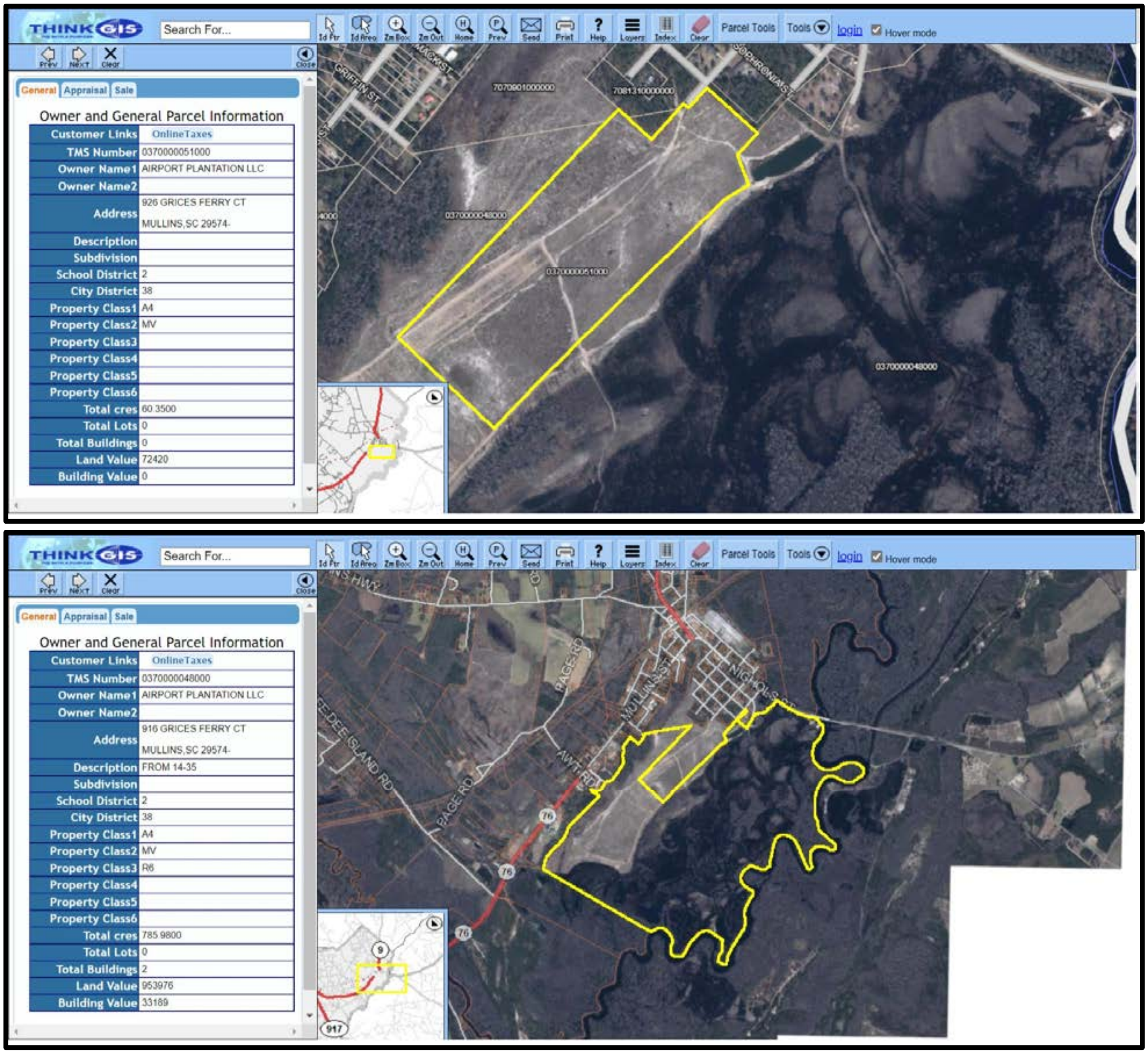


Figure M3: Parcels containing the former airport site (https://marionsc.wthgis.com/)

The 60.35 acre tract is generally dry land and has been logged and replanted several times in pine trees. A portion of the larger 785.98 acre tract is also planted in young pine trees, but the majority of the tract is Lumber River floodplain that was logged in approximately 2016 according to aerial photographs. The area planted in pine trees is a defined peninsula that is approximately 5' – 6' higher than the adjacent Lumber River floodplain. The higher ground on the peninsula has the potential to serve as a relocation site for flood impacted residents or essential town facilities.

The FEMA flood hazard areas for the Lumber River are based on old 1-D modeling from 1978. The Flood Insurance Rate Maps show most of the peninsula in the 100-year floodplain with some areas in the 500-year floodplain.

Looking at actual aerial photographs from after Hurricane Florence in 2018, the FEMA floodplains appear to be inaccurate for the peninsula where the former airport was. The 2D model originally created by Woolpert and reviewed for this study shows much of the peninsula not inundated for the 100-year flood, which matches very closely with aerial imagery from 2018.

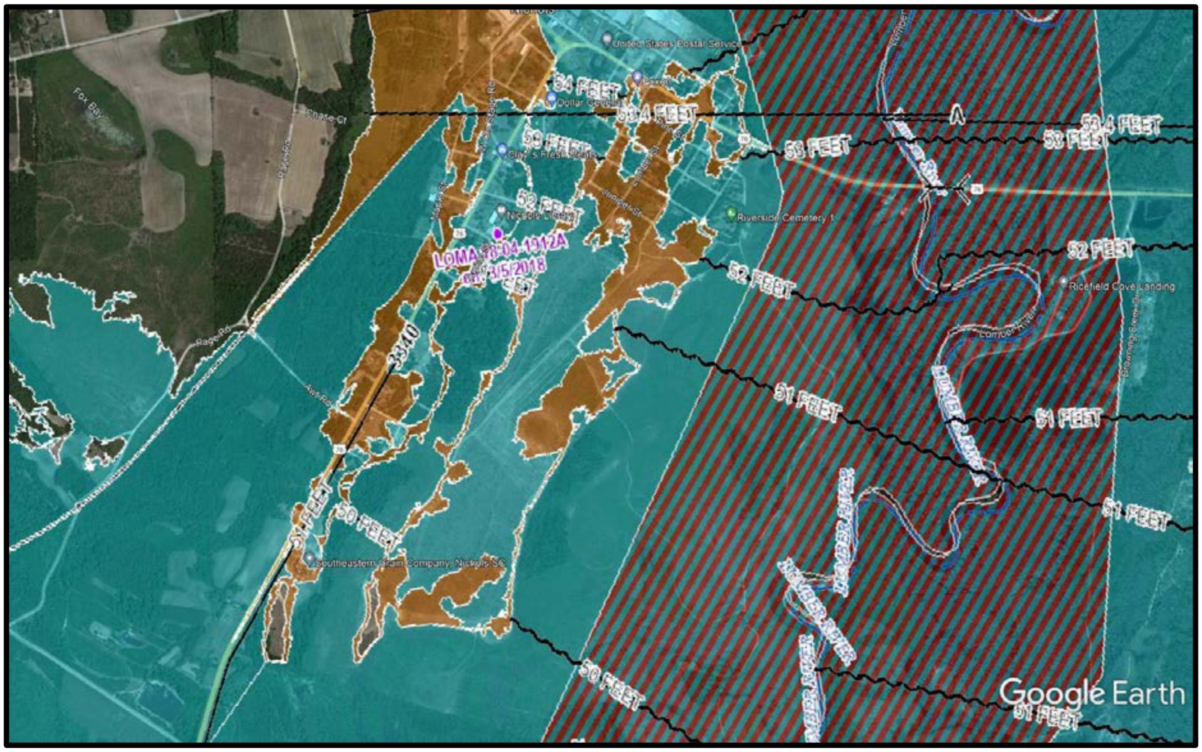


Figure M4: Effective FEMA Flood Insurance Rate Map

Figure M5: 100 year flood inundation from the 2D model matches very closely with actual aerial photography from Hurricane Florence (2018). The peninsula that was the site of the former airport is circled in red.

Per the Marion County Floodplain Ordinance of 2011, new construction of any residential structure shall have the lowest floor elevated no lower than 2 feet above the Base Flood Elevation (BFE). Using the apparently conservative FEMA maps, there is still 15-20 acres in Zone X, which is outside of the BFE on the former airport site. A restudy of the FEMA map could potentially show that there is actually much more land that is outside of the BFE on the peninsula. For those property owners currently located within the low areas of Nichols that repeatedly experience flooding, this would present an opportunity to buy them out while providing a way for them to remain within Nichols on a newly developed site that is adjacent to existing Town limits.

For the remainder of the larger 785.98 acre tract that is not part of the peninsula, public recreational options such as multiuse paths and boardwalks could be incorporated. Attempting to gain any additional flood storage on these two parcels is highly unlikely to affect flood elevations due to the enormous volume of flow in the Lumber River.

Additional Considerations

If this alternative is selected for detailed concept plans by SCOR, Marion County and the Town of Nichols, further discussion and analysis would be required to determine what is in the parameters of SCOR funding and acceptable per Marion County's floodplain ordinance.

The potential of acquiring some or all of the property is unknown.

The proposed Nichols Evacuation Route project would provide residents from the proposed new residential area improved access to the high ground provided by US 76.

PROJECT BENEFITS

Site for potential annexation is contiguous to current Town Limits

Contains 15-20 acres outside of BFE

FEMA restudy could show much higher acreage outside of BFE

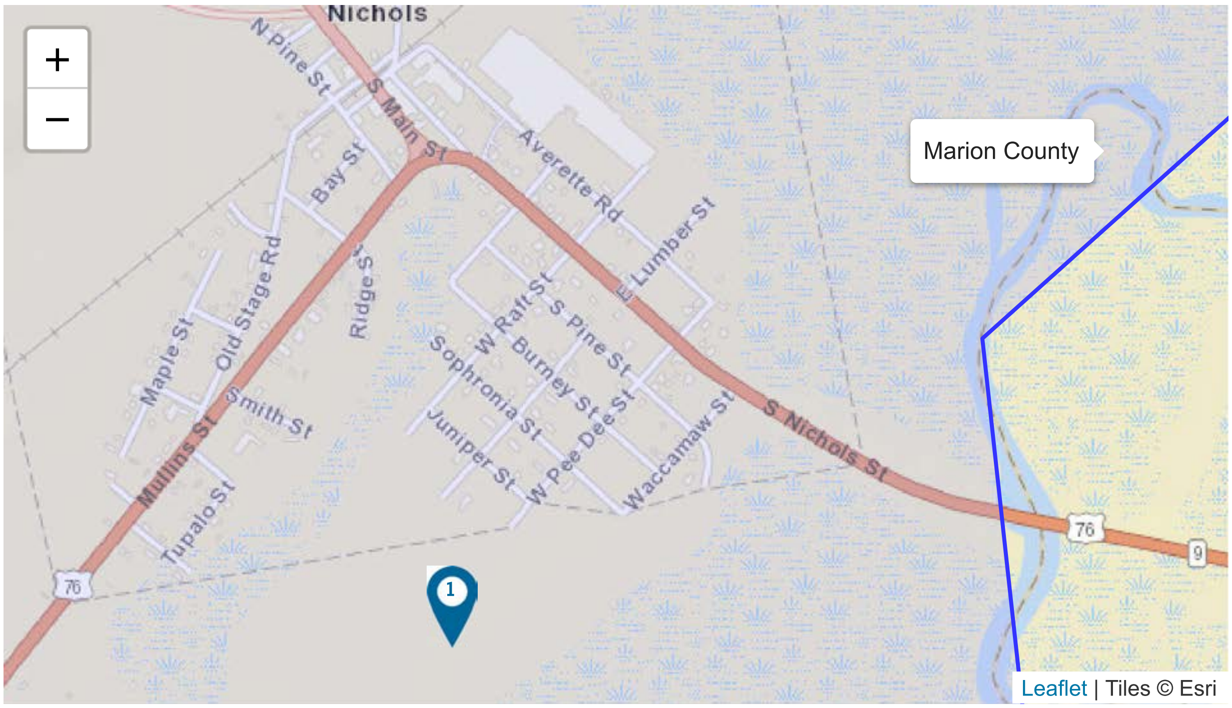
Public Recreation options possible

Project is scalable based on funding/needs

FEMA | Benefit-Cost Calculator
V.6.0 (Build 20221028.1600 | Release Notes)

Benefit-Cost Analysis

Project Name: M - Airport Annexation - Nichols, SC



				Using 7% Discount Rate			Using 3% Discount Rate (For FY22 BRIC and FMA only)		
Map Marker ▲	Mitigation Title	Property Type	Hazard	Benefits (B)	Costs (C)	BCR (B/C)	Benefits (B)	Costs (C)	BCR (B/C)
1	Other @ 34° 13' 24.9999600"; -79° -8' -49.3900800"	•••	DFA - Riverine Flood	$ 5,899,465	$ 4,800,000	1.23	$ 13,064,220	$ 4,800,000	2.72
TOTAL (SELECTED)				**$ 5,899,465**	**$ 4,800,000**	**1.23**	**$ 13,064,220**	**$ 4,800,000**	**2.72**
TOTAL				**$ 5,899,465**	**$ 4,800,000**	**1.23**	**$ 13,064,220**	**$ 4,800,000**	**2.72**

Property Configuration

Property Title:	Other @ 34° 13' 24.9999600"; -79° -8' -49.3900800"
Property Location:	29581, Marion, South Carolina
Property Coordinates:	34.2236111, -79.1470528
Hazard Type:	Riverine Flood
Mitigation Action Type:	Other
Property Type:	Other
Analysis Method Type:	Professional Expected Damages

Cost Estimation

Other @ 34° 13' 24.9999600"; -79° -8' -49.3900800"

Project Useful Life (years):	100
Project Cost:	$4,800,000
Number of Maintenance Years:	100 Use Default:Yes
Annual Maintenance Cost:	$0

Comments

-

Project Useful Life:

Assumes 32 properties/homes are bought out at approximately $150,000 each.

Damage Analysis Parameters - Damage Frequency Assessment

Other @ 34° 13' 24.9999600"; -79° -8' -49.3900800"

Year of Analysis was Conducted:	2022
Year Property was Built:	1973
Analysis Duration:	50 Use Default:Yes

Professional Expected Damages Before Mitigation

Other @ 34° 13' 24.9999600"; -79° -8' -49.3900800"

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
25	0	10,336,000	0	0	0	0	10,336,000

Comments

-

Damages Before Mitigation:
Using $323,000 per buy out (standard benefit built into this spreadsheet) for each of the 32 properties.

Annualized Damages Before Mitigation
Other @ 34° 13' 24.9999600"; -79° -8' -49.3900800"

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
25	10,336,000	413,439
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	10,336,000	413,439

Professional Expected Damages After Mitigation
Other @ 34° 13' 24.9999600"; -79° -8' -49.3900800"

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
0	0	0	0	0	0	0	0

Annualized Damages After Mitigation
Other @ 34° 13' 24.9999600"; -79° -8' -49.3900800"

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	0	0

Standard Benefits - Ecosystem Services
Other @ 34° 13' 24.9999600"; -79° -8' -49.3900800"

Total Project Area (acres):	0
Percentage of Urban Green Open Space:	0.00%
Percentage of Rural Green Open Space:	0.00%
Percentage of Riparian:	0.00%
Percentage of Coastal Wetlands:	0.00%
Percentage of Inland Wetlands:	0.00%
Percentage of Forests:	0.00%
Percentage of Coral Reefs:	0.00%
Percentage of Shellfish Reefs:	0.00%
Percentage of Beaches and Dunes:	0.00%
Expected Annual Ecosystem Services Benefits:	$0

Benefits-Costs Summary

Other @ 34° 13' 24.9999600"; -79° -8' -49.3900800"

Total Standard Mitigation Benefits:	$5,899,465
Total Social Benefits:	$0
Total Mitigation Project Benefits:	$5,899,465
Total Mitigation Project Cost:	$4,800,000
Benefit Cost Ratio - Standard:	1.23
Benefit Cost Ratio - Standard + Social:	1.23

N - Golf Course Annexation - Nichols, SC

N - Golf Course Annexation - Nichols, SC			
Prioritization Category	**Sub-Category**	**Points**	**Maximum Point**
LMI % Served	*LMI % X 20 points*	6.6	20
Level of Flood Risk Reduction	Above a 25-year / 24-hour storm event level of protection	10	10
Quantity of Flood Risk Reduction	50+ Structures	10	10
Benefit-Cost Ratio	50-75%	13	20
Leveraged Funding	Limited potential cost share identified	5	10
Permitting/Scheduling	Little-to-no challenges	10	10
Mobility Improvement	Significant mobility improvements	5	5
Phasing Considerations	Limited Contribution	3	5
Project Synergies	Limited cost savings	3	5
Environmental Impact	Neutral Impact	3	5
		68.6	100

GOLF COURSE ANNEXATION

Nichols, South Carolina

Category:
Potential Buyouts

Purpose:
To assess the potential of annexing property adjacent to the current Town limits for potential relocations and potentially incorporating public recreation benefits

Background

Approximately 1.6 miles northwest of the Town of Nichols, along Old Mullins Highway, is a 262-acre parcel that was formerly the site of the Pineland Country Club Golf Course. The golf course closed in January of 2017 and currently remains undeveloped.

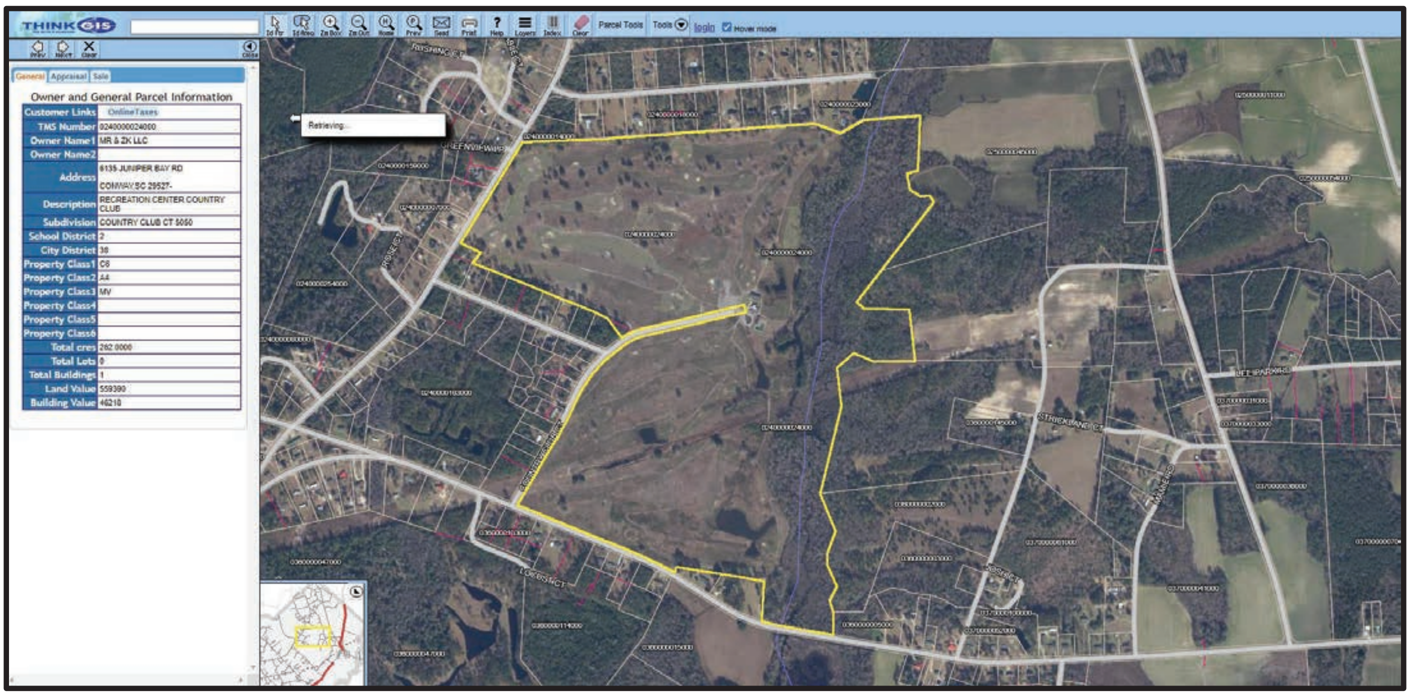


Figure N1: Parcel containing the former golf course site (https://marionsc.wthgis.com/)

Potential Project

The former golf course property is located within close proximity of the limits of the Town of Nichols therefore making annexation of the site a viable option. The Town would also likely have to annex the 1.6-mile portion of Old Mullins Highway from Page Road to Country Club Court in order to have access to the site. The majority of the site's 262 acres is developable high ground with the exception of Crutchlow Branch, which runs along the east side of the property. Crutchlow Branch is a tributary to the Little Pee Dee River and is in a FEMA Zone A according to the currently published FEMA maps.

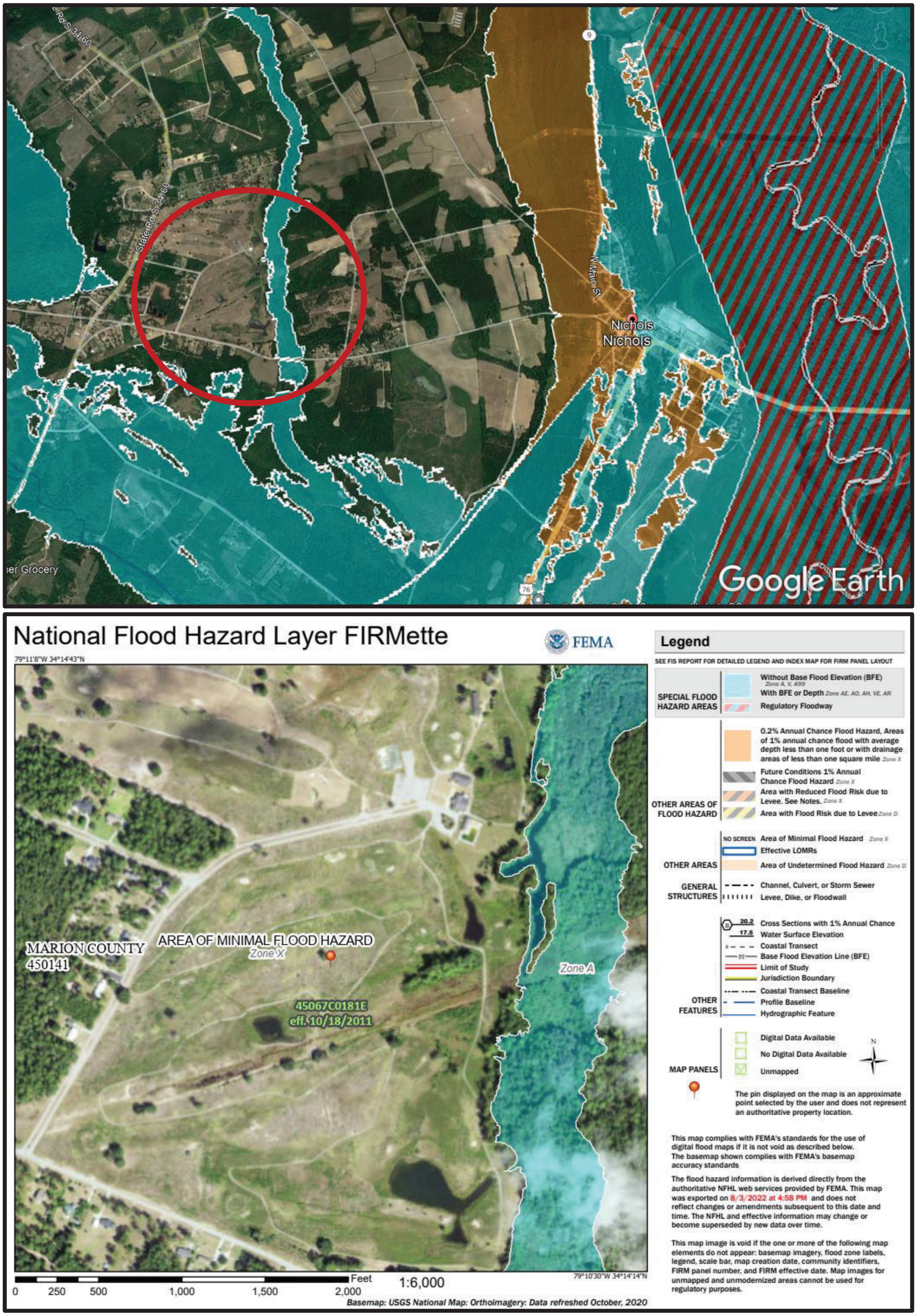


Figure N2: Effective FEMA Flood Insurance Rate Map

This large tract of developable land would provide an ideal site for residential development. For those property owners currently located within the low areas of Nichols that repeatedly experience flooding, this would be a great opportunity to buy them out while providing a way for them to remain within Nichols on a newly developed site well outside the limits of the current flood zones.

Attempting to gain any additional flood storage on this parcel is highly unlikely to effect flood elevations due to the enormous volume of flow in the Little Pee Dee and Lumber Rivers. However, public recreational options such as multiuse paths and boardwalks could be incorporated to manage the stormwater from the developed site.

Additional Considerations

If this alternative is selected for detailed concept plans by SCOR, Marion County and the Town of Nichols, further discussion and analysis would be required to determine what is in the parameters of SCOR funding and acceptable per Marion County's floodplain ordinance.

The potential of acquiring some or all the property is unknown.

PROJECT BENEFITS

Site is within close proximity to current Town limits for potential annexation

Contains roughly 193 acres of land outside of flood zone

Public recreation features are possible

Project is scalable based on funding/needs

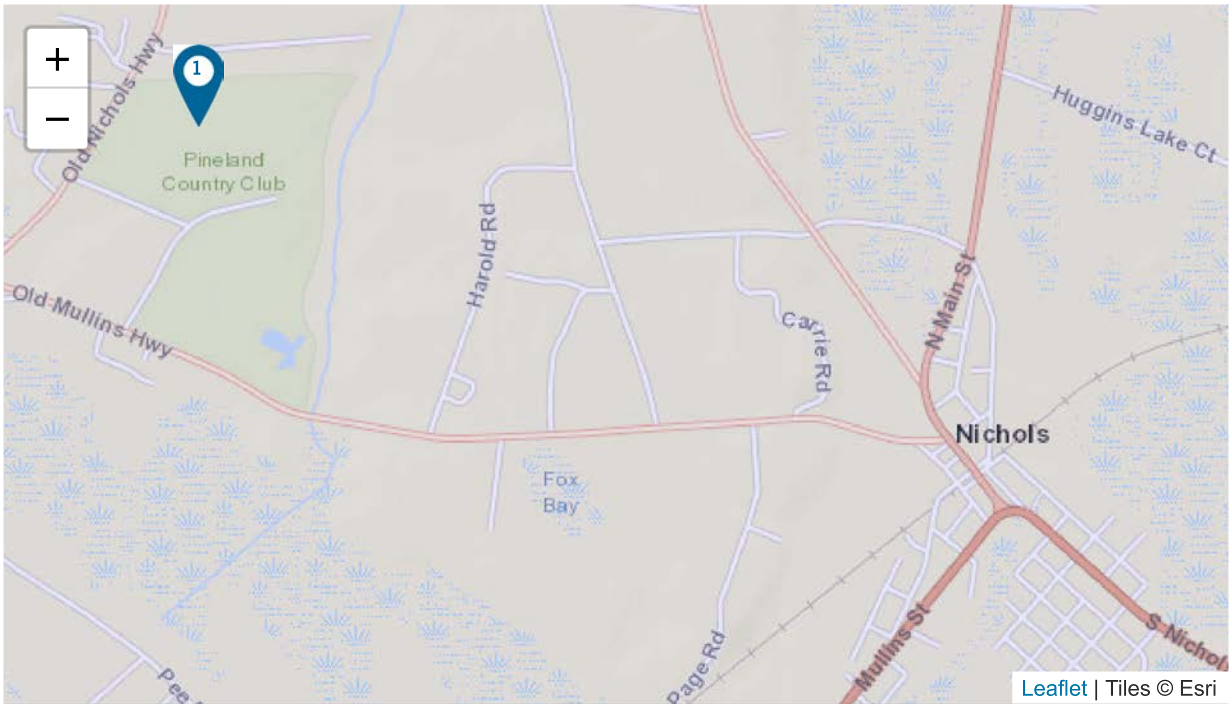
FEMA

Benefit-Cost Calculator

V.6.0 (Build 20221028.1600 | Release Notes)

Benefit-Cost Analysis

Project Name: N - Golf Course Annexation - Nichols, SC



				Using 7% Discount Rate			Using 3% Discount Rate (For FY22 BRIC and FMA only)		
Map Marker ▲	Mitigation Title	Property Type	Hazard	Benefits (B)	Costs (C)	BCR (B/C)	Benefits (B)	Costs (C)	BCR (B/C)
1	Other @ 34° 14' 45.7501200"; -79° -10' -55.7799600"	•••	DFA - Riverine Flood	$ 11,798,929	$ 9,600,000	1.23	$ 26,128,440	$ 9,600,000	2.72
TOTAL (SELECTED)				**$ 11,798,929**	**$ 9,600,000**	**1.23**	**$ 26,128,440**	**$ 9,600,000**	**2.72**
TOTAL				**$ 11,798,929**	**$ 9,600,000**	**1.23**	**$ 26,128,440**	**$ 9,600,000**	**2.72**

Property Configuration

Property Title:	Other @ 34° 14' 45.7501200"; -79° -10' -55.7799600"
Property Location:	29581, Marion, South Carolina
Property Coordinates:	34.2460417, -79.1821611
Hazard Type:	Riverine Flood
Mitigation Action Type:	Other
Property Type:	Other
Analysis Method Type:	Professional Expected Damages

Cost Estimation

Other @ 34° 14' 45.7501200"; -79° -10' -55.7799600"

Project Useful Life (years):	100
Project Cost:	$9,600,000
Number of Maintenance Years:	100 Use Default:Yes
Annual Maintenance Cost:	$0

Comments

-

Project Useful Life:

Assumes 64 properties/homes are bought out at approximately $150,000 each.

Damage Analysis Parameters - Damage Frequency Assessment

Other @ 34° 14' 45.7501200"; -79° -10' -55.7799600"

Year of Analysis was Conducted:	2022
Year Property was Built:	1973
Analysis Duration:	50 Use Default:Yes

Professional Expected Damages Before Mitigation

Other @ 34° 14' 45.7501200"; -79° -10' -55.7799600"

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
25	0	20,672,000	0	0	0	0	20,672,000

Comments

-

Damages Before Mitigation:

Using $323,000 per buy out (standard benefit built into this spreadsheet) for each of the 64 properties.

Annualized Damages Before Mitigation

Other @ 34° 14' 45.7501200"; -79° -10' -55.7799600"

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
25	20,672,000	826,878
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	20,672,000	826,878

Professional Expected Damages After Mitigation

Other @ 34° 14' 45.7501200"; -79° -10' -55.7799600"

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
0	0	0	0	0	0	0	0

Annualized Damages After Mitigation

Other @ 34° 14' 45.7501200"; -79° -10' -55.7799600"

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	0	0

Standard Benefits - Ecosystem Services

Other @ 34° 14' 45.7501200"; -79° -10' -55.7799600"

Total Project Area (acres):	0
Percentage of Urban Green Open Space:	0.00%
Percentage of Rural Green Open Space:	0.00%
Percentage of Riparian:	0.00%
Percentage of Coastal Wetlands:	0.00%
Percentage of Inland Wetlands:	0.00%
Percentage of Forests:	0.00%
Percentage of Coral Reefs:	0.00%
Percentage of Shellfish Reefs:	0.00%
Percentage of Beaches and Dunes:	0.00%
Expected Annual Ecosystem Services Benefits:	$0

Benefits-Costs Summary

Other @ 34° 14' 45.7501200"; -79° -10' -55.7799600"

Total Standard Mitigation Benefits:	$11,798,929
Total Social Benefits:	$0
Total Mitigation Project Benefits:	$11,798,929
Total Mitigation Project Cost:	$9,600,000
Benefit Cost Ratio - Standard:	1.23
Benefit Cost Ratio - Standard + Social:	1.23

O - Downtown/North Main Street Runoff Reduction - Nichols, SC

O - Downtown/North Main Street Runoff Reduction - Nichols, SC			
Prioritization Category	**Sub-Category**	**Points**	**Maximum Point**
LMI % Served	*LMI % X 20 points*	7.2	20
Level of Flood Risk Reduction	Minimal increase	0	10
Quantity of Flood Risk Reduction	0-10 Structures	0	10
Benefit-Cost Ratio	50-75%	13	20
Leveraged Funding	Significant potential or specific cost share identified	10	10
Permitting/Scheduling	Little-to-no challenges	10	10
Mobility Improvement	Limited mobility improvements	3	5
Phasing Considerations	Limited Contribution	3	5
Project Synergies	Limited cost savings	3	5
Environmental Impact	Green Infrastructure or Improved Impact	5	5
		54.2	100

DOWNTOWN / MAIN STREET RUNOFF REDUCTION

Nichols, South Carolina

Category:
Low Impact Development and/or Retrofit

Purpose:
To reduce small storm event peak flow rates observed during small return period storm events

Background

Though the Town of Nichols is a small and rural community it also has a strong commercial presence since the early 1900's. Due to this commerce mainly consisting of agricultural storage and occurring prior to there being significant guidance/knowledge associated with stormwater conveyance much of the Town's commercial area is densely impervious. See Figure O1 below depicting an aerial image from May 2021.

These large expansive areas of impervious surfaces contribute to localized flooding during small return period storm events and are susceptible to poor drainage during intense storm events.

Figure O1: Aerial of the Town of Nichols from May 2021. Source: Google Earth

Potential Project

Several Low Impact Development/Retrofit practices could be employed in downtown Nichols to help with the collection and potential infiltration of stormwater.

One option is to collect roof runoff associated with a few of the large storage facilities located downtown. The larger blue area shown in Figure O2 below represents an approximately 8.3-acre roof area. The first flush (1-inch) of rainfall alone represents over 30,000 cubic feet (225,000 gallons) of runoff. This first flush could be stored in cisterns (above or below ground) and used to cool and plumb (toilets only) the storage facility itself or irrigate adjacent areas.

Figure O2: Large roof areas in downtown Nichols. Approximately 8.3 acres and 0.9 acres of roof area.

Cisterns come in a variety of shapes and sizes and are constructed from a wide range of materials. Selection and specific site location are usually based on the intent/purpose of the stormwater collection as well as the roof-pitch configuration of the subject building(s). Examples of above ground metal cisterns on a flat and sloped area are shown in Figures O3A & O3B below.

Figures O3A & O3B: Above ground cisterns on a sloped and a flat site.

Much of downtown Nichols has significant pavement areas and limited drainage infrastructure. See Figures O4 and O5 of Main Street, Averette Street, and S. Nichols Street. Other LID options could be bioretention cells/rain gardens and permeable pavement. With much of the downtown area being located within a Lakeland Sand soil type, there is capacity for infiltration if the drainage system is designed to promote it.

Figure O4: Expansive impervious areas near intersection of Main Street and Averette Street.

Figure O5: Expansive impervious areas along S. Nichols Street. Note sedimentation and standing water along valley gutters.

Bioretention cells can be designed to fit most areas and provide water quantity controls as well as water quality treatment via physical filtration and phytoremediation. These designs typically consist of a filter media contained within a low-lying storage area that is designed to promote rapid infiltration and healthy native plant growth, a perforated underdrain with clean-out, and an overflow structure that routes water more directly to the system outfall during high-flow events. Figures O6, O7, and O8 depict examples of bioretention cells and a standard detail.

Figure O6: Aerial image of a retrofit bioretention cell designed by MBI.

Figure O7: Retrofit bioretention cell designed by MBI shortly after a rain event.

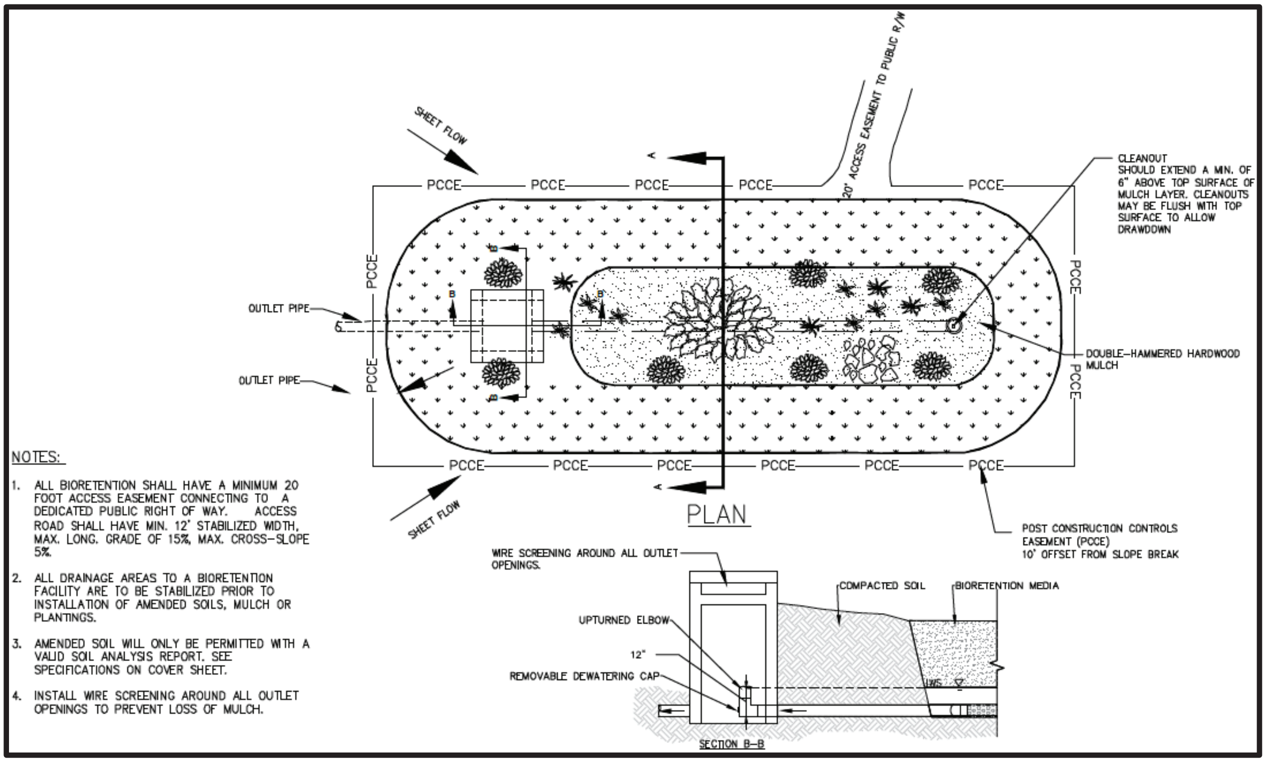


Figure O8: Typical bioretention detail.

Figure O9A & O9B: Permeable gutter system designed by MBI.

Permeable pavement systems can be utilized in lieu of valley gutters and within parking areas throughout downtown Nichols. These systems can also provide water quantity controls as well as water quality treatment via physical filtration and reducing observed runoff downstream. These designs typically consist of pavers or bricks installed on top of a filter media within areas that are typically paved with conventional asphalt or concrete. The intent is to promote rapid infiltration. Perforated underdrains with clean-outs coupled with standard drainage structures such as curb or drop inlets are typically utilized. Figures O9A and O9B above depict a permeable gutter system employed on a past project.

Additional Considerations

Maintenance can sometimes be a concern with cistern and infiltration systems. Maintenance plans and agreements need to be developed and adopted during the design phase and discussed at stakeholder meetings.

Bioretention and permeable paver systems can be costly and require a functioning underlying drainage system. System outfall locations would need to be properly vetted and assessed.

These LID solutions are geared towards smaller more frequent and intense storm events and would have little to no positive effect during large-scale storms and high flows.

PROJECT BENEFITS

Alleviate small return period storm event flooding in the Town by reducing impervious areas promoting infiltration

Reduce strain on downstream outfalls during small return period storm events

Improve water quality by detaining first-flush from impervious surfaces

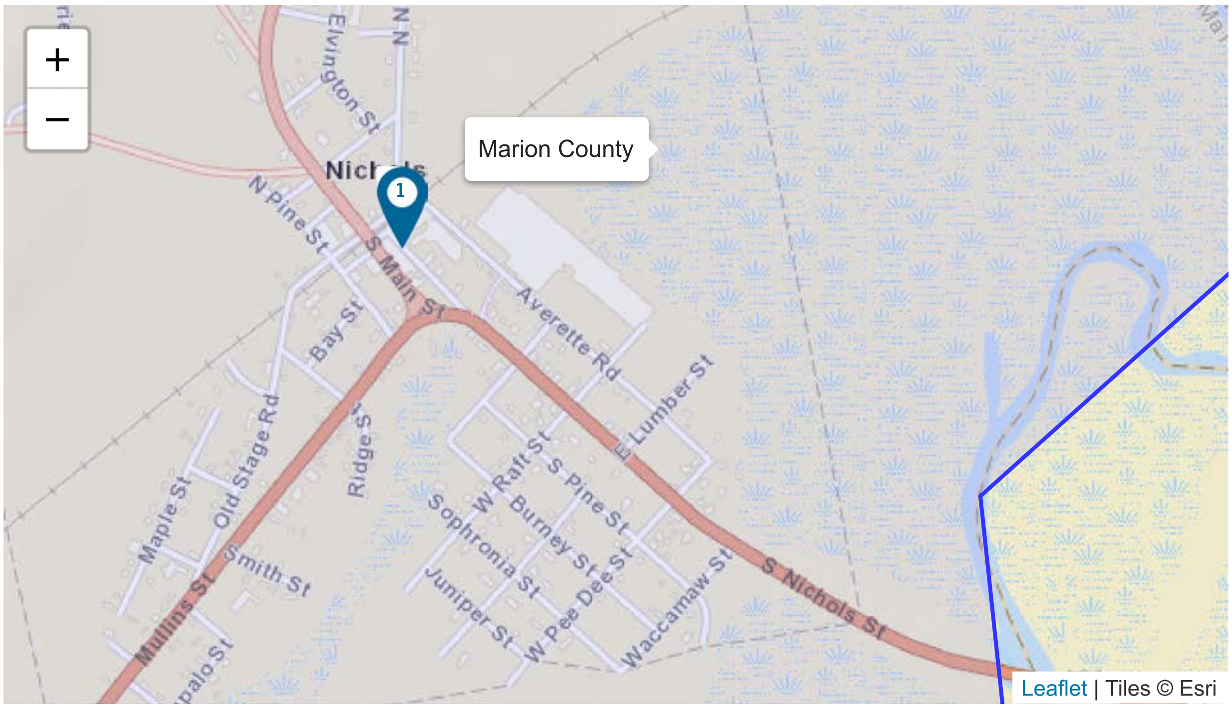
Project is scalable based on funding/needs

Benefit-Cost Calculator

V.6.0 (Build 20221028.1600 | Release Notes)

Benefit-Cost Analysis

Project Name: O - Downtown / Main Street Runoff Reduction - Nichols, SC



				Using 7% Discount Rate			Using 3% Discount Rate (For FY22 BRIC and FMA only)		
Map Marker ▲	Mitigation Title	Property Type	Hazard	Benefits (B)	Costs (C)	BCR (B/C)	Benefits (B)	Costs (C)	BCR (B/C)
1	Drainage Improvement @ 34.2335083; -79.1480833		DFA - Riverine Flood	$ 2,048,003	$ 1,525,502	1.34	$ 3,818,246	$ 1,555,324	2.45
TOTAL (SELECTED)				**$ 2,048,003**	**$ 1,525,502**	**1.34**	**$ 3,818,246**	**$ 1,555,324**	**2.45**
TOTAL				**$ 2,048,003**	**$ 1,525,502**	**1.34**	**$ 3,818,246**	**$ 1,555,324**	**2.45**

Property Configuration

Property Title:	Drainage Improvement @ 34.2335083; -79.1480833
Property Location:	29581, Marion, South Carolina
Property Coordinates:	34.2335083, -79.1480833
Hazard Type:	Riverine Flood
Mitigation Action Type:	Drainage Improvement
Property Type:	Roads & Bridges
Analysis Method Type:	Professional Expected Damages

Cost Estimation

Drainage Improvement @ 34.2335083; -79.1480833

Project Useful Life (years):	50
Project Cost:	$1,491,000
Number of Maintenance Years:	50 Use Default:Yes
Annual Maintenance Cost:	$2,500

Damage Analysis Parameters - Damage Frequency Assessment

Drainage Improvement @ 34.2335083; -79.1480833

Year of Analysis was Conducted:	2022
Year Property was Built:	1960
Analysis Duration:	63 Use Default:Yes

Roads and Bridges Properties

Drainage Improvement @ 34.2335083; -79.1480833

Estimated Number of One-Way Traffic Detour Trips per Day:	0
Additional Time per One-Way Detour Trip (minutes):	0
Number of Additional Miles:	0
Federal Rate ($):	0.625 Use Default:Yes
Economic Loss Per Day of Loss of Function ($):	0

Comments

-

Number of Trips:

AADT 2021 is estimated via engineering judgement and population of the area.

Professional Expected Damages Before Mitigation

Drainage Improvement @ 34.2335083; -79.1480833

	ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
10	3	1,403,979	80,000	0	0	0	1,483,979

Comments

-

Damages Before Mitigation:

Category 1 damages represent the value of benefit associated with the reduction of pollutants (N, P, TSS) by approximately 50% from the installation of bioretention cells, reference US EPA's Water Quality Benefits Spreadsheet. Category 2 damages represent the value in additional runoff storage ($2/CF) added by the installation of bioretention cells and cisterns (approximately 2,000 CF per cell and cistern), reference "The Economics of Low-Impact Development: A Literature Review" published in November 2007 by ECONorthwest.

Annualized Damages Before Mitigation

Drainage Improvement @ 34.2335083; -79.1480833

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
10	1,483,979	148,398
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	1,483,979	148,398

Professional Expected Damages After Mitigation

Drainage Improvement @ 34.2335083; -79.1480833

	ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
0	0	0	0	0	0	0	0

Annualized Damages After Mitigation

Drainage Improvement @ 34.2335083; -79.1480833

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	0	0

Standard Benefits - Ecosystem Services

Drainage Improvement @ 34.2335083; -79.1480833

Total Project Area (acres):	0
Percentage of Urban Green Open Space:	0.00%
Percentage of Rural Green Open Space:	0.00%
Percentage of Riparian:	0.00%
Percentage of Coastal Wetlands:	0.00%
Percentage of Inland Wetlands:	0.00%
Percentage of Forests:	0.00%
Percentage of Coral Reefs:	0.00%
Percentage of Shellfish Reefs:	0.00%
Percentage of Beaches and Dunes:	0.00%
Expected Annual Ecosystem Services Benefits:	$0

Benefits-Costs Summary

Drainage Improvement @ 34.2335083; -79.1480833

Total Standard Mitigation Benefits:	$2,048,003
Total Social Benefits:	$0
Total Mitigation Project Benefits:	$2,048,003
Total Mitigation Project Cost:	$1,525,502
Benefit Cost Ratio - Standard:	1.34
Benefit Cost Ratio - Standard + Social:	1.34

BCA Cost Estimate - O - Downtown Main Street Runoff Reduction, Nichols SC

HARD COSTS

ITEM	IDESCR	IDESCRL	QUANTITY	UNITS	UNIT COST	COST
1031010	MOBILIZATION	MOBILIZATION		LS	5%	$ 42,218.80
1071000	TRAFFIC CONTROL	TRAFFIC CONTROL		LS	8%	$ 67,550.08
2011000	CLEAR. & GRUB. WITHIN R/W	CLEARING & GRUBBING WITHIN RIGHT OF WAY		LS	0.0%	$ -
4012120	FULL DEP.ASPH.PAV.PATCH-12"	FULL DEPTH ASPH. PAV. PATCHING 12"UNIF	100	SY	$ 120.00	$ 12,000.00
7141136	36" RC PIPE CUL.-CLASS V	36" RC PIPE CUL.-CLASS V	200	LF	$ 240.00	$ 48,000.00
8041020	RIP-RAP (CLASS B)	RIP-RAP (CLASS B)	50	TON	$ 98.38	$ 4,919.00
8048105	GEOTEX/EROS.CONT(CLASS1)TYPE B	GEOTEXTILE FOR EROSION CONTROL UNDER RIPRAP(CLASS 1)TYPE B	50	SY	$ 4.14	$ 207.00
8101000	SEEDING (MULCHED)	SEEDING (MULCHED)	1	MSY	$ 750.00	$ 750.00
8153000	SILT FENCE	SILT FENCE	1000	LF	$ 3.50	$ 3,500.00
	15,000 GAL CORRAGATED STEEL CISTERN (INCLUSIVE)	15,000 GAL CORRAGATED STEEL CISTERN (INCLUSIVE)	10	EA	$ 25,000.00	$ 250,000.00
	BIORETENTION AREA (INCLUSIVE)	BIORETENTION AREA (INCLUSIVE)	10	EA	$ 50,000.00	$ 500,000.00
	PERVIOUS PAVEMENT GUTTER (INCLUSIVE)	PERVIOUS PAVEMENT GUTTER (INCLUSIVE)	100	SY	$ 250.00	$ 25,000.00
	CONTINGENCY	CONTINGENCY 25%	-	-		$ 238,536.22
					SUB-TOTAL:	$ 844,376.00
					HARD COST TOTAL:	$ 1,192,681.10

SOFT COSTS

DESIGN	SURVEY, STRUCTURAL DESIGN, HYDRO DESIGN, AND ENVIRO COMPLIANCE	$ 238,536.22
PERMITTING & FEES	LAND DISTURBANCE/NPDES PERMITTING, ENVIRO, SCDOT, ETC.	$ 59,634.06
	SOFT COST TOTAL:	$ 298,170.28
	GRAND TOTAL:	$ 1,490,851.38
	ROUNDED TOTAL:	$ 1,491,000.00

P - Nichols Evacuation Route - Nichols, SC

P - Nichols Evacuation Route - Nichols, SC			
Prioritization Category	**Sub-Category**	**Points**	**Maximum Point**
LMI % Served	*LMI % X 20 points*	7.2	20
Level of Flood Risk Reduction	Above a 25-year / 24-hour storm event level of protection	10	10
Quantity of Flood Risk Reduction	50+ Structures	10	10
Benefit-Cost Ratio	50-75%	13	20
Leveraged Funding	Limited potential cost share identified	5	10
Permitting/Scheduling	Potential challenges	5	10
Mobility Improvement	Significant mobility improvements	5	5
Phasing Considerations	Limited Contribution	3	5
Project Synergies	Limited cost savings	3	5
Environmental Impact	Neutral Impact	3	5
		64.2	100

NICHOLS EVACUATION ROUTE - REVISED

Nichols, South Carolina

Category:
Improves Level of Service

Purpose:
To provide an evacuation route for residents in the event major flooding occurs

Background

The Town of Nichols is located within the limits of the FEMA 100-year floodplain. In previous years where the Town has flooded, US 76 has also flooded as shown in Figure P1 below. Because US 76 is the main route both into and out of town, locals were unable to evacuate by car. Additionally, emergency responders were unable to enter the town except by boat as US 76 was impassable.

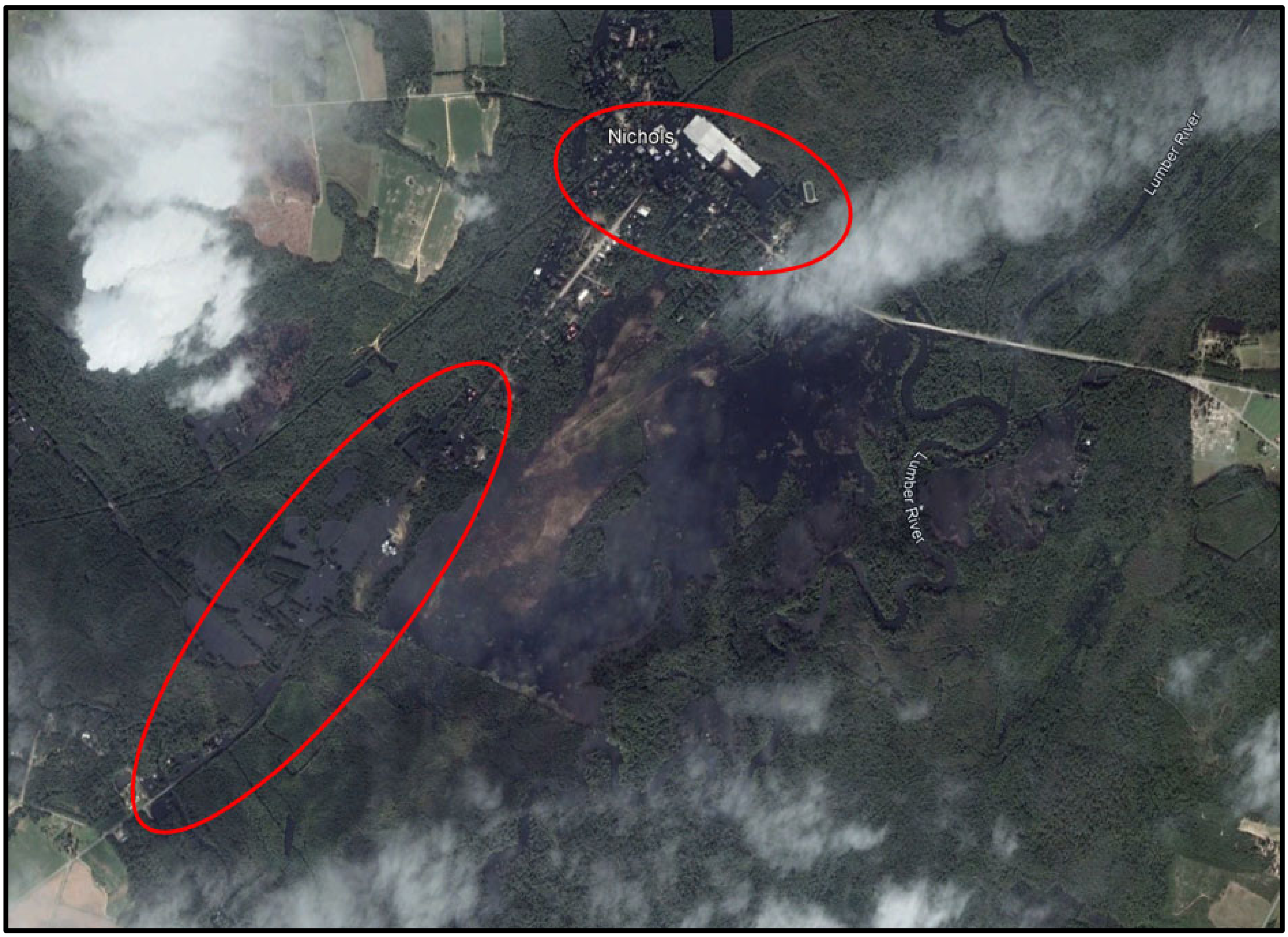


Figure P1: September 2018 flooding showing US 76 under water in the red circled areas

Potential Project

Providing residents of Nichols an evacuation route out of the town as well as a route into Nichols for emergency responders is a great way to minimize additional damages and loss of life. In reviewing the current road elevations along US 76, it was determined that an evacuation route to the east of Nichols was the shortest route compared to upgrading the western portion of US 76. In addition to upgrades to US 76, West Lumber Street would also need to be raised to elevate the road above the 100-year baseflood elevations. An extension of Smith Street would also provide access to US 76 for residents in western portion of Nichols. The proposed limits of roadway improvements can be seen in red in Figure P2 below. Additionally, this proposed evacuation route would be an added benefit to the proposed Nichols airport annexation project as this route would provide residents from the new residential area safe access to the high ground provided by US 76.

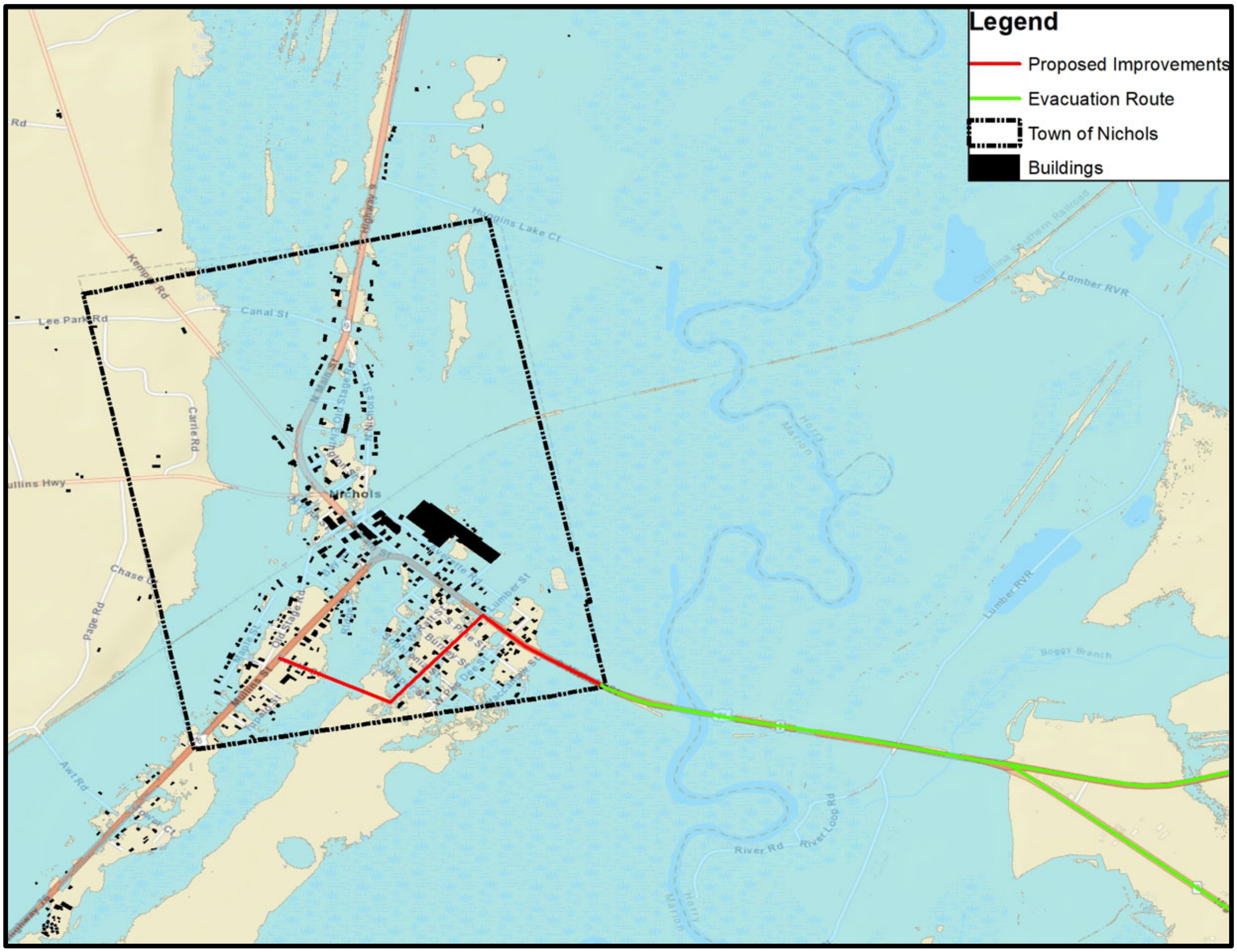


Figure P2: Town of Nichols Proposed Evacuation Route

Additional Considerations

The Town of Nichols is located within a FEMA designated zone AE with an established floodway. Any fill and/or improvements will require communication with the local floodplain manager and/or potentially FEMA.

Updated topographic information may be required to better define the floodplain inundation limits as the existing LiDAR is from 2008.

PROJECT BENEFITS

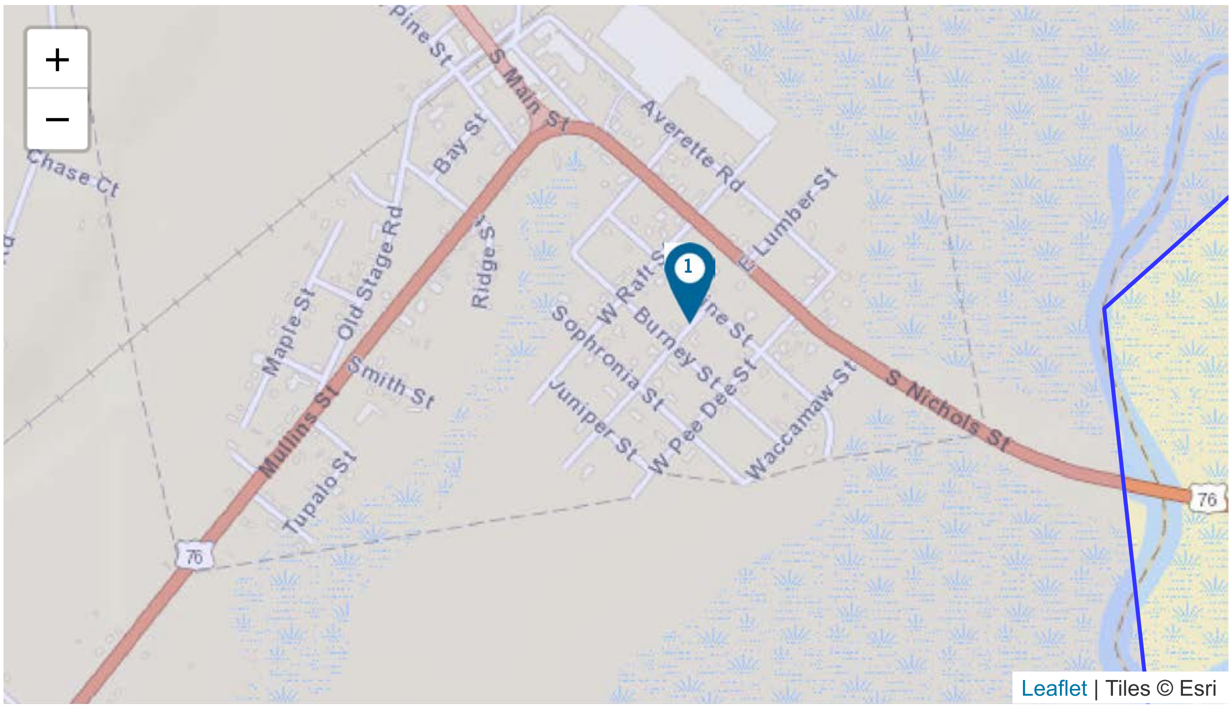
Provides a dry route for residents to evacuate and/or emergency responders to enter

Benefit-Cost Calculator

V.6.0 (Build 20221028.1600 | Release Notes)

Benefit-Cost Analysis

Project Name: P - Nichols Evacuation Route - Nichols, SC



				Using 7% Discount Rate			Using 3% Discount Rate (For FY22 BRIC and FMA only)		
Map Marker ▲	Mitigation Title	Property Type	Hazard	Benefits (B)	Costs (C)	BCR (B/C)	Benefits (B)	Costs (C)	BCR (B/C)
1	Elevation @ W Lumber St, Nichols, South Carolina, 29581		DFA - Riverine Flood	$ 1,935,803	$ 1,576,801	1.23	$ 3,609,063	$ 1,588,730	2.27
TOTAL (SELECTED)				**$ 1,935,803**	**$ 1,576,801**	**1.23**	**$ 3,609,063**	**$ 1,588,730**	**2.27**
TOTAL				**$ 1,935,803**	**$ 1,576,801**	**1.23**	**$ 3,609,063**	**$ 1,588,730**	**2.27**

Property Configuration

Property Title:	Elevation @ W Lumber St, Nichols, South Carolina, 29581
Property Location:	29581, Marion, South Carolina
Property Coordinates:	34.22882503561155, -79.14455491078297
Hazard Type:	Riverine Flood
Mitigation Action Type:	Elevation
Property Type:	Roads & Bridges
Analysis Method Type:	Professional Expected Damages

Cost Estimation

Elevation @ W Lumber St, Nichols, South Carolina, 29581

Project Useful Life (years):	50
Project Cost:	$1,563,000
Number of Maintenance Years:	50 Use Default:Yes
Annual Maintenance Cost:	$1,000

Damage Analysis Parameters - Damage Frequency Assessment

Elevation @ W Lumber St, Nichols, South Carolina, 29581

Year of Analysis was Conducted:	2022
Year Property was Built:	0
Analysis Duration:	50 Use Default: *No*

Roads and Bridges Properties

Elevation @ W Lumber St, Nichols, South Carolina, 29581

Estimated Number of One-Way Traffic Detour Trips per Day:	0
Additional Time per One-Way Detour Trip (minutes):	0
Number of Additional Miles:	0
Federal Rate ($):	0.625 Use Default:Yes
Economic Loss Per Day of Loss of Function ($):	0

Professional Expected Damages Before Mitigation

Elevation @ W Lumber St, Nichols, South Carolina, 29581

	ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
100	2	2,219,200	11,800,000	0	20	2	14,026,910

Comments

-

Damages Before Mitigation:
It is assumed that at least four (4) people could become incapacitated and at least one (1) person could die if residents are unable to evacuate Nichols during a similar storm even to the 2016 and 2018 hurricanes. Category 1 damages represent incapacitating (4 X $554,800) and Category 2 damages represents being killed ($11,800,000) per the FHWA's Benefit Cost Analysis Guidance 2022.

Annualized Damages Before Mitigation

Elevation @ W Lumber St, Nichols, South Carolina, 29581

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
100	14,026,910	140,268
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	14,026,910	140,268

Professional Expected Damages After Mitigation

Elevation @ W Lumber St, Nichols, South Carolina, 29581

	ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
0	0	0	0	0	0	0	0

Annualized Damages After Mitigation

Elevation @ W Lumber St, Nichols, South Carolina, 29581

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	0	0

Benefits-Costs Summary

Elevation @ W Lumber St, Nichols, South Carolina, 29581

Total Standard Mitigation Benefits:	$1,935,803
Total Social Benefits:	$0
Total Mitigation Project Benefits:	$1,935,803
Total Mitigation Project Cost:	$1,576,801
Benefit Cost Ratio - Standard:	1.23
Benefit Cost Ratio - Standard + Social:	1.23

BCA Cost Estimate - P - Nichols Evacuation Route, Nichols SC

HARD COSTS

ITEM	IDESCR	IDESCRL	QUANTITY	UNITS	UNIT COST	COST
	PRICE PER MILE OF ROADWAY	PRICE PER MILE OF ROADWAY	1.0	MILE	$ 1,000,000.00	$ 1,000,000.00
	CONTINGENCY	CONTINGENCY 25%	-	-		$ 250,000.00
					SUB-TOTAL:	$ 1,000,000.00
					HARD COST TOTAL:	$ 1,250,000.00

SOFT COSTS

	DESIGN	SURVEY, STRUCTURAL DESIGN, HYDRO DESIGN, AND ENVIRO COMPLIANCE				$ 250,000.00
	PERMITTING & FEES	LAND DISTURBANCE/NPDES PERMITTING, ENVIRO, SCDOT, ETC.				$ 62,500.00
					SOFT COST TOTAL:	$ 312,500.00
					GRAND TOTAL:	$ 1,562,500.00
					ROUNDED TOTAL:	$ 1,563,000.00

Q - Great Pee Dee River Flooding - Marion County, SC

Q1 - Great Pee Dee River Flooding - [redacted] Bear Pond Rd, Gresham SC 29546 - Marion County, SC			
Prioritization Category	**Sub-Category**	**Points**	**Maximum Point**
LMI % Served	*LMI % X 20 points*	11.4	20
Level of Flood Risk Reduction	Above a 25-year / 24-hour storm event level of protection	10	10
Quantity of Flood Risk Reduction	0-10 Structures	0	10
Benefit-Cost Ratio	75-100%	20	20
Leveraged Funding	Significant potential or specific cost share identified	10	10
Permitting/Scheduling	Little-to-no challenges	10	10
Mobility Improvement	Minimal mobility improvements	0	5
Phasing Considerations	Limited Contribution	3	5
Project Synergies	Limited cost savings	3	5
Environmental Impact	Neutral Impact	3	5
		70.4	100

Q2 - Great Pee Dee River Flooding - [redacted] Bear Pond Rd, Gresham SC 29546 - Marion County, SC			
Prioritization Category	**Sub-Category**	**Points**	**Maximum Point**
LMI % Served	*LMI % X 20 points*	11.4	20
Level of Flood Risk Reduction	Above a 25-year / 24-hour storm event level of protection	10	10
Quantity of Flood Risk Reduction	0-10 Structures	0	10
Benefit-Cost Ratio	75-100%	20	20
Leveraged Funding	Significant potential or specific cost share identified	10	10
Permitting/Scheduling	Little-to-no challenges	10	10
Mobility Improvement	Minimal mobility improvements	0	5
Phasing Considerations	Limited Contribution	3	5
Project Synergies	Limited cost savings	3	5
Environmental Impact	Neutral Impact	3	5
		70.4	100

Q3 - Great Pee Dee River Flooding - [redacted] Goose Pond Rd, Gresham SC 29546 - Marion County, SC			
Prioritization Category	**Sub-Category**	**Points**	**Maximum Point**
LMI % Served	*LMI % X 20 points*	11.4	20
Level of Flood Risk Reduction	Above a 25-year / 24-hour storm event level of protection	10	10
Quantity of Flood Risk Reduction	0-10 Structures	0	10
Benefit-Cost Ratio	75-100%	20	20
Leveraged Funding	Significant potential or specific cost share identified	10	10
Permitting/Scheduling	Little-to-no challenges	10	10
Mobility Improvement	Minimal mobility improvements	0	5
Phasing Considerations	Limited Contribution	3	5
Project Synergies	Limited cost savings	3	5
Environmental Impact	Neutral Impact	3	5
		70.4	100

GREAT PEE DEE RIVER FLOODING - REVISED

Marion County, South Carolina

Category:
Potential Buyouts

Purpose:
To assess the potential buyouts of properties within the Great Pee Dee River floodplain.

Background

The Great Pee Dee River runs along the western border of Marion County. The Pee Dee, Gresham, and Brittons Neck communities experienced flooding from the Great Pee Dee River during Hurricane Florence in 2018. USGS has several documented high-water marks in these areas confirming the flooding.

Potential Project

Given the large size of the Great Pee Dee watershed, there is little that can be done to effectively eliminate flooding. The most productive solution would be to restore the floodplain through the elimination of structures within them. Property files from Marion County confirm several structures are located within the Great Pee Dee River floodplain. These structures would be prime candidates for buyout and relocation. Figure Q1 below shows an area in Britton's Neck where there are approximately 160 parcels with structures within the 100-year FEMA floodplain.

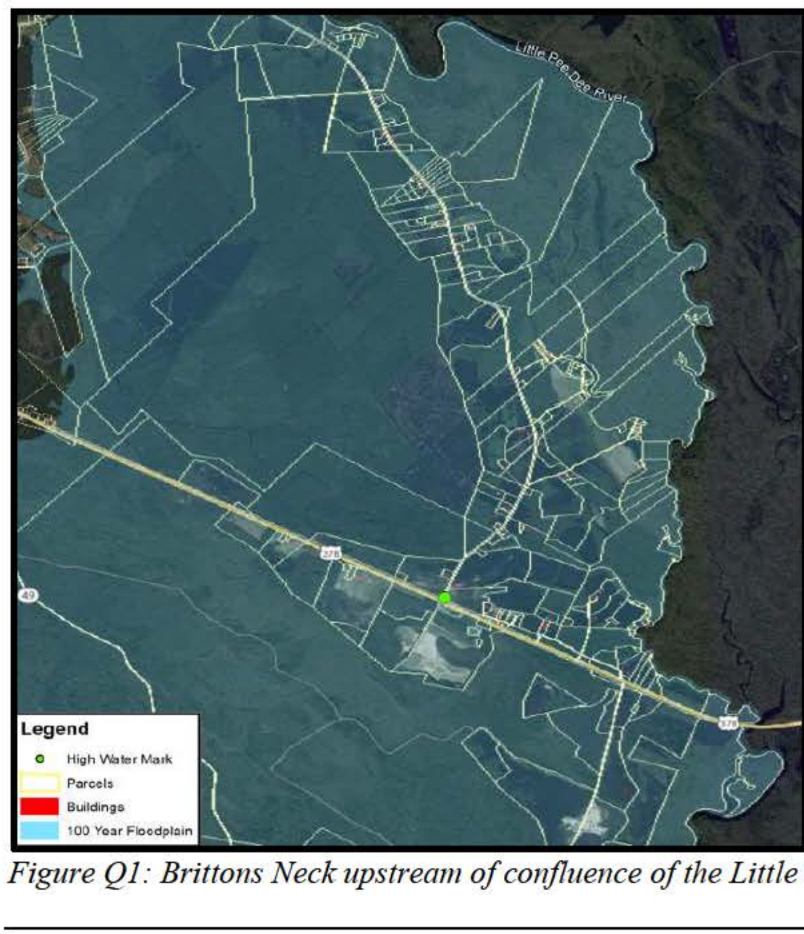


Figure Q1: Brittons Neck upstream of confluence of the Little Pee Dee and Great Pee Dee Rivers

Figure Q2 below depicts an area in Gresham that experienced flooding during Hurricane Florence. Although the structures south of Bear Pond Road fall outside of the 100-year FEMA floodplain boundary, a USGS high water mark from 2018 indicates these structures were impacted by flood waters.

[redacted]

Figure Q2: Flooding near Bear Pond Road in Gresham

Additionally, flooding from the Great Pee Dee River was experienced in the Pee Dee community. Figure Q3 below highlights an area in purple that was picked up by Google Earth historical imagery from September 2018. Although the structures shown in red are located outside the FEMA 100-year floodplain, these structures experienced flooding during Hurricane Florence. A USGS high water mark from a wooden utility pole indicated approximately 1.78’ of flooding above natural ground elevation. The location of this utility pole is indicated by a green dot in the figure below.

During the development of project BCA’s/BCR’s it was determined that three (3) specific properties within the Great Pee Dee River floodplain be selected/highlighted as good candidates for buyout to narrow down the scope of this project and provide examples of the benefits associated with buyouts. The three (3) properties that were selected were [redacted] Bear Pond Rd, Gresham SC 29546, [redacted] Bear Pond Rd, Gresham SC 29546, and [redacted] Goose Pond Rd, Gresham SC 29546. Each of these properties contained structures that are currently located within the 100-year FEMA floodplain and therefore subject to the standard benefit dollar amount supplied in the FEMA BCA toolkit spreadsheet.

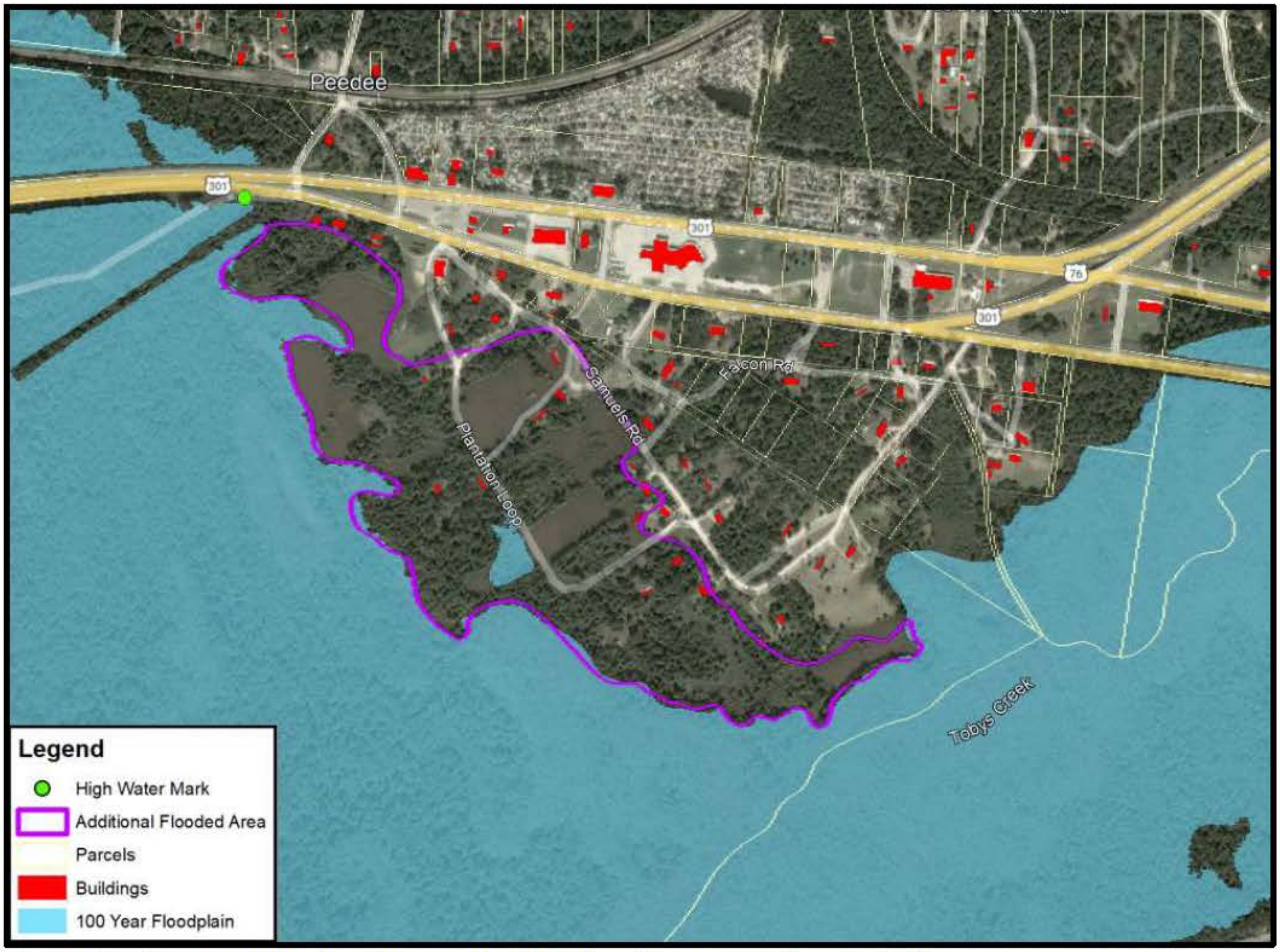


Figure Q3: Historical flooding limits in Pee Dee from Hurricane Florence 2018

Additional Considerations

If this alternative is attractive for both SCOR and Marion County, further discussion and analysis would be required to determine what is in the parameters of SCOR funding.

The potential of acquiring some or all the property is unknown.

PROJECT BENEFITS

Elimination of structures in the floodplain allows for more floodplain storage during large storm events

Project is scalable based on funding/needs

R - Phil Court Berm Removal on Lower Catfish Creek - Marion County, SC

R - Phil Court Berm Removal on Lower Catfish Creek - Marion County, SC			
Prioritization Category	**Sub-Category**	**Points**	**Maximum Point**
LMI % Served	*LMI % X 20 points*	12	20
Level of Flood Risk Reduction	Above a 25-year / 24-hour storm event level of protection	10	10
Quantity of Flood Risk Reduction	0-10 Structures	0	10
Benefit-Cost Ratio	25-50%	7	20
Leveraged Funding	No potential cost share identified	0	10
Permitting/Scheduling	Potential challenges	5	10
Mobility Improvement	Minimal mobility improvements	0	5
Phasing Considerations	Limited Contribution	3	5
Project Synergies	Limited cost savings	3	5
Environmental Impact	Green Infrastructure or Improved Impact	5	5
		45	100

PHIL COURT BERM REMOVAL ON LOWER CATFISH CREEK

Marion County, South Carolina

Category:
Stream/Wetland Restoration

Purpose:
To remove a man-made berm on Lower Catfish Creek near Phil Court in Marion County allowing for the restoration of the riparian buffer zone/natural habitat.

Background

During the Public Outreach meeting in the City of Marion on September 26th, 2022, a resident provided feedback about concerns regarding a man-made berm that was constructed on Lower Catfish Creek near Phil Court in Marion County. It was stated that the berm had become common knowledge locally, among some circles, and that there was apparently no FEMA nor USACE coordination/permit issued approving its construction.

Upon further assessment it was determined that the berm was constructed at some point between March 2015 and February 2017, based on Google Earth aerial imagery. Due to the very rural nature of the area, and the berm's location on Lower Catfish Creek, there appears to be limited hydraulic impact to the upstream more inhabited areas. However, there is an environmental/ecological impact associated with the destruction of the riparian buffer zone/natural habitat.

Figure R1: Aerial Imagery dated March 2015 depicting no berm, source Google Earth

Figure R2: Aerial Imagery dated February 2017 depicting berm, source Google Earth

Potential Project

The goal of this potential project would be the excavation and removal of the imported fill material and allowing the area to resume/reestablish its original riparian buffer zone/natural habitat function.

Additional Considerations

There is potential for significant environmental (USACE), and regulatory (FEMA) permitting/coordination associated with the removal of the berm. Further, due to the berm being located on private property, permissions and a temporary grading agreement would be required for [redacted].

PROJECT BENEFITS

Improved Water Quality

Reestablishment of natural habitat

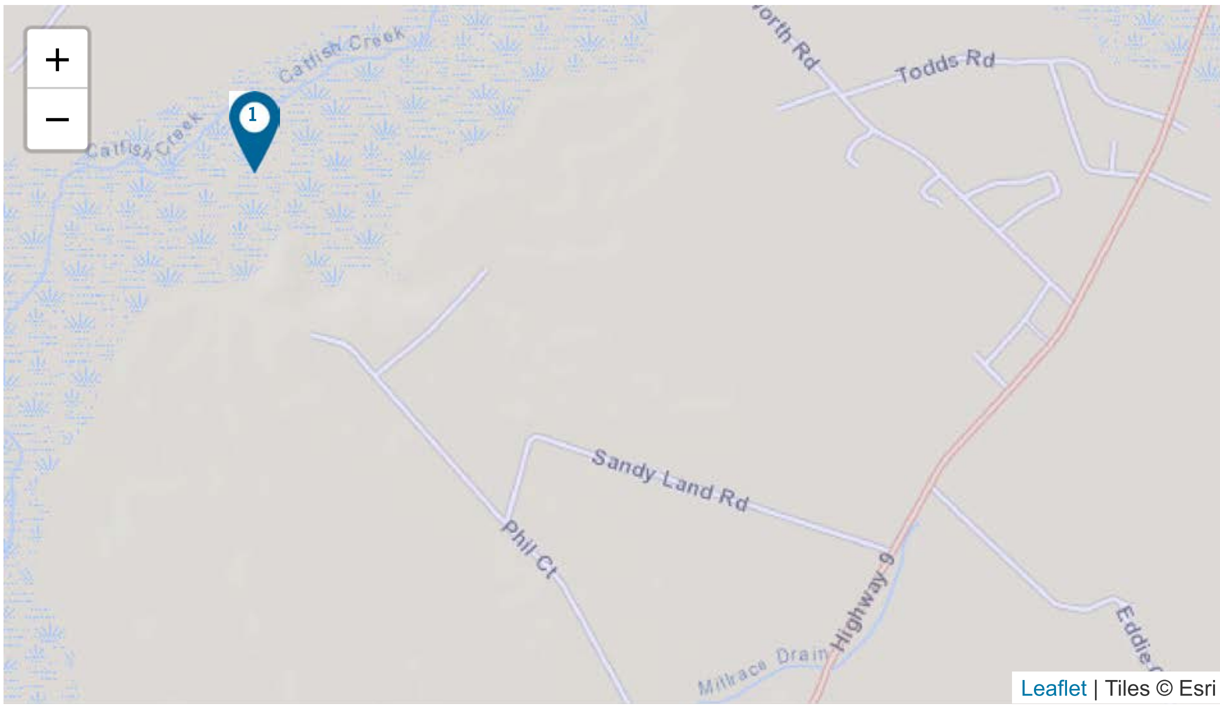
FEMA

Benefit-Cost Calculator

V.6.0 (Build 20221028.1600 | Release Notes)

Benefit-Cost Analysis

Project Name: R - Phil Court Berm Removal on Lower Catfish Creek - Marion County, SC



				Using 7% Discount Rate			Using 3% Discount Rate (For FY22 BRIC and FMA only)		
Map Marker ▲	Mitigation Title	Property Type	Hazard	Benefits (B)	Costs (C)	BCR (B/C)	Benefits (B)	Costs (C)	BCR (B/C)
1	Floodplain and Stream Restoration @ 34° 13' 16.9600800"; -79° -24' -56.1301200"	•••	DFA - Riverine Flood	$ 796,203	$ 792,000	1.01	$ 1,763,172	$ 792,000	2.23
TOTAL (SELECTED)				**$ 796,203**	**$ 792,000**	**1.01**	**$ 1,763,172**	**$ 792,000**	**2.23**
TOTAL				**$ 796,203**	**$ 792,000**	**1.01**	**$ 1,763,172**	**$ 792,000**	**2.23**

Property Configuration

Property Title:	Floodplain and Stream Restoration @ 34° 13' 16.9600800"; -79° -24' -56.1301200"
Property Location:	29546, Marion, South Carolina
Property Coordinates:	34.0884222, -79.4528944
Hazard Type:	Riverine Flood
Mitigation Action Type:	Floodplain and Stream Restoration
Property Type:	Other
Analysis Method Type:	Professional Expected Damages

Cost Estimation

Floodplain and Stream Restoration @ 34° 13' 16.9600800"; -79° -24' -56.1301200"

Project Useful Life (years):	100
Project Cost:	$792,000
Number of Maintenance Years:	100 Use Default: *No*
Annual Maintenance Cost:	$0

Damage Analysis Parameters - Damage Frequency Assessment

Floodplain and Stream Restoration @ 34° 13' 16.9600800"; -79° -24' -56.1301200"

Year of Analysis was Conducted:	2022
Year Property was Built:	2016
Analysis Duration:	10 Use Default:Yes

Professional Expected Damages Before Mitigation

Floodplain and Stream Restoration @ 34° 13' 16.9600800"; -79° -24' -56.1301200"

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
0	0	0	0	0	0	0	0

Annualized Damages Before Mitigation

Floodplain and Stream Restoration @ 34° 13' 16.9600800"; -79° -24' -56.1301200"

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	0	0

Professional Expected Damages After Mitigation

Floodplain and Stream Restoration @ 34° 13' 16.9600800"; -79° -24' -56.1301200"

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
0	0	0	0	0	0	0	0

Annualized Damages After Mitigation

Floodplain and Stream Restoration @ 34° 13' 16.9600800"; -79° -24' -56.1301200"

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	0	0

Standard Benefits - Ecosystem Services

Floodplain and Stream Restoration @ 34° 13' 16.9600800"; -79° -24' -56.1301200"

Total Project Area (acres):	1.5
Percentage of Urban Green Open Space:	0.00%
Percentage of Rural Green Open Space:	0.00%
Percentage of Riparian:	100.00%
Percentage of Coastal Wetlands:	0.00%
Percentage of Inland Wetlands:	0.00%
Percentage of Forests:	0.00%
Percentage of Coral Reefs:	0.00%
Percentage of Shellfish Reefs:	0.00%
Percentage of Beaches and Dunes:	0.00%
Expected Annual Ecosystem Services Benefits:	$55,799

Benefits-Costs Summary

Floodplain and Stream Restoration @ 34° 13' 16.9600800"; -79° -24' -56.1301200"

Total Standard Mitigation Benefits:	$796,203
Total Social Benefits:	$0
Total Mitigation Project Benefits:	$796,203
Total Mitigation Project Cost:	$792,000
Benefit Cost Ratio - Standard:	1.01
Benefit Cost Ratio - Standard + Social:	1.01

BCA Cost Estimate - R - Phil Court Berm Removal on Lower Catfish Creek - Marion County, SC

HARD COSTS

ITEM	IDESCR	IDESCRL	QUANTITY	UNITS	UNIT COST	COST
2031000	UNCLASSIFIED EXCAVATION	UNCLASSIFIED EXCAVATION	14400	CY	$ 40.00	$ 576,000.00
	CONTINGENCY	CONTINGENCY 25%	-	-		$ 144,000.00
					SUB-TOTAL:	$ 576,000.00
					HARD COST TOTAL:	$ 720,000.00

SOFT COSTS

	DESIGN	SURVEY, STRUCTURAL DESIGN, HYDRO DESIGN, AND ENVIRO COMPLIANCE (5%)				$ 36,000.00
	PERMITTING & FEES	LAND DISTURBANCE/NPDES PERMITTING, ENVIRO, SCDOT, ETC.				$ 36,000.00
					SOFT COST TOTAL:	$ 72,000.00
					GRAND TOTAL:	$ 792,000.00
					ROUNDED TOTAL:	$ 792,000.00

S - Canal Street SC Highway 9 Crossing Improvements - Nichols, SC

S - Canal Street SC Highway 9 Crossing Improvements - Nichols, SC			
Prioritization Category	**Sub-Category**	**Points**	**Maximum Point**
LMI % Served	*LMI % X 20 points*	7.2	20
Level of Flood Risk Reduction	Above a 25-year / 24-hour storm event level of protection	10	10
Quantity of Flood Risk Reduction	0-10 Structures	0	10
Benefit-Cost Ratio	0-25%	0	20
Leveraged Funding	Limited potential cost share identified	5	10
Permitting/Scheduling	Potential challenges	5	10
Mobility Improvement	Significant mobility improvements	5	5
Phasing Considerations	Limited Contribution	3	5
Project Synergies	Limited cost savings	3	5
Environmental Impact	Neutral Impact	3	5
		41.2	100

CANAL STREET HIGHWAY 9 CROSSING IMPROVEMENTS

Nichols, South Carolina

Category:
Improves Level of Service

Purpose:
Upsize the existing SC Highway 9 crossing to reduce scour potential at the upstream inlet and channel shoring as well as meet current design criteria

Background

The culvert crossing under SC Highway 9 directly adjacent to its intersection with Canal Street is conveying water from an unnamed tributary of the Lumber River, north of the Town of Nichols. During the Public Outreach meeting in the Town of Nichols on October 13th, 2022, a resident provided feedback about observable scour along the canal shoring and the potential for failure. A quick site visit was conducted, and the existing conditions were documented via photographs. Channel bank scour and areas of failing shoring were apparent upstream of the existing 8’ X 6’ reinforced concrete box culvert (RCBC).

Figure S1: View of SC Highway 9 crossing, upstream inlet

[redacted]

Figures S2: [redacted] *upstream of Highway 9 crossing*

Upon further analysis, the crossing was modeled in HY-8 and was found to overtop for the 50-year storm event.

Potential Project

Remove and replace the existing 8' X 6' RCBC culvert with an 8' X 7' RCBC culvert as well as replacing approximately 1,000-LF of wooden channel shoring with steel sheet piling. This project would prevent the road from being overtopped during a 50-year storm event by providing adequate capacity to convey the flow reaching the crossing and would re-establish the structural integrity of the existing canal banks.

Additional Considerations

There is potential that the grade of Highway 9 will need to be slightly adjusted to provide necessary cover for the proposed culvert. Another consideration would be the potential for significant environmental permitting associated with the removal and replacement of the failing channel shoring. Further, an easement or, at a minimum a temporary grading agreement, would be required within private property ([redacted]).

PROJECT BENEFITS

Improved conveyance of water under SC Highway 9

Increased level of service of SC Highway 9 to convey the 50-year event without overtopping

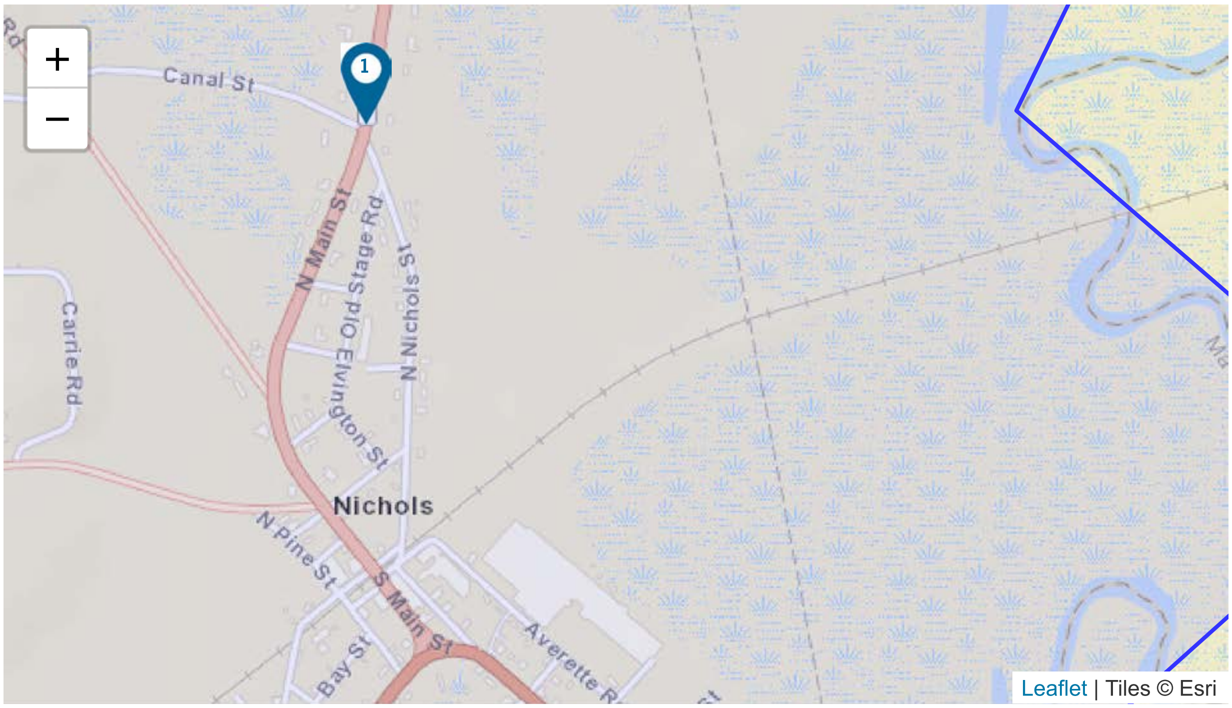
Increased stabilization/safety associated with the canal adjacent to Canal Street

Benefit-Cost Calculator

V.6.0 (Build 20221028.1600 | Release Notes)

Benefit-Cost Analysis

Project Name: S - Canal Street & Hwy 9 Crossing Improvements - Nichols, SC



				Using 7% Discount Rate			Using 3% Discount Rate (For FY22 BRIC and FMA only)		
Map Marker ▲	Mitigation Title	Property Type	Hazard	Benefits (B)	Costs (C)	BCR (B/C)	Benefits (B)	Costs (C)	BCR (B/C)
1	Drainage Improvement @ 34° 14' 30"; -79° -8' -56.53"		DFA - Riverine Flood	$ 393,307	$ 886,801	0.44	$ 733,273	$ 898,730	0.82
TOTAL (SELECTED)				**$ 393,307**	**$ 886,801**	**0.44**	**$ 733,273**	**$ 898,730**	**0.82**
TOTAL				**$ 393,307**	**$ 886,801**	**0.44**	**$ 733,273**	**$ 898,730**	**0.82**

Property Configuration

Property Title:	Drainage Improvement @ 34° 14' 30"; -79° -8' -56.53"
Property Location:	29581, Marion, South Carolina
Property Coordinates:	34.2416667, -79.1490361
Hazard Type:	Riverine Flood
Mitigation Action Type:	Drainage Improvement
Property Type:	Roads & Bridges
Analysis Method Type:	Professional Expected Damages

Cost Estimation

Drainage Improvement @ 34° 14' 30"; -79° -8' -56.53"

Project Useful Life (years):	50
Project Cost:	$873,000
Number of Maintenance Years:	50 Use Default:Yes
Annual Maintenance Cost:	$1,000

Damage Analysis Parameters - Damage Frequency Assessment

Drainage Improvement @ 34° 14' 30"; -79° -8' -56.53"

Year of Analysis was Conducted:	2022
Year Property was Built:	1960
Analysis Duration:	63 Use Default:Yes

Roads and Bridges Properties

Drainage Improvement @ 34° 14' 30"; -79° -8' -56.53"

Estimated Number of One-Way Traffic Detour Trips per Day:	850
Additional Time per One-Way Detour Trip (minutes):	20
Number of Additional Miles:	5
Federal Rate ($):	0.625 Use Default:Yes
Economic Loss Per Day of Loss of Function ($):	12,742.92

Comments

-

Number of Trips:

2021 ADT from SCDOT database.

Professional Expected Damages Before Mitigation

Drainage Improvement @ 34° 14' 30"; -79° -8' -56.53"

	ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
50	1	302,600	1,109,600	0	0	0	1,424,943

Comments

-

Damages Before Mitigation:

When road overtops, hydroplaning accidents are likely. Assuming three potential accidents with 2 passengers per road overtopping event, due to the high volume of traffic. Two of these potential accidents are assumed to be incapacitating due to the higher speed limit and rural nature of this area. An injury crash is valued as $302,600 of damage per incident and an incapacitating level of injury is valued as $554,800 of damage per incident per Table A-1: Value of Reduced Fatalities and Injuries within the Benefit Cost Analysis Guidance for Discretionary Grant Programs, U.S. Department of Transportation, March 2022.

Annualized Damages Before Mitigation

Drainage Improvement @ 34° 14' 30"; -79° -8' -56.53"

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
50	1,424,943	28,499
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	1,424,943	28,499

Professional Expected Damages After Mitigation

Drainage Improvement @ 34° 14' 30"; -79° -8' -56.53"

	ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
0	0	0	0	0	0	0	0

Annualized Damages After Mitigation

Drainage Improvement @ 34° 14' 30"; -79° -8' -56.53"

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	0	0

Standard Benefits - Ecosystem Services

Drainage Improvement @ 34° 14' 30"; -79° -8' -56.53"

Total Project Area (acres):	0
Percentage of Urban Green Open Space:	0.00%
Percentage of Rural Green Open Space:	0.00%
Percentage of Riparian:	0.00%
Percentage of Coastal Wetlands:	0.00%
Percentage of Inland Wetlands:	0.00%
Percentage of Forests:	0.00%
Percentage of Coral Reefs:	0.00%
Percentage of Shellfish Reefs:	0.00%
Percentage of Beaches and Dunes:	0.00%
Expected Annual Ecosystem Services Benefits:	$0

Benefits-Costs Summary

Drainage Improvement @ 34° 14' 30"; -79° -8' -56.53"

Total Standard Mitigation Benefits:	$393,307
Total Social Benefits:	$0
Total Mitigation Project Benefits:	$393,307
Total Mitigation Project Cost:	$886,801
Benefit Cost Ratio - Standard:	0.44
Benefit Cost Ratio - Standard + Social:	0.44

BCA Cost Estimate - S - Canal Street_Hwy 9 Crossing Improvements, Marion SC

HARD COSTS

ITEM	IDESCR	IDESCRL	QUANTITY	UNITS	UNIT COST		COST
1031010	MOBILIZATION	MOBILIZATION		LS		5%	$ 19,150.20
1071000	TRAFFIC CONTROL	TRAFFIC CONTROL		LS		20%	$ 76,600.80
2011000	CLEAR. & GRUB. WITHIN R/W	CLEARING & GRUBBING WITHIN RIGHT OF WAY		LS		0.0%	$ -
2028500	REM&DISP.OF EX.CULV 8'X7'	REMOVAL & DISPOSAL OF EXISTING CULVERT 8'X7'	1	EA	$	45,000.00	$ 45,000.00
4012120	FULL DEP.ASPH.PAV.PATCH-12"	FULL DEPTH ASPH. PAV. PATCHING 12"UNIF	500	SY	$	120.00	$ 60,000.00
7221045	8'X7' PCBOX CULV.{M-273}FH<2	8'X 7' P.C. BOX CULVERT {AASHTO M-273} FH < 2 8'X 7'	75	LF	$	3,400.00	$ 255,000.00
8041020	RIP-RAP (CLASS B)	RIP-RAP (CLASS B)	200	TON	$	98.38	$ 19,676.00
8048105	GEOTEX/EROS.CONT(CLASS1)TYPE B	GEOTEXTILE FOR EROSION CONTROL UNDER RIPRAP(CLASS 1)TYPE B	200	SY	$	4.14	$ 828.00
8101000	SEEDING (MULCHED)	SEEDING (MULCHED)	1	MSY	$	750.00	$ 750.00
8153000	SILT FENCE	SILT FENCE	500	LF	$	3.50	$ 1,750.00
	SHEET PILING CHANNEL STABILIZATION	SHEET PILING CHANNEL STABILIZATION	1000	LF	$	100.00	$ 100,000.00
	CONTINGENCY	CONTINGENCY 25%	-	-			$ 119,688.75
					SUB-TOTAL:		$ 383,004.00
					HARD COST TOTAL:		$ 698,443.75

SOFT COSTS

DESIGN	SURVEY, STRUCTURAL DESIGN, HYDRO DESIGN, AND ENVIRO COMPLIANCE		$ 139,688.75
PERMITTING & FEES	LAND DISTURBANCE/NPDES PERMITTING, ENVIRO, SCDOT, ETC.		$ 34,922.19
		SOFT COST TOTAL:	$ 174,610.94
		GRAND TOTAL:	$ 873,054.69
		ROUNDED TOTAL:	$ 873,000.00

Appendix F: Example Concept Design Plans

FED. RD DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
	SC	MARION			XX

Michael Baker INTERNATIONAL

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

REV. NO.	BY	DATE	DESCRIPTION OF REVISION

DESIGNED BY:		DATE:	$$DDMMYY$$
DRAWN BY:		DATE:	$$DDMMYY$$
CHECKED BY:		DATE:	$$DDMMYY$$

MULLINS, SC

EAST FRONT STREET AND RAILROAD CROSSING
PLAN SHEET

SHEET NO.: XX | SCALE: 1" = 20'

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
	SC	MARION			XX

Michael Baker INTERNATIONAL

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

REV. NO.	BY	DATE	DESCRIPTION OF REVISION

DESIGNED BY: ______ DATE: $$DDMMYY$$
DRAWN BY: ______ DATE: $$DDMMYY$$
CHECKED BY: ______ DATE: $$DDMMYY$$

MULLINS, SC

EAST MCINTYRE STREET CROSSING
PLAN SHEET

SHEET NO.: XX | SCALE: 1" = 20'

$$USERNAME$$
$$$$DGNSPEC$$$$
$$$$SYSTIME$$$$

FED. RD DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
	SC	MARION			XX

Michael Baker
INTERNATIONAL

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

REV. NO.	BY	DATE	DESCRIPTION OF REVISION

DESIGNED BY:	DATE: $$DDMMYY$$
DRAWN BY:	DATE: $$DDMMYY$$
CHECKED BY:	DATE: $$DDMMYY$$

MULLINS, SC

THREE BRIDGE ROAD CROSSING
PLAN SHEET

SHEET NO.: XX

SCALE: 1" = 20'

FED. RD DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
	SC	MARION			XX

Michael Baker INTERNATIONAL

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

REV. NO.	BY	DATE	DESCRIPTION OF REVISION

DESIGNED BY:	DATE: $$DDMMYY$$
DRAWN BY:	DATE: $$DDMMYY$$
CHECKED BY:	DATE: $$DDMMYY$$

MULLINS, SC

WEST MCINTYRE STREET CROSSING
PLAN SHEET

SHEET NO.: XX | SCALE: 1" = 20'

$$USERNAME$$ $$$$SYTIME$$$$

FED. RD DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
	SC	MARION			XX

Michael Baker
INTERNATIONAL

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

REV. NO.	BY	DATE	DESCRIPTION OF REVISION

DESIGNED BY:	DATE: $$DDMMYY$$
DRAWN BY:	DATE: $$DDMMYY$$
CHECKED BY:	DATE: $$DDMMYY$$

NICHOLS, SC

AWT ROAD CROSSING
PLAN SHEET

SHEET NO.: XX

SCALE: 1" = 20'

$$USERNAME$$ $$DGNSPEC$$ $$SYSTIME$$

FED. RD DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
	SC	MARION			XX

Michael Baker INTERNATIONAL

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

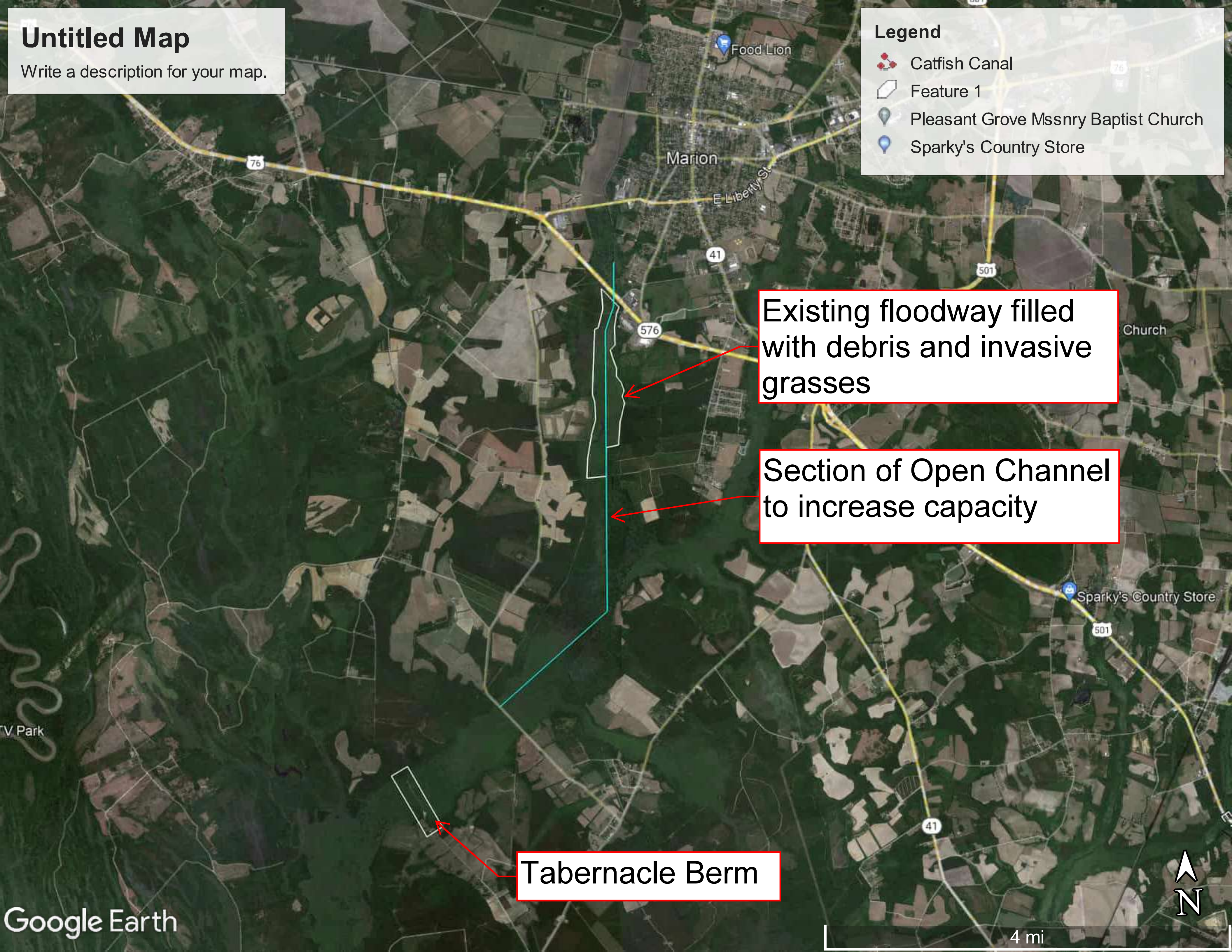
REV. NO.	BY	DATE	DESCRIPTION OF REVISION

DESIGNED BY: ______ DATE: $$DDMMYY$$
DRAWN BY: ______ DATE: $$DDMMYY$$
CHECKED BY: ______ DATE: $$DDMMYY$$

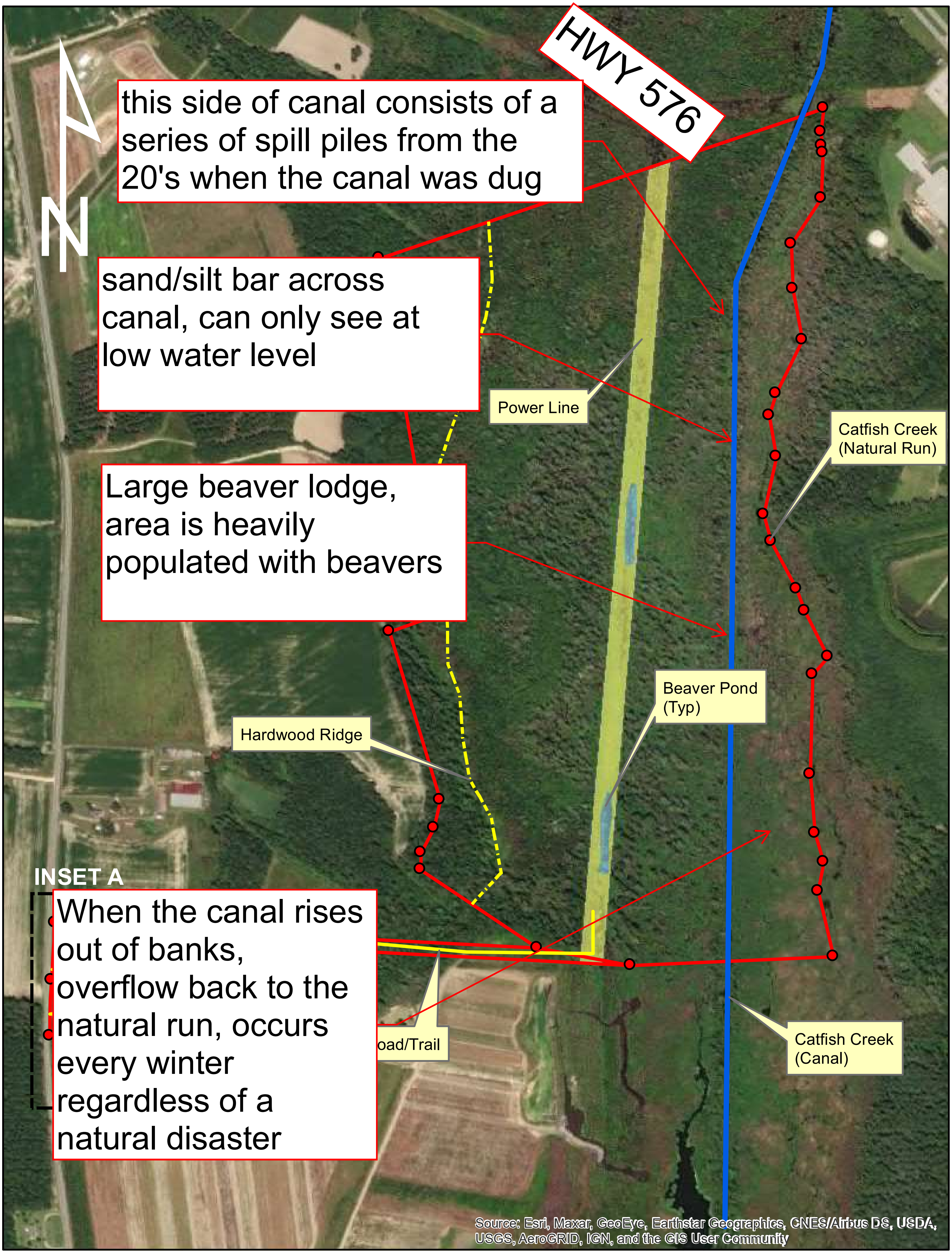
SELLERS, SC

RAILROAD CROSSING IMPROVEMENTS
PLAN SHEET

SHEET NO.: XX SCALE: 1" = 20'



Untitled Map
Write a description for your map.
Legend
Catfish Canal
Feature 1
Pleasant Grove Mssnry Baptist Church
Sparky's Country Store
Food Lion
Marion
E Liberty St
76
41
501
576
Church
Existing floodway filled with debris and invasive grasses
Section of Open Channel to increase capacity
Sparky's Country Store
V Park
Tabernacle Berm
Google Earth
N
4 mi


HWY 576
this side of canal consists of a series of spill piles from the 20's when the canal was dug
sand/silt bar across canal, can only see at low water level
Power Line
Catfish Creek (Natural Run)
Large beaver lodge, area is heavily populated with beavers
Beaver Pond (Typ)
Hardwood Ridge
INSET A
When the canal rises out of banks, overflow back to the natural run, occurs every winter regardless of a natural disaster
oad/Trail
Catfish Creek (Canal)
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community