WHITEVILLE COMMUNITY FLOODPRINT

MOLLIE'S BRANCH + DOWNTOWN CORE

www.coastaldynamicsdesignlab.com

CREDITS + THANKS

This report was completed by the NC State University Coastal Dynamics Design Lab (CDDL). Grant funding for this project was generously provided by the U.S. Department of Housing and Urban Development (HUD) Community Development Block Grant-Mitigation program, which is administered at the state-level by the North Carolina Office of Recovery & Resiliency (NCORR). This document represents the first of five "Floodprint" reports to be completed as part of the grant agreement with NCORR and HUD.

We would also like to thank our project partners, technical advisors, and participating community members who guided the development and refinement of the information presented herein. You invited us into your community, donated your time, and offered invaluable expertise that helped to make this project locally relevant and its processes broadly transferable. This document would not have been possible without your support. Thank you.

NC State University College of Design Publication

PROJECT TEAM

NC STATE UNIVERSITY COASTAL DYNAMICS DESIGN LAB (CDDL): PROJECT LEAD

The mission of the CDDL is to lead trans-disciplinary research and design teams that address critical ecological and community development challenges facing vulnerable coastal regions and shoreline communities. The CDDL is a team of architects, landscape architects, and environmental planners who collaborate with communities that lack the local capacity and/or financial resources to secure long-term design and planning services. Increasingly, the work of the CDDL has focused on providing technical assistance to North Carolina communities that are grappling with the impacts of severe flood events.

ANALYSIS, PLANNING, DESIGN & PUBLIC ENGAGEMENT

Andy Fox, PLA, FASLA: Professor, Department of Landscape Architecture and Environmental Planning + Director, Coastal Dynamics Design Lab

As Director of the CDDL and a licensed landscape architect, Andy specializes in the development and management of high-performing public landscapes, with expertise in natural infrastructure, resiliency planning, community design, and land/water conservation assessment.

Travis Klondike, PLA, ASLA: Assistant Research Professor, Coastal Dynamics Design Lab + Department of Landscape Architecture and Environmental Planning

Travis is a licensed landscape architect and an Assistant Research Professor in the CDDL. His work blends hazard mitigation assistance and resilience planning by leveraging contemporary methods of geospatial analysis, community engagement, visual narration, and grant-writing as catalysts for public good.

Madalyn Baldwin, ASLA: Assistant Research Professor, Coastal Dynamics Design Lab + Department of Landscape Architecture and Environmental Planning

Madalyn specializes in the assessment of large-scale landscape systems, including geospatial analytics, planning for complex environmental networks, and ecological integration of native and threatened plant communities. Her current research interests include working lands, rural landscapes and economies, and high-performing landscapes.

Marybeth Campeau: Graduate Student Research Assistant, Coastal Dynamics Design Lab
Evan Holliday: Graduate Student Research Assistant, Coastal Dynamics Design Lab
Katarina King: Graduate Student Research Assistant, Coastal Dynamics Design Lab

PROJECT PARTNERS

In addition to CDDL staff, multiple project partners were specifically identified for their knowledge and expertise in topics relevant to the Whiteville Community Floodprint and were intimately involved in advancing the project's impact and applicability.

HYDRAULIC MODELING

Barbara Doll, PhD, PE: Extension Associate Professor, Department of Biological & Agricultural Engineering + Extension Specialist, NC Sea Grant

Dr. Doll is a licensed professional engineer with over 20 years of experience in ecological restoration. She teaches professional development workshops and academic courses in fluvial geomorphology and ecological restoration. As part of her dual appointment, Barbara has conducted design, permitting, bidding and construction oversight for numerous restoration projects throughout North Carolina.

Jack Kurki-Fox, PhD, PE: Research Associate, Department of Biological & Agricultural Engineering

Dr. Kukri-Fox is a licensed professional engineer who conducts monitoring, modeling and engineering analysis to support research and extension efforts related to water quality, flooding and water management. He supports training programs for professionals focused on stream morphology assessment, restoration and hydraulic modeling. He has conducted extensive modeling and analyses to identify flood mitigation options for communities in eastern NC, evaluate infrastructure improvements to increase resiliency, and test the flood mitigation potential of natural infrastructure.

COST ESTIMATING

Gresham Smith

A team of licensed landscape architects, civil engineers, and structural engineers from Gresham Smith provided planning support services through the development of opinions of probable project cost, including: financial and feasibility evaluations, economic analysis of alternative solutions, and considerations of operations and maintenance costs.

TECHNICAL ADVISORY COMMITTEE (TAC)

Lastly, a group of local and state representatives provided feedback at various intervals as part of this study's Technical Advisory Committee (TAC). In addition to their TAC roles, Terry Mann (Mayor), Darren Currie (City Manager), and Hal Lowder (Emergency Management Director) met on a monthly basis with the CDDL team and also played critical roles in assisting with outreach efforts, site visits, and presentations in Whiteville.

Darren Currie: Administration, City of Whiteville
Robert Lewis: Planning & Inspections, City of Whiteville
Hal Lowder: Emergency Services, City of Whiteville
Terry Mann: Administration, City of Whiteville
Blake Spivey: Parks & Recreation, City of Whiteville
Madison Ward: Downtown Main Street, City of Whiteville
Maggie Battaglin: North Carolina Office of Recovery & Resiliency (NCORR)

EXECUTIVE SUMMARY

Purpose of the Project. The City of Whiteville is in the process of recovering and rebuilding from the devastating floods that occurred as a result of Hurricane Matthew (2016) and Hurricane Florence (2018), and increasingly, many neighborhoods are becoming more susceptible to recurring flood damages from smaller and more frequent, unnamed storm events.

In recent years the city has taken numerous steps to reduce the severity of future floods. Select properties have been acquired and demolished, a stormwater fee has been implemented, and various drainage improvement projects are currently underway. As the community continues to adapt, the Whiteville Community Floodprint aims to bolster these efforts through planning and design recommendations that reduce flood risk, improve public safety, and enhance long-term environmental function within historically flood-prone areas.

This study used an environmental and community planning approach referred to as "floodprinting," which specifically highlights the use of place-based approaches as a response to natural hazards and climate change. As part of the Whiteville Community Floodprint, discrete project phases and scope items included: inventory and analysis, public outreach and engagement, hydraulic modeling, schematic planning and design, three-dimensional modeling, photorealistic rendering, benefit-cost analysis, and grant-writing.

Created over a 16-month project period, the resulting document is meant to both provide direction regarding feasible and sustainable practices within the identified focus areas, while also providing actionable collateral that can be used to attract external resources towards these projects.

An abbreviated summary of the proposed projects included in the Whiteville Community Floodprint include:

Mollie's Branch: Stream Restoration & Infrastructure Improvements. The neighborhood surrounding the Mollie's Branch stream corridor is a historically underserved community of color that was, and continues to be, disproportionately impacted by floodwaters. This focus area observes increased vulnerabilities due to: i) a high concentration of buildings within the 100-year floodplain; ii) multiple roadways that regularly overtop with floodwaters due to low elevation and/or undersized culverts; and iii) socioeconomic factors that correlate with a historical lack of investment in resilience-building projects.

The proposed combination of "green" and "gray" infrastructure enhancements includes 5,100 linear feet of stream restoration, four roadway modifications (e.g., upgraded culverts) at locations where Mollie's Branch passes underneath existing roads, and an expanded area of educational wetlands within the Central Middle School recreational complex.

Already, this project has: i) been awarded a grant from the Golden LEAF Foundation to assist with additional surveying, design, and engineering costs; and ii) is currently under review for the FY2023 FEMA Building Resilient Infrastructure and Communities (BRIC) grant program, where a state-level review board ranked and prioritized the project as #1 (out of 82 initial subapplications) in the State of North Carolina for FEMA to consider.

Downtown Core: Interior Retrofits / Elevations & "De-Pave" Program. Sixty-two (62) address points were assessed as being within Whiteville's Central Business District (CBD) and Special Flood Hazard Area (SFHA). Each of these structures were screened through geospatial criteria and field-collected data in order to determine which buildings: i) are currently not in conformance with the Columbus County Flood Damage Prevention Ordinance (Base Flood Elevation (BFE) of a 100-year flood event plus an additional two-feet of Freeboard); and ii) may be suitable for elevation as a mitigation strategy. Because of the prevalence of slab-on-grade structures throughout the CBD, an interior retrofit ("floating floor") form of elevation was specifically analyzed on a building-by-building level of detail.

Of the 62 address points screened, ten (10) addresses (five unique structures) were determined to have the most suitable conditions for this specific form of elevation. Section and elevation drawings for each building are provided in the report to illustrate how the proposed interventions can fit within the existing building shell of each structure.

In addition to the elevation assessment, a second measure is proposed for the Whiteville CBD: a "de-pave" program. While not intended to significantly mitigate the damages from severe flooding events (e.g., 500-year flood event), the "de-pave" proposition is a more broadly applicable response to stakeholder concerns regarding the presence of nuisance flooding along the roads and business fronts in the downtown area. By decreasing the total area of paved surfaces in downtown Whiteville through the conversion of underutilized hardscape areas into various forms of green infrastructure, a network of small-scale interventions will be able to better absorb stormwater while also beautifying the streetscape.

Lastly, these projects are collectively illustrated at a city-wide scale in a single "Linkage Plan," which offers additional opportunities for planning connectivity and points of funding leverage.

A summary of the final report will be presented to Whiteville City Council in May 2023, where a vote will be held to formally adopt the plan and subsequent recommendations.

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BACKGROUND + APPROACH

The City of Whiteville is in the process of recovering, responding, and rebuilding from the devastating floods that occurred in 2016 (Hurricane Matthew) and 2018 (Hurricane Florence). In Whiteville, the impacts of these storms, during Hurricane Florence in particular, far exceeded the extent of the 500-year floodplain – causing widespread damage to residences, businesses, and public infrastructure across the city.

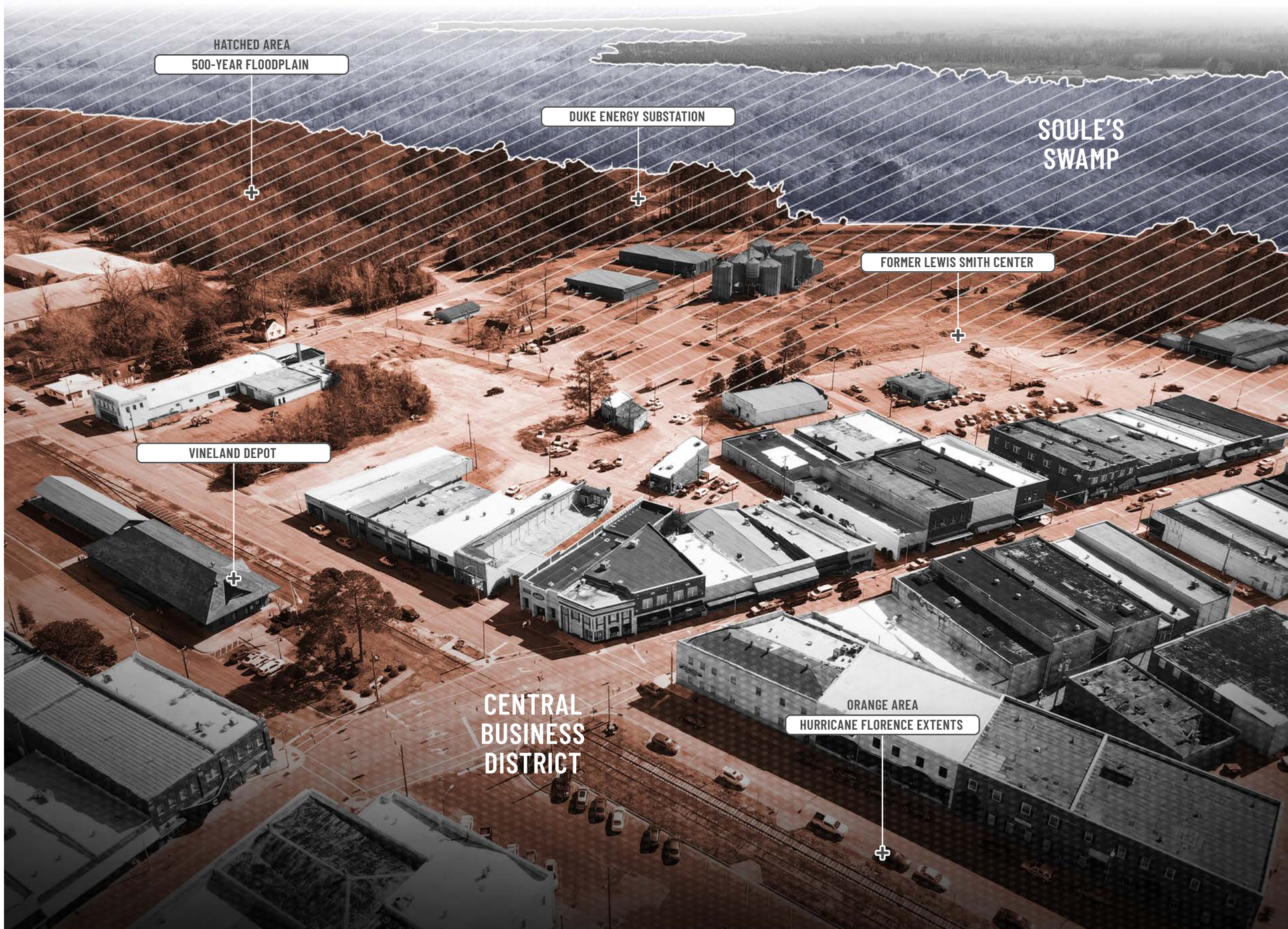
As a community and as a political unit, the city has taken numerous steps to reduce the severity of future floods in recent years. Select properties have been acquired and demolished, a stormwater fee has been implemented, and various drainage improvement projects are currently underway. The Whiteville Floodprint aims to bolster these efforts through the creation of a framework plan that can integrate existing initiatives within a new portfolio of flood mitigation projects that are informed by community input, rigorous analyses, and best practices in hazard mitigation. Ultimately, the material created herein is meant to serve as collateral for local leadership to attract, attain, and leverage investments focused on implementing the projects and recommendations included in this report.

LOCAL IMPACTS OF FLOODING

Established in 1933, the City of Whiteville is located in Columbus County, North Carolina. With a population of more than 5,000 residents and a total area of 5.4 square miles, it is the largest city in Columbus County and is the county seat. The City's downtown is home to locally-owned restaurants and shops, as well as residences. The restored Vineland Station, originally a railroad depot, serves as the City's civic center. The State of North Carolina has designated the City of Whiteville as a NC Main Street Community.

The City of Whiteville regularly experiences flooding from routine storm events. More extensive flooding occurs in the wake of larger storms like Hurricane Joaquin in 2015 and Tropical Storm Hermie in 2016. Hurricanes Matthew and Florence each caused historic levels of flooding in low-lying areas located within and near downtown, and in surrounding neighborhoods that border adjacent swamps, wetlands, and tributaries. Whiteville is still in the process of recovering from the historic flood that occurred as a result of Florence in 2018. For homes and businesses built in the floodplain, flooding is an ongoing and cyclical issue. Floodwaters in the floodplain reached six to seven feet deep during both Hurricane Matthew and Florence and resulted in repetitive losses.

More frequent and severe flooding is a result of both climate change and regional commercial development, among other factors. More locally, social and economic challenges associated with recovery and preparing for future flooding include the delicate balance of mitigating the risk of repetitive flood damages through strategies like elevations, acquisitions, and floodproofing, while simultaneously improving the civic realm within Whiteville's commercial corridor. However, infrastructure projects providing these types of benefits are seldom accessible to residents of Whiteville, and more generally Columbus County, due to a combination of demographic and environmental vulnerabilities.



CITY-LED INITIATIVES

Engaging With Flooding Issues. The City of Whiteville has been actively tackling these increased flooding issues. In 2017, the city commissioned a stormwater study for the Downtown Municipal Service District (DMSD). This report identified seven improvement projects to address the strain and overburdening of the city's stormwater infrastructure, and the City continues to make progress on its project goals. The study provided additional policy and program recommendations, including the implementation of a stormwater utility fee and related ordinances. In 2018, the City of Whiteville received a grant from the Golden LEAF Foundation to aid in the aftermath of Hurricane Matthew. This resulted in the deployment of several strategies to address flooding issues, including laying new underground pipes to facilitate better drainage in identified locations throughout the City. Through a separate grant completed in 2019, the City commissioned an analysis of a potential stormwater utility fee and passed a stormwater ordinance that included provisions for stormwater permits and the aforementioned utility fee.

Downtown Revitalization Efforts. Concurrent with the stormwater efforts, the City has also turned its attention to revitalization of the downtown area. In 2021, Whiteville was designated as a Main Street Community, committing to the nationally-recognized program focusing on economic development through historic preservation. As part of this initiative, Whiteville has addressed its downtown development in a four-prong approach championed by the Main Street Program: design, economic vitality, organization, and promotion.

A New Framework for Downtown Whiteville. In 2021, the City completed a downtown streetscape master planning process to create a vision for the streetscape and to guide future improvements. This plan -- covering the southern portion of Madison St. between Lee St. and Webster St.-- highlights the pedestrian experience through the introduction of green space, and several traffic calming techniques. The plan also positions these improvements to align with future stormwater improvement projects and park space being proposed in similar areas.

2016

+ DR-4285-NC: HURRICANE MATTHEW

2017

2018

+ DR-4364-NC: TORNADO & SEVERE STORMS
+ DR-4393-NC: HURRICANE FLORENCE
+ DR-4412-NC: TROPICAL STORM MICHAEL

2019

+ DR-4465-NC: HURRICANE DORIAN

2020

+ DR-4543-NC: SEVERE STORMS & FLOODING
+ DR-4568-NC: HURRICANE ISAIAS

2021

+ DR-4588-NC: TROPICAL STORM ETA
+ DR-4617-NC: TROPICAL STORM FRED

MOST IMPACTED AND DISTRESSED (MID) CRITERIA

EQUIREMENTS FOR SUB-COUNTY AREAS TO QUALIFY FOR "MID" DESIGNATIO

DEMONSTRATING "MOST IMPACTED"
QUALIFYING UNDER AT LEAST ONE CATEGORY:

- HOUSING
- INFRASTRUCTURE
- ECONOMIC REVITALIZATION
- ENVIRONMENTAL DEGRADATION

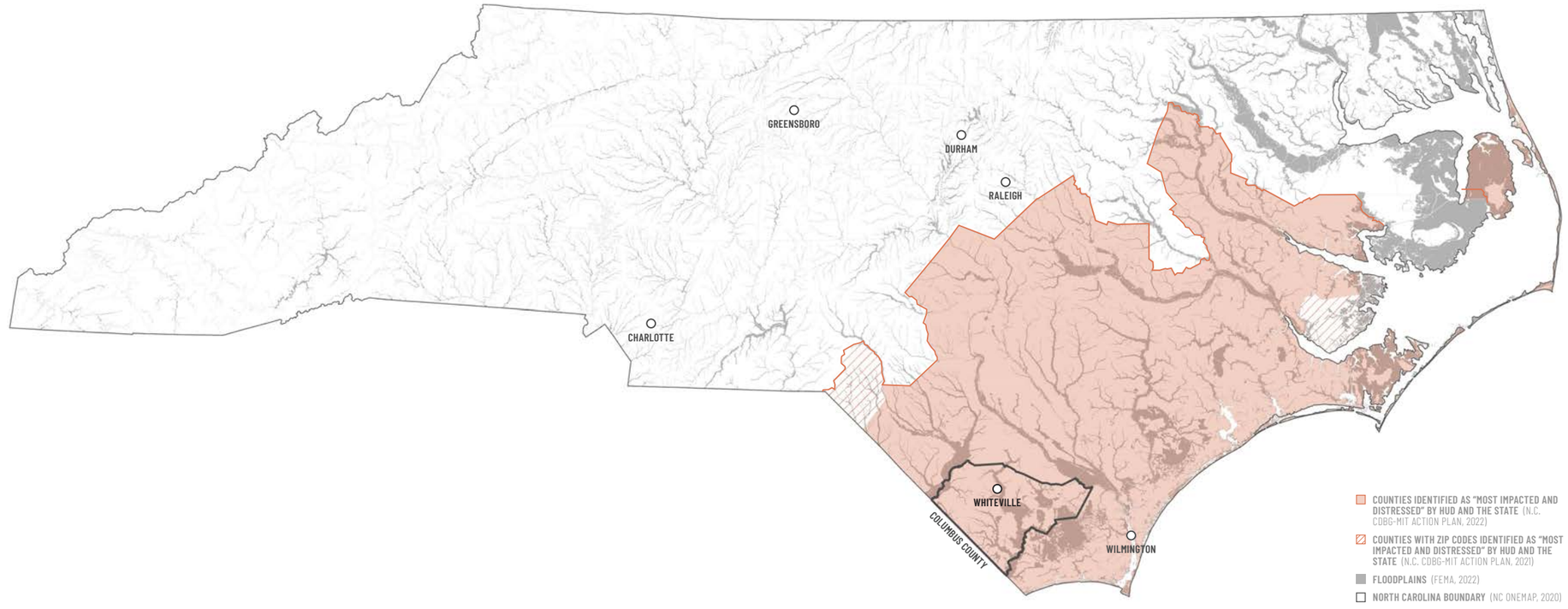
+

DEMONSTRATING "MOST DISTRESSED"
QUALIFYING UNDER AT LEAST ONE CATEGORY:

- LOW- AND MODERATE INCOME HOUSEHOLDS
- LOSS OF AFFORDABLE RENTAL HOUSING
- FEDERAL TARGET AREA OR ECONOMICALLY FRAGILE AREA
- PRIOR DOCUMENTATION OF ENVIRONMENTAL DISTRESS

OR

A COUNTY that was previously determined by HUD to be most impacted



"MOST IMPACTED AND DISTRESSED" COMMUNITIES

As part of the state-level response to Hurricanes Matthew and Florence, the North Carolina Office of Recovery and Resiliency (NCORR) has been consistently engaged with elected officials, residents, and stakeholders of Whiteville. Through allocations of funding provided by the U.S. Department of Housing and Urban Development (HUD) Community Development Block Grant Mitigation program (CDBG-MIT), NCORR has been able to offer a variety of services to counties designated as "most impacted and distressed" (MID) from the two storms (see 'Appendix A' for a full definition of "most impacted and distressed" as defined by HUD and NCORR). These services range in scope, but most pertinent to the Whiteville Floodprint effort are:

+ A Strategic Buyout Program; and
+ Planning and Technical Assistance

While monies allocated for buyouts have been primarily focused in the southwest portion of Whiteville -- to the north of Soule's Swamp -- a newly established agreement between NCORR and the NC State University Coastal Dynamics Design Lab (CDDL) is allowing for the creation of five (5) new "Floodprint" reports, in five communities, over a three year time span as part of the planning and technical assistance scope of work being administered by NCORR. Partner communities must satisfy certain criteria in order to be eligible for this focused planning assistance, including:

+ The community resides within a MID county, as identified by HUD (first priority), or by NCORR (second priority);
+ Interest/willingness to participate by community leadership;
+ Population distribution, with priority given to communities fitting the FEMA definition of "economically disadvantaged and rural" and/or "small and impoverished";
+ Quantity and spatial distribution (higher concentrations preferable) of flood-vulnerable properties; and
+ Availability of existing HEC-RAS models and hydraulic data.

WHAT IS A "FLOODPRINT?"

A FRAMEWORK FOR BUILDING RURAL RESILIENCE

FOUR KEY STRATEGIES

"Floodprint" is a term coined by the NC State University Coastal Dynamics Design Lab (CDDL) to describe a specific form of analysis and land planning that focuses on the recovery and resilience-building needs of flood-prone communities. Based on a body of work initiated post-Hurricane Matthew in 2016, Floodprint processes and resultant outcomes are strategically organized to bridge gaps and leverage opportunities related to project: **scoping, scaling, communicating, and implementing** that often pose significant challenges to communities attempting to recover from or prepare for natural hazards.

SCOPING

Scope with the Scorecard. Many small, rural communities face financial challenges that make the implementation of resilience-building projects cost prohibitive. In these cases, externally funded grant programs offer a critical lifeline to support projects that may not otherwise receive enough local funding. In recognizing this reliance on grants, a project team and associated scopes of work have been assembled to best align community needs with the required deliverables and scoring metrics of relevant grant programs. Overall, this strategy aims to help communities better position themselves to secure grant funding for implementing projects of scale

SCALING

Nest Small Projects within Bigger Plans. Lengthy time horizons associated with implementing projects are commonplace in disaster recovery and/or preparedness situations. Therefore, it is critical to address both the timing of project phasing and the ways various physical scales of projects – small to large – are unified under a single vision, mission, and purpose. Nesting smaller projects within broader plans offers opportunities for more financially nimble, "shovel-ready" projects to quickly move forward while projects requiring longer development, review, and award timelines can simultaneously process in the background.

COMMUNICATING

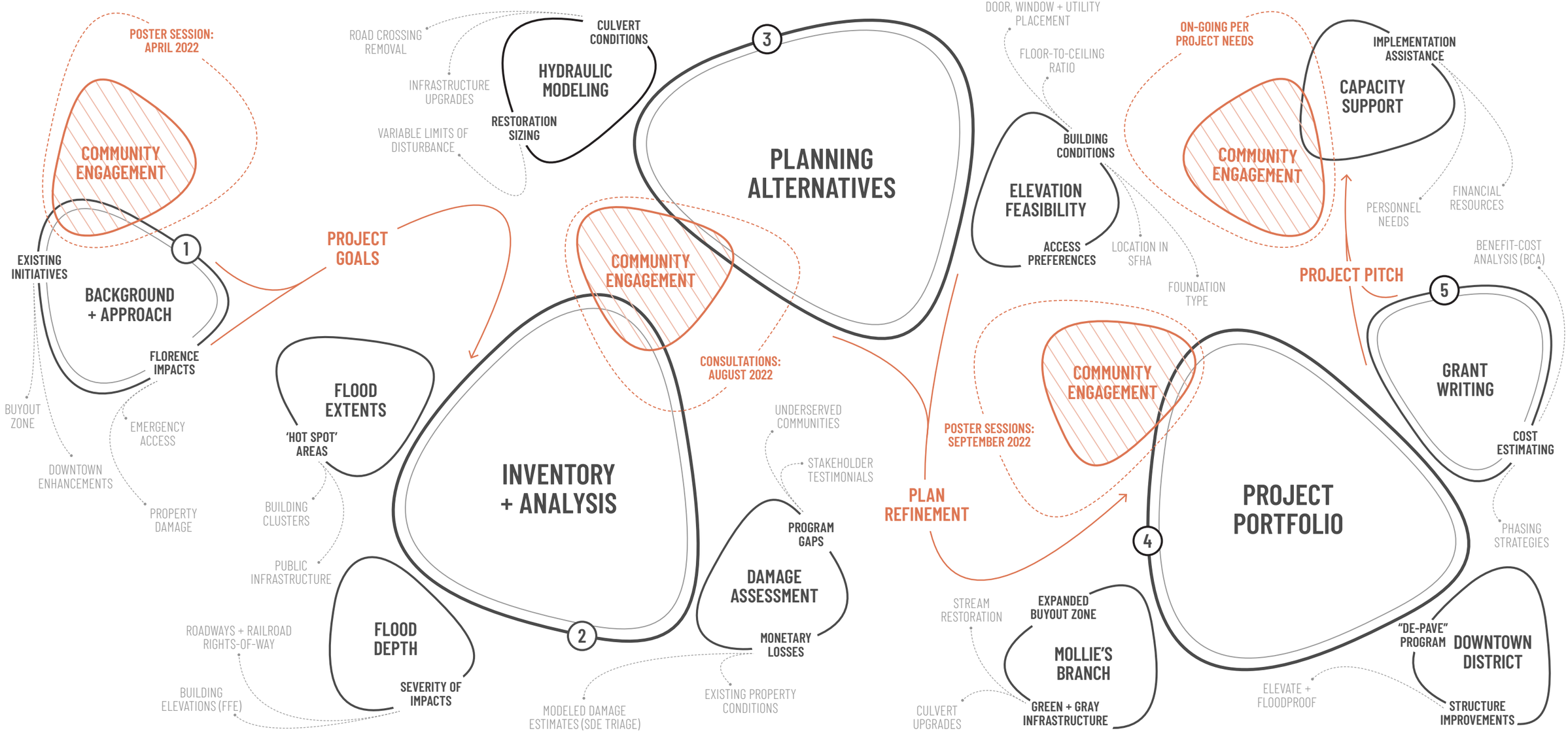
Create Collateral. It is typically the responsibility of local governments to assemble the required materials for grant applications. While larger municipalities are more likely to have either the internal personnel or available financial resources to hire consultants for this purpose, smaller units of governments are less likely to have access to these critical resources. In an effort to equalize the competitiveness of communities like Whiteville, the final documentation package of a Floodprint report is intentionally curated to serve as collateral for local government staff to submit to specific grant programs.

IMPLEMENTING

Close Capacity Gaps. If any combination of proposed Floodprint projects are to receive funding for implementation, specific capacity limitations must be well understood in order to ensure projects are successfully constructed and sustained. A local government's ability to: manage and administer concurrent grant agreements, coordinate with technical expertise before and during construction, and to maintain new infrastructure post-construction is highly variable community to community. Acknowledging each community's capacity ceilings during the creation of a Floodprint report allows for the advanced planning of project types, scopes of work, implementation teams, and maintenance plans that address specific gaps in local capacity.

As part of the CDDL grant agreement with the North Carolina Office of Recovery and Resiliency (NCORR), these strategies are being assembled in a Floodprint report specific to Whiteville, at no direct cost to the City or its residents.

Photo. Princeville (NC) workshop (CDDL, 2017).



PROJECT APPROACH

While the goals of a Floodprint study are uniquely defined by each community, the Floodprint process has important methodological consistencies across communities that include: i) inventory and analysis; ii) community outreach and engagement; iii) hydraulic modeling; iv) schematic planning and design; v) three-dimensional modeling / photorealistic rendering; vi) benefit-cost analysis; and vii) grant-writing. As in each precedent Floodprint report, the Whiteville Floodprint process was guided by communicated project goals from local leadership and attention to focus areas that emerged during the early phases of due diligence. Once these parameters were established, the aforementioned methodologies were used to develop the portfolio of projects and overall recommendations included in the Whiteville Floodprint.

While deviations from the proposed Floodprint projects are expected to occur as local conditions and priorities shift, it is the aspiration of each Floodprint plan to serve as a guiding framework for recovery and rebuilding across a range of scales (e.g., county, city/town, neighborhood, individual), and timeframes (e.g., immediate versus long-term).

CHAPTER
02

INVENTORY + ANALYSIS

Various modes of data collection, analysis, and community engagement were all used throughout the Whiteville Floodprint project timeline in order to more holistically understand the existing conditions, context, and characteristics of the city, its people, and the environment. Items assessed include topics such as: the flood vulnerability of buildings and infrastructure, community demographics, and municipal capacity.

Findings from these initial assessments were confirmed and more acutely framed after the first public engagement session with local stakeholders. This feedback alongside subsequent follow-up actions established the basis for prioritizing neighborhoods in need of additional planning recommendations and potential policy actions that can adequately respond to the emergent community needs.

VULNERABILITY ASSESSMENT: METHODS OVERVIEW

Flood Vulnerability: Columbus County. Flood prone buildings and parcels in Columbus County were identified using a series of spatial selections in ArcGiS Pro, illustrated and described below.

First, the "Select by Location" geoprocessing tool was used to identify buildings (converted to points) in Columbus County that intersected with the Special Flood Hazard Area (SFHA). The selection was refined by eliminating any structures with a tax value of $0 and the remaining structures were exported as a new layer.

Second, high-risk parcels were identified using the "Select by Location" geoprocessing tool to select all Columbus County parcels containing flood prone buildings identified in Step One. Similar to Step One, this selection was further refined by eliminating parcels not containing any structures (according to Columbus County tax records) and the remaining parcels were exported as a new layer. Results of this analysis indicated a total of 775 parcels containing flood-prone buildings.

Flood Vulnerability: Flood Depth. To better understand depth and extent of flooding impacts from various storm intensities, flood depth rasters were created for the 10-, 25-, 50-, 100-, and 500-year flood events in Whiteville and the surrounding areas. Water surface elevation (WSE) rasters for each of the flood events, downloaded from North Carolina's Flood Risk Information System (FRIS), were the primary data source for this analysis. In this dataset, WSE values are presented as elevation above sea level and were translated to flood depth above ground level through the following process:

Using the Raster Calculator in ArcGIS Pro, a 5-meter digital elevation model (DEM) (NC Spatial Data Download), representing the ground surface elevation of the study area, was subtracted from the WSE and repeated for each of the five flood events. The resulting rasters delineated the spatial extent as well as flood depth above ground level for each event.

Flood Vulnerability: Flood Extents & Preliminary Estimate of Damages. While there are over two-hundred structures in Whiteville that are located within the 500-year floodplain, there are many additional factors that must be considered in order to determine the severity of flood risk germane to each individual building. In order to determine this risk on a structure-by-structure basis, this study performed the following analysis:

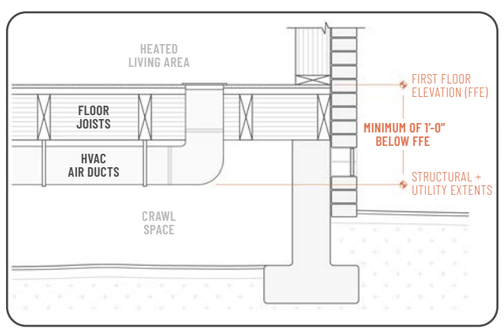
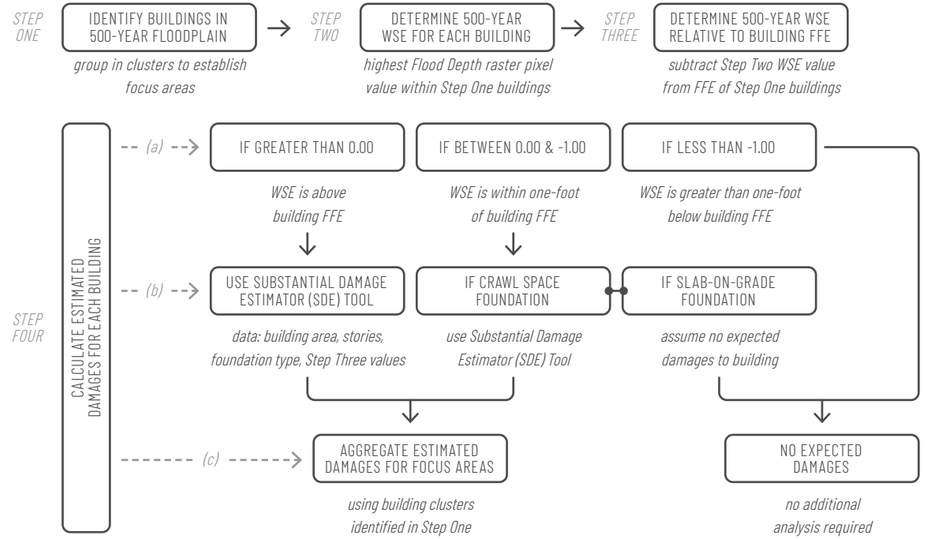
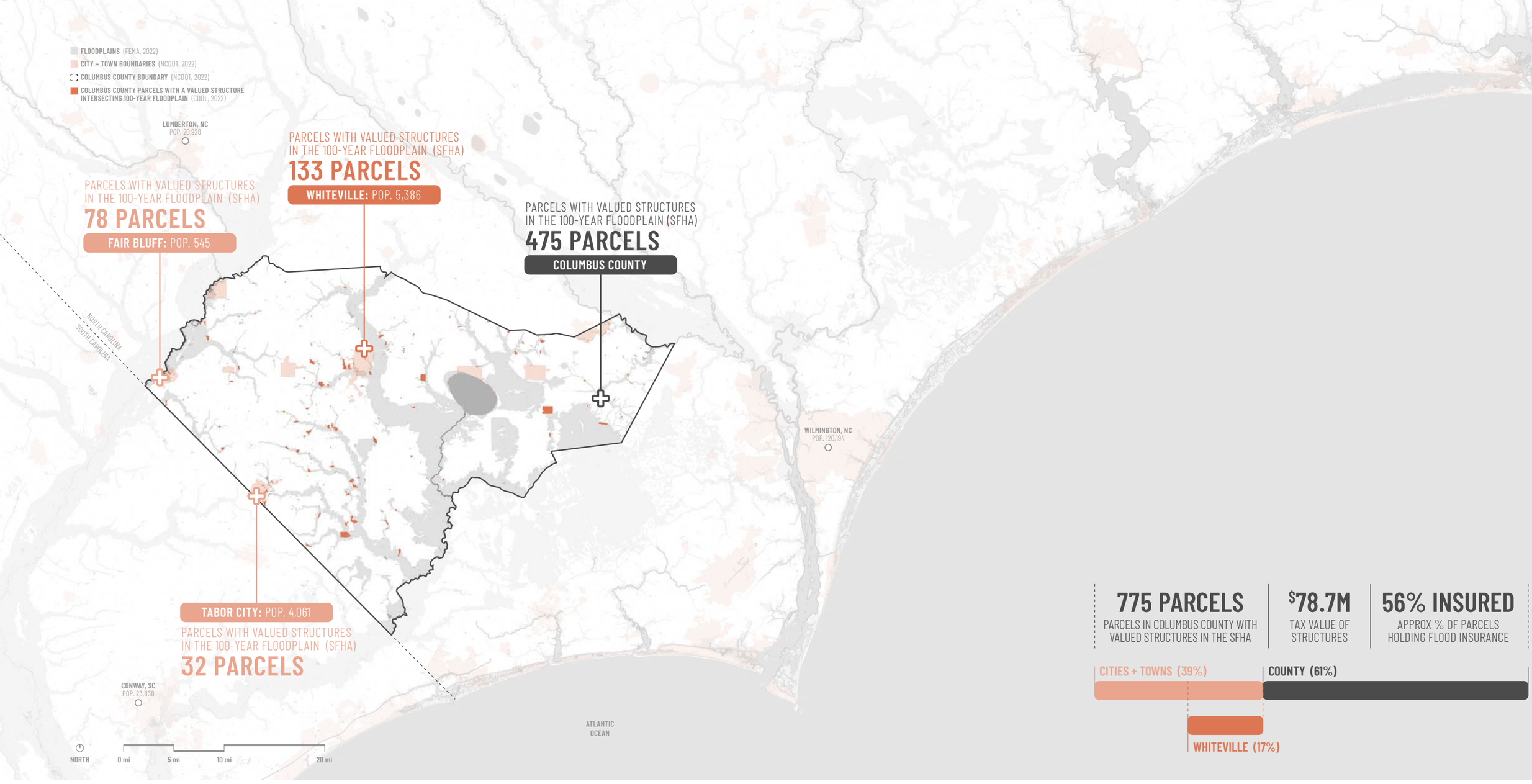


Figure. Typical house crawl space with flood damage considerations noted.

First, using GIS data, the value for each building's First Floor Elevation (FFE) was subtracted from its Lowest Adjacent Grade (LAG) in order to determine the first floor's highest elevation above the surrounding ground plane. Second, using the flood depth raster image created as a result of the hydraulic analysis, the pixel with the highest Water Surface Elevation (WSE) of flood depth above the ground plane intersecting the perimeter of each building was selected for a 500-year flood event. Third, subtracting the FFE height above the LAG from the highest 500-year flood depth value established the vertical relationship between FFE and the 500-year WSE. Structures with associated 500-year WSE's that were either: i) above the FFE; or ii) within 1.00-feet of the FFE and were noted as having a crawl space foundation, were noted as being susceptible to damage during a 500-year flood event.





COLUMBUS COUNTY: AT-RISK STRUCTURES

This assessment identified parcels with tax-valued structures intersecting the FEMA 100-year floodplain (also known as "Special Flood Hazard Area," or "SFHA"). Findings illustrate a geographic correlation between flood vulnerability and riverine adjacency across the region, where many of the most at-risk parcels are either along the main stems or associated tributaries of the Lumber and Waccamaw Rivers. The 966 buildings (775 parcels) in Columbus County fitting this criteria represent an improved tax value of over $78.7M that are most vulnerable to flood damage during a 100-year flood event. However, the 2020 update to the Bladen, Columbus, Robeson Regional Hazard Mitigation Plan indicates only 56% of these properties (n = 436) are currently covered by active flood insurance policies (Regional HMP, 2020). This condition leaves many residents of Columbus County susceptible to extreme financial hardship when major flooding occurs, and establishes a heavy reliance on state and local officials to successfully administer challenging, and often slow, public programs (e.g., "Hazard Mitigation Grant Program," or "HMGP") in order to mitigate property losses. These trends are most acutely observed in Whiteville, where there are only 76 active NFIP policies (Regional HMP, 2020) despite having the largest concentration of flood-prone structures in Columbus County (173 parcels; 17% of the total).

FLOOD DEPTH: TRANSPORTATION VULNERABILITIES

Most notable from a city-scale analysis of flood depth is the prevalence of roadways and railroad rights-of-way effectively acting as levees during severe flood events (e.g., 500-year flood; shown in the provided map). As illustrated below, this is typically due to at least one of two conditions that are present within these transportation corridors: i) added fill material and/or modified earthen embankments used to elevate roadways above baseline flood elevations that do not allow for the passage of floodwater across wide swathes of floodplain lands; and ii) inadequate quantities and/or sizes of pipes and culverts that do not allow for enough volume of water to pass through designed openings within these earthen embankments. Four locations around the periphery of Whiteville most substantially illustrate these conditions at the city-scale lens:

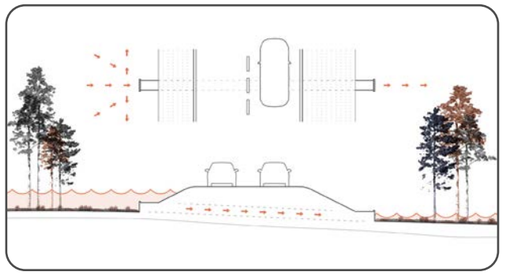


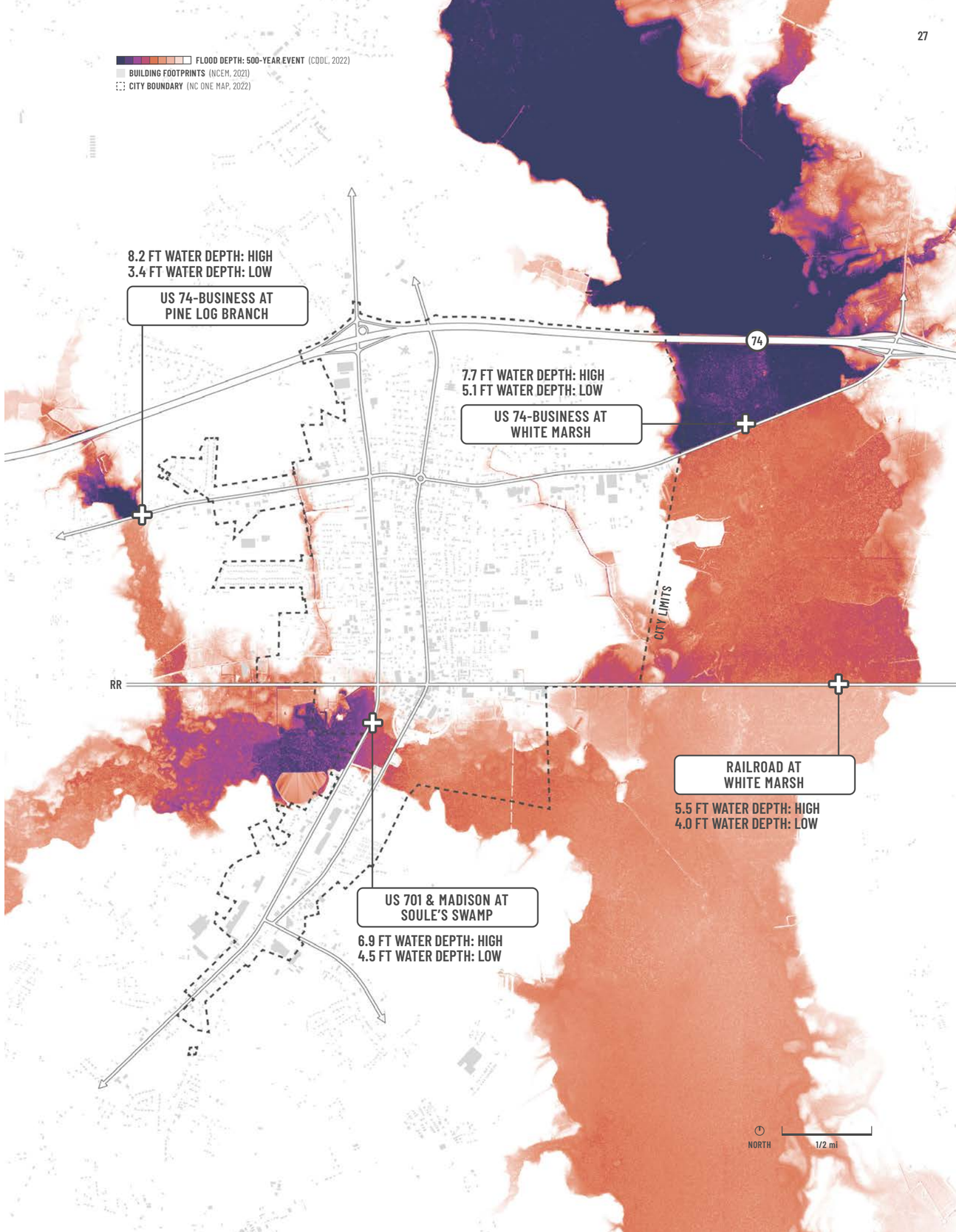
Figure. Typical profile of roadway with embankment and undersized culvert.

US-74 Business at Pine Log Branch; US-74 Business along White Marsh; the Railroad along White Marsh; and at US-701 and Madison Street along Soule's Swamp. The differences in floodwater depth from the high-side to the low-side of these rights-of-way range from 1.5-feet to 4.8-feet across these locations, where under natural conditions, the difference in water depth would be nearly indistinguishable (close to zero) across these distances.

Earthen embankments and undersized culvert conditions has established a pattern of transportation corridors acting as levees during severe flood events. While this is most notable in discrete locations at the city-scale of study, it serves as an indicator to also analyze these conditions in smaller, more localized contexts.

These conditions can be problematic during times of severe flooding because it causes water to back up on the headwater/high-side of the embankments which can push water out into areas that would not otherwise flood, and if in the event that the rights-of-way are overtopped by floodwaters, a greater volume of floodwater would be traveling downstream at higher velocities than what would otherwise naturally occur.

While this pattern is observed most notably in discrete locations at this scale of analysis, it serves as an indicator that these conditions may also exist at more localized scales where similar conditions (e.g., undersized culverts at intersections of roads and stream channels) may be impeding the flow of water, particularly during severe flood events.



FLOOD EXTENTS: INTERSECTING BUILDING CLUSTERS

While the extents of Hurricane Florence reached far beyond the boundaries of FEMA-designated floodplains in Whiteville, an assessment of locations where there are groupings of buildings, structures, and properties that intersect the 500-year floodplain was used to establish preliminary areas within

Locations with concentrated groupings of buildings intersecting the 500-year floodplain served as preliminary focus areas requiring more in-depth analysis of expected flood damages.

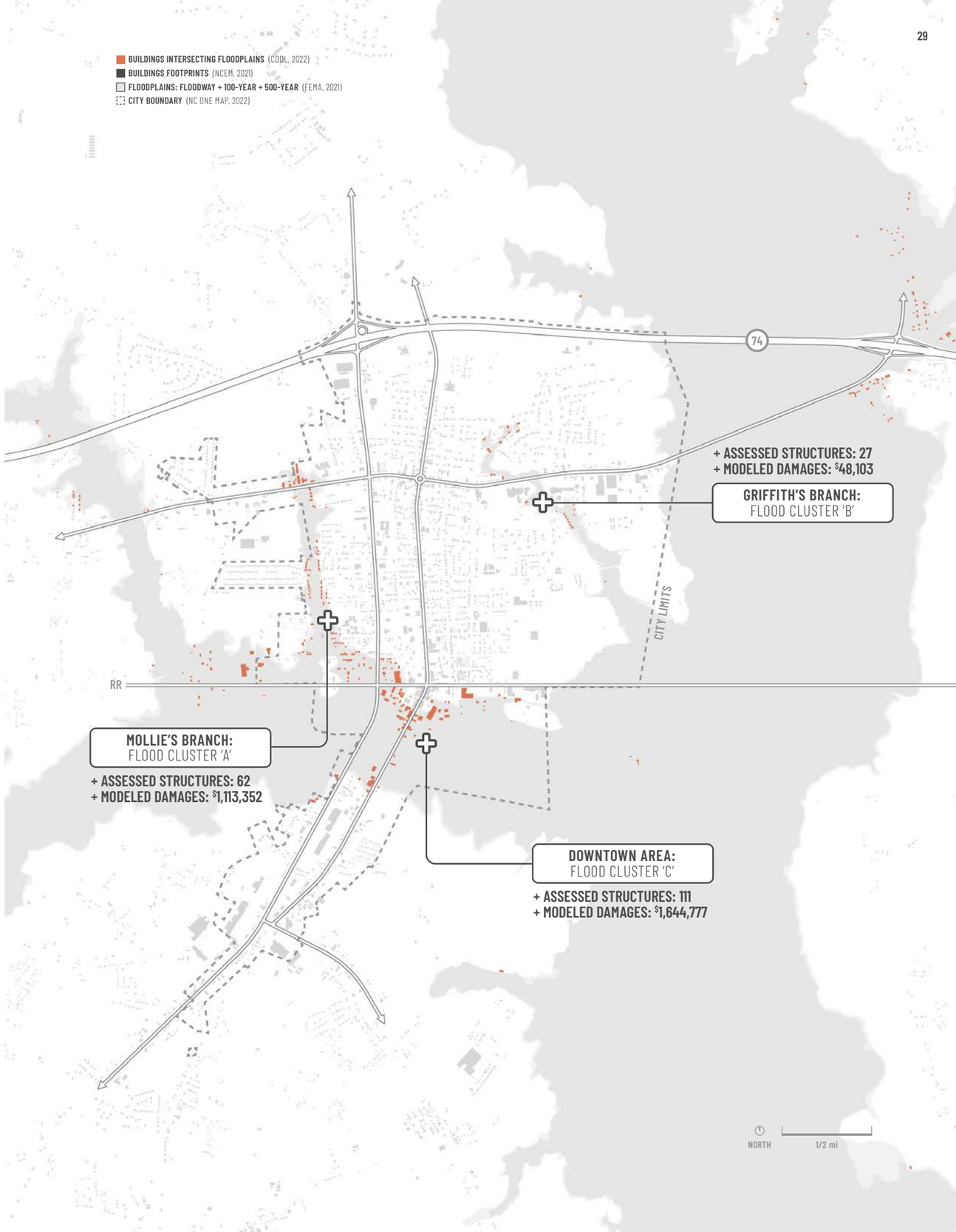
Whiteville's city limits that may constitute deeper levels of analysis as a dedicated "focus area." Three building clusters have been initially identified, with brief descriptions of each surrounding neighborhood provided below:

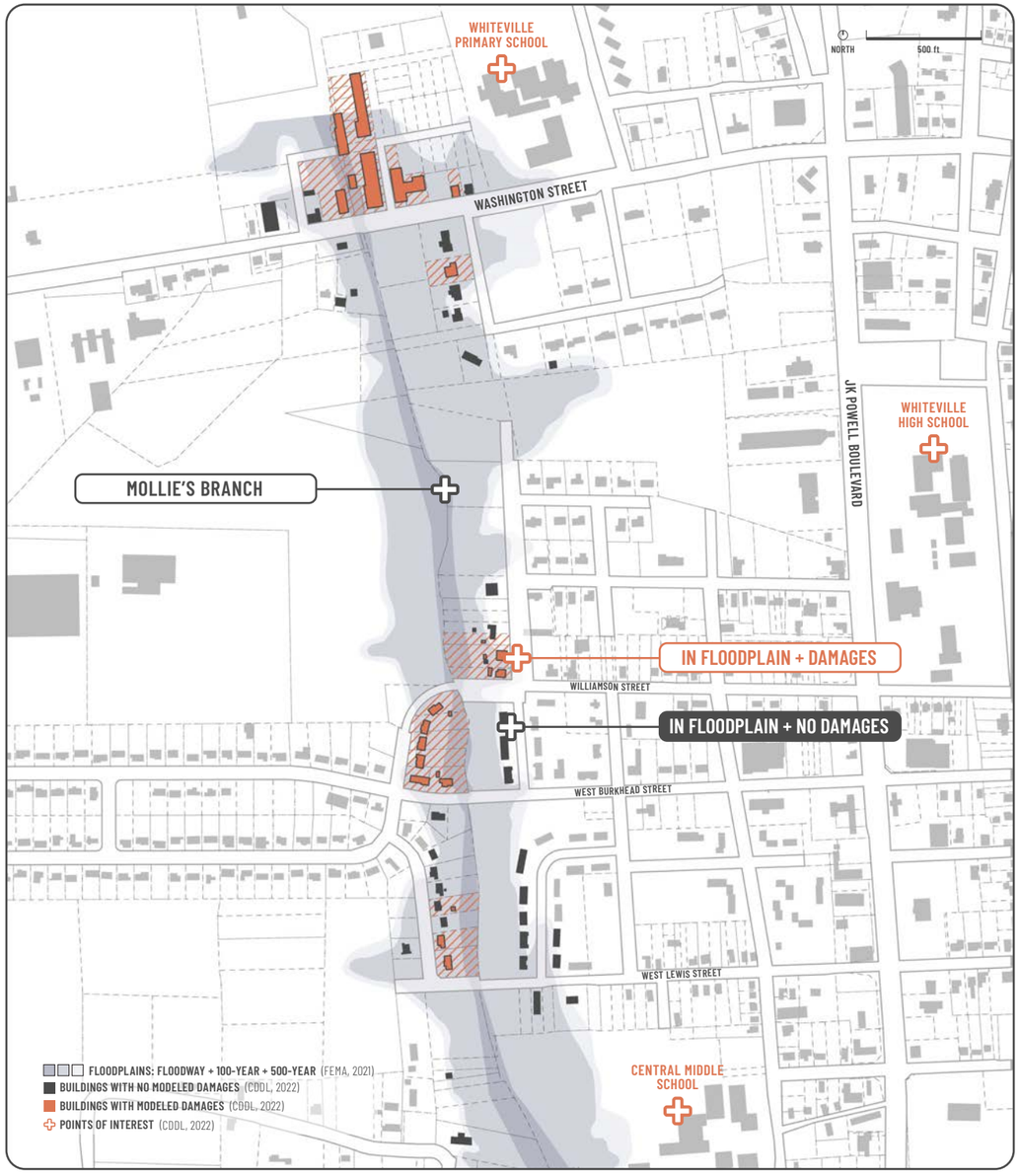
Enlargement 'A': Mollie's Branch. Most of the residential buildings within the Mollie's Branch study area consist of single-family, single-story homes built in the 1970s. Generally, most of these homes are 1-2 feet above grade with crawl spaces, and sit on relatively flat lots. There are additional residential units in this study area that are multi-family and owned by the Whiteville Housing Authority, and there is a cluster of commercial / industrial-use buildings toward the northern extents of the study area. The commercial / industrial buildings primarily consist of slab-on-grade foundations.

Enlargement 'B': Griffith's Branch. The vast majority of buildings in the Griffith's Branch study area are single-family, residential-use that were built between the 1970s and 1990s. Compared to residential structures in Mollie's Branch, the first floor elevation (FFE) height above the adjacent grade was more variable, with most of these homes being between 2-5 feet above grade (with a crawl space), on relatively flat lots. Additionally auxiliary structures immediately to the south of the Columbus Regional Hospital, and several manufactured homes are also within this study area, though these were not the dominant structure condition observed.

Enlargement 'C': Downtown + Soule's Swamp. Existing building conditions in the Downtown + Soule's Swamp study area were the most variable of the three enlargement zones analyzed. Many of the commercial buildings nearest the Central Business District (CBD) were constructed between the 1940s and 1950s, however, many of the outlier structures that appear to be largely industrial-use were built more recently. Of the buildings assessed, many of them consist of slab-on-grade foundations, meaning that floodwaters would need to breach the first floor elevation (FFE) in order to cause damages to the structure.

While not included in the flood-risk assessment, there are several blocks of buildings in between JK Powell Boulevard and Mollie's Branch that are within a designated 'buyout zone' – currently being administered by the North Carolina Office of Recovery and Resiliency (NCORR). Eligible property owners within this buyout zone are currently being given the option to sell their property and relocate to safer land. Purchased properties within the buyout zone will subsequently be demolished, cleared, and must be permanently maintained as open green space by the local government. Because of the large number of vacated and expected-to-be demolished structures within this buyout zone, these structures were not included as part of this analysis.





ESTIMATED DAMAGES

MODELED 500-YEAR FLOOD EVENT

62 (#) STRUCTURES ASSESSED

24 (#) STRUCTURES WITH DAMAGES

38% (%) STRUCTURES WITH DAMAGES

$1,113,352 ($) PROJECTED DAMAGES TO STRUCTURES DURING A MODELED 500-YEAR FLOOD EVENT

MOLLIE'S BRANCH: ENLARGEMENT AREA 'A'

Sixty-two (62) structures were assessed as intersecting the 500-year floodplain of Mollie's Branch along the stretch of stream spanning from Whiteville Primary School (north) to Central Middle School (south). Of these 62 structures, twenty-four (24) were identified as likely to be damaged during a 500-year flood event with associated damages projected to be near $1,113,352 across the 24 structures. The distribution and severity of these damages were shown to be in two distinct categories, however: commercial/industrial and residential.

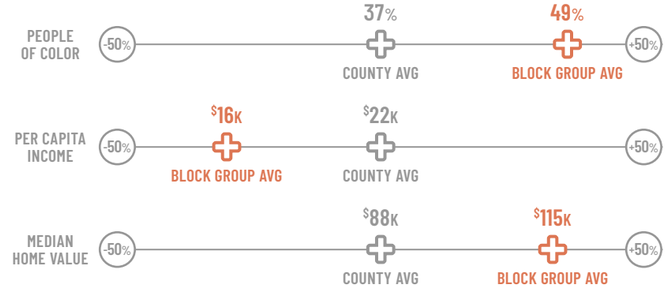
The highest projected dollar-amount of damages are associated with the cluster of commercial and industrial buildings just to the north of Washington Street (US-74 Business) along Mollie's Branch, where 500-year floodwaters are modeled to be higher than the FFE of many of these building, and due to the large heated square footage areas of these buildings, the SDE Triage tool used for equating flood depth to dollar estimates in damages, calculated high figures for expected damages.

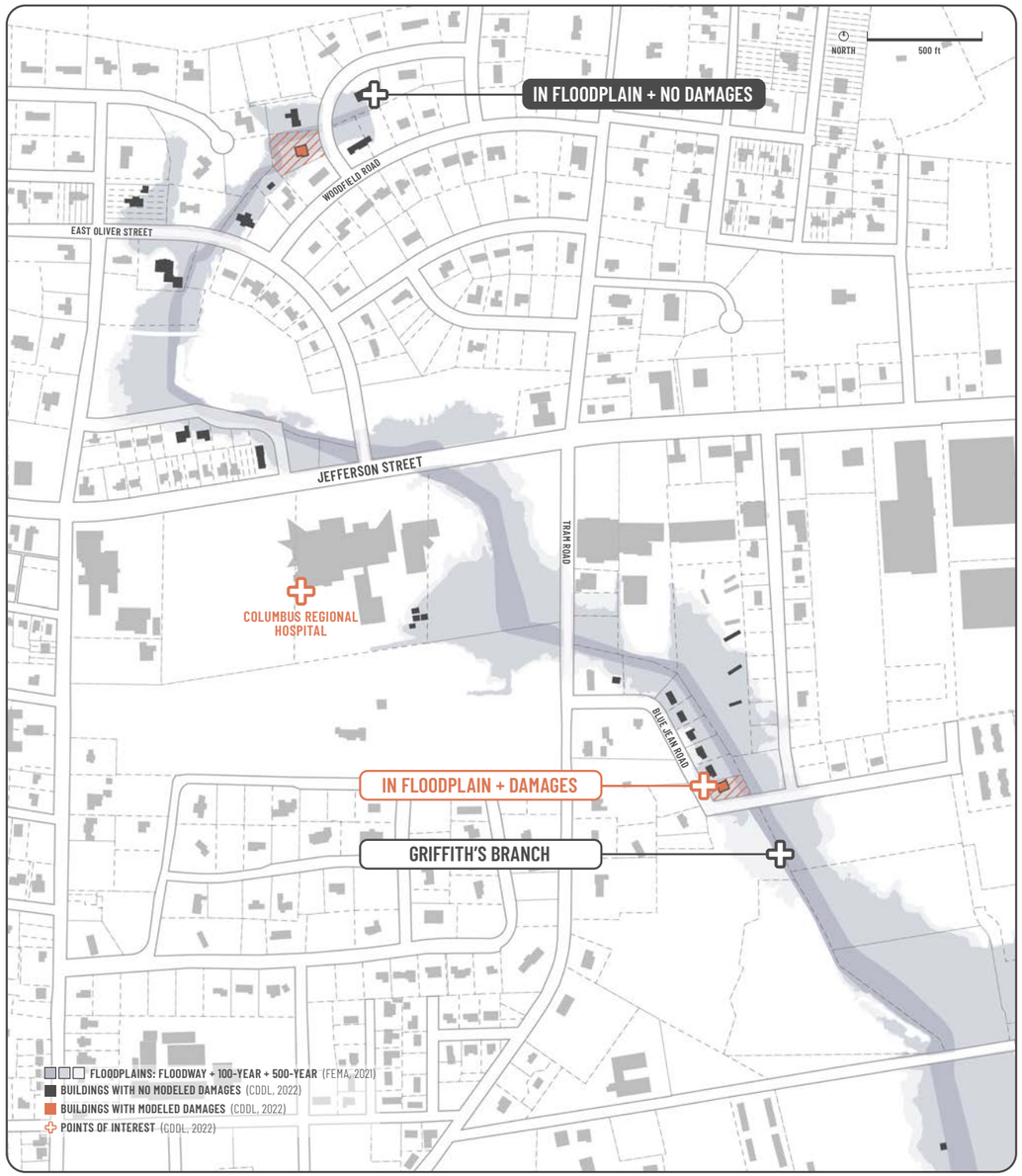
For the residential buildings assessed, largely concentrated between Williamson Street and West Lewis Street, modeling shows that many of the structures are likely to receive floodwaters that enter the crawl space and get near, but would not overtop, the FFE during a 500-year flood event. While these damages are typically lower in overall dollar amount to repair (typically requiring repairs to items such as insulation, HVAC air ducts, floor joists, electrical wiring, etc.), the cost of materials and services may be prohibitive to homeowners without active flood insurance policies.

These flood risks are paired with a demographic profile for the U.S. Census Bureau Block Groups intersecting the Mollie's Branch Enlargement Area that present the following environmental justice concerns:

A racial makeup that includes more People of Color (49%) than the Columbus County average (37%); a Per Capita Income (approx. $16,000) that is below the Columbus County average ($22,000); and a Median Home Value ($115,000) that while above the Columbus County average ($88,000), is nearly half of the Median Home Value for more affluent areas in Whiteville.

DEMOGRAPHIC PROFILE
INTERSECTING BLOCK GROUPS





ESTIMATED DAMAGES

MODELED 500-YEAR FLOOD EVENT

27 (#) STRUCTURES ASSESSED

2 (#) STRUCTURES WITH DAMAGES

7% (%) STRUCTURES WITH DAMAGES

$48,103 ($) PROJECTED DAMAGES TO STRUCTURES DURING A MODELED 500-YEAR FLOOD EVENT

GRIFFITH'S BRANCH: ENLARGEMENT AREA 'B'

Twenty-seven (27) structures were assessed as intersecting the 500-year floodplain of Griffith's Branch along the stretch of stream spanning from Woodfield Road (north) to City of Whiteville Recreation Center off Nolan Avenue (south). Of these 27 structures, only two (2) were identified as likely to be damaged during a 500-year flood event with associated damages projected to be near $48,103 across the 2 structures.

There were not any spatial clusters or land use types that correlated with any larger patterns of flood risks within this Enlargement Area. Compared to the Mollie's Branch Enlargement Area, many of the structures along Griffith's Branch were observed as having FFE's that were higher above their associated LAG's. This foundation condition, along with lower relative 500-year WSE along Griffith's Branch, creates a condition where many properties in this Enlargement Area may observe floodwaters within open areas of land, but damages affecting the structural and/or utility components of buildings would likely be minimal.

In addition to the low quantity (7%) of buildings projected to receive damages during a 500-year event, the 2 buildings were damages are projected are both "crawl-space only" flood conditions, where the WSE of a 500-year flood are not expected to breach the FFE of either of the two buildings.

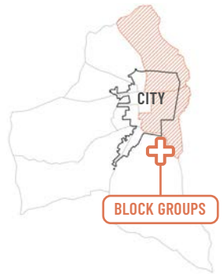
These minimal flood risks are also paired with a demographic profile for the U.S. Census Bureau Block Groups intersecting the Griffith's Branch Enlargement Area:

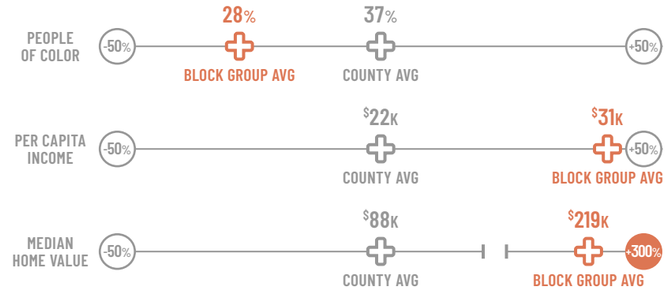
A racial makeup that includes fewer People of Color (28%) than the Columbus County average (37%); a Per Capita Income (approx. $31,000) that is above the Columbus County average ($22,000); and a Median Home Value ($219,000) that is above the Columbus County average ($88,000).

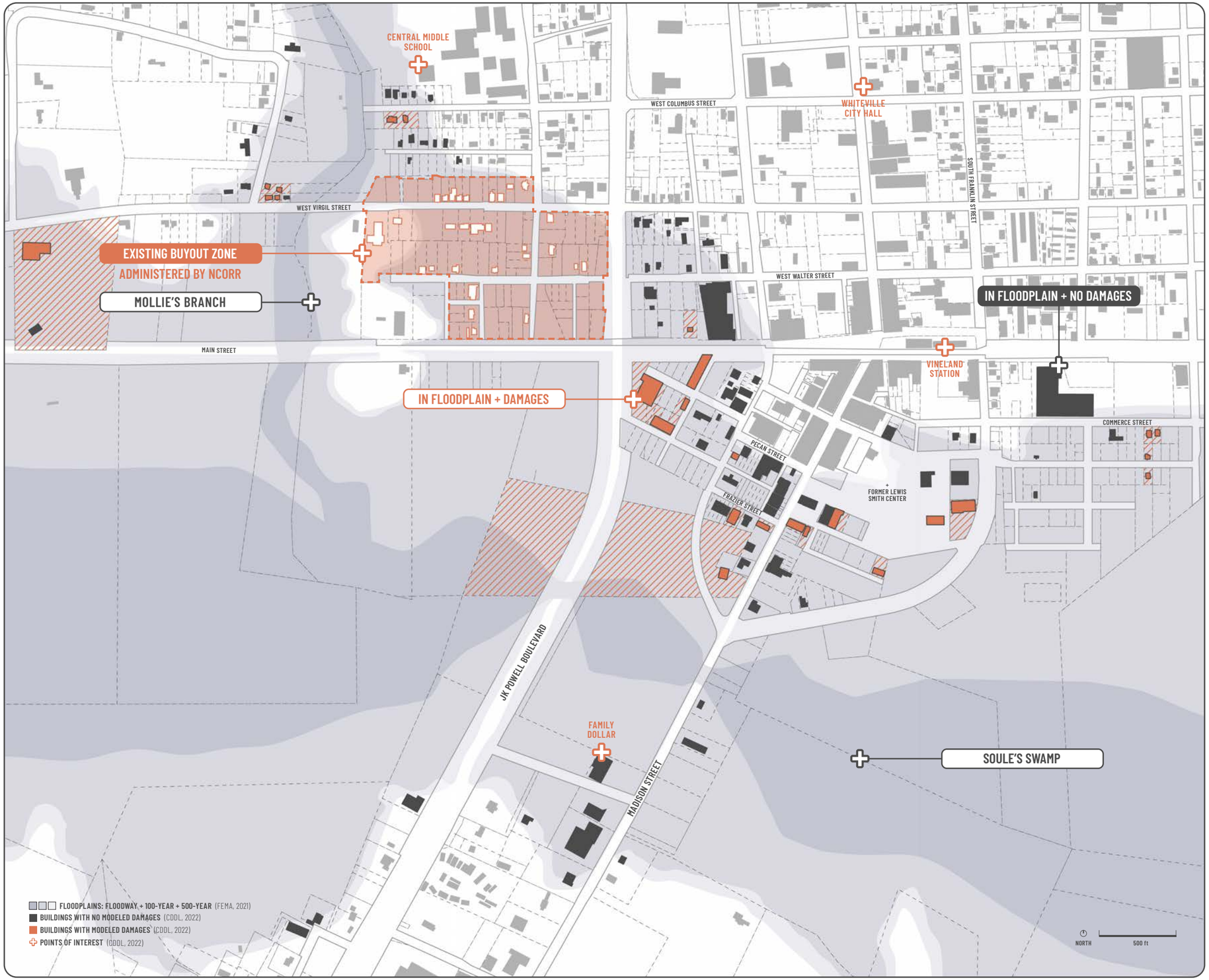
The only demographic characteristic assessed in this Enlargement Area that presents potentially more vulnerable conditions during flood event is the percent of the population with an average age over 65 (25%), which is more than the Columbus County average (19%).

DEMOGRAPHIC PROFILE

INTERSECTING BLOCK GROUPS







DOWNTOWN + SOULE'S SWAMP: ENLARGEMENT AREA 'C'

Whiteville's downtown area hosts a wide array of locally-owned restaurants and shops, as well as residences. The restored Vineland Station, originally a railroad depot, serves as the City's civic center, and the State of North Carolina has designated the City of Whiteville as a NC Main Street Community.

However, elevated flood stages from Soule's Swamp frequently threaten properties, business operations, and vehicular / pedestrian traffic in the area.

DOWNTOWN + SOULE'S SWAMP: ENLARGEMENT AREA 'C' (CONT'D)

One-hundred eleven (111) structures were assessed as intersecting the 500-year floodplain with the Downtown + Soule's Swamp study area, which spans from Central Middle School (north) to Talbot Street (south). Of these 111 structures, twenty-five (25) were identified as likely to be damaged during a 500-year flood event with associated damages projected to be near $1,644,777 across the 25 structures. The highest projected dollar-amount of damages are associated with several of the industrial-use complexes near the intersection of JK Powell Boulevard and Main Street, and near the western extent of the study area off of Virgil Street.

While there are other commercial- and residential-use buildings within the Enlargement Area that are also expected to receive damages from a 500-year event based on this study's hydraulic modeling, the industrial complexes – due to their size, land use, and location within the floodplain, present the potential for hazardous materials and contaminants to enter the floodway during extreme weather events, and also are more likely to equate to elevated costs of repairs to damages to be incurred by the private landowners.

Since many of the buildings within this study area are slab-on-grade foundation types, most of the calculated damages would result from floodwaters breaching the first floor elevation (FFE) – causing damages to the interior, heated living space of the buildings. Only two (2) of the 25 structures that were modeled to receive damages were shown to have damages explicitly within the crawl space / utility zone (within one foot of the FFE).

These flood risks are paired with a demographic profile for the U.S. Census Bureau Block Groups intersecting the Downtown + Soule's Swamp Enlargement Area that present the following environmental justice concerns: A racial makeup that includes more People of Color (50%) than the Columbus County average (37%); a Per Capita Income (approx. $18,000) that is below the Columbus County average ($22,000); and a Median Home Value ($111,000) that while above the Columbus County average ($88,000), is nearly half of the Median Home Value for more affluent areas in Whiteville.

> "Over two-dozen buildings in the downtown area of Whiteville are projected to sustain damages during a modeled 500-year flood event, which is less severe than Hurricane Florence."

ESTIMATED DAMAGES

MODELED 500-YEAR FLOOD EVENT

111 (#) STRUCTURES ASSESSED

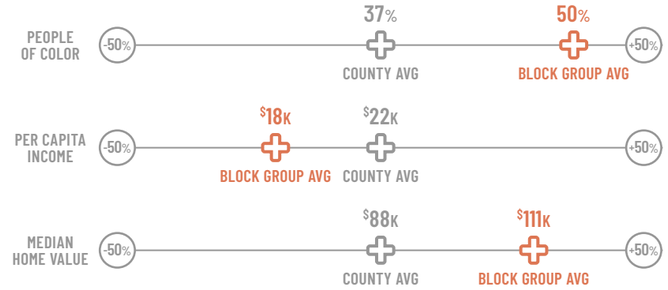
25 (#) STRUCTURES WITH DAMAGES

22% (%) STRUCTURES WITH DAMAGES

$1,644,777 ($) PROJECTED DAMAGES TO STRUCTURES DURING A MODELED 500-YEAR FLOOD EVENT

DEMOGRAPHIC PROFILE

INTERSECTING BLOCK GROUPS



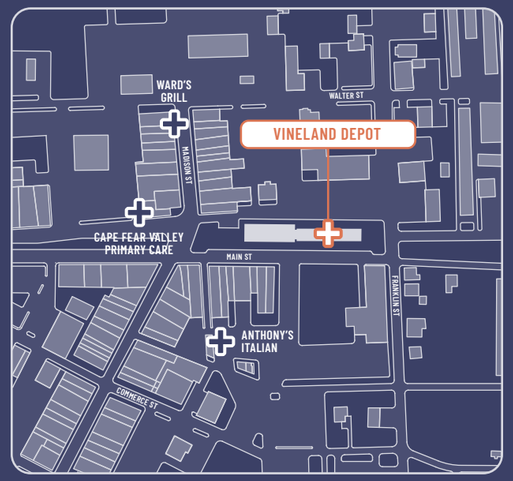
PUBLIC ENGAGEMENT #1

APRIL 2022

CITY-SCALE LISTENING SESSION

+ Format, Setup, and Goals: During these initial listening sessions with residents, area stakeholders, agency partners, representatives from the CDDL and project partners from the CIty presented findings from initial analyses and asked respondents to interact with posters and personnel through voting mechanisms and series of open-ended questions. Activities focused on listening to resident needs, wants, issues, and opportunities relating to flood recovery, and sharing mitigation options that may be available to them. The activities conducted in the first community meeting focused on listening to residents. The objective was to gain an understanding of neighborhood needs, wants, issues, and opportunities related to current recovery and acquisition processes, as well as creation and care of future green spaces. Most specifically, the project team led interactive activities to gather feedback on: i) community needs and opportunities most important for flood recovery and rebuilding purposes, ii) areas in Whiteville where chronic flooding along roadways is problematic, iii) residential areas in Whiteville where chronic flooding is prevalent, iv) preferences for allowable land uses implemented within the properties that participate in a buyout program administered by NCORR, and v) on-going projects and initiatives within the most flood-prone areas of downtown.

"Engagement activities focused on listening to stakeholder needs, wants, issues, and opportunities relating to flood recovery, and sharing mitigation options that may be available to them."



Key Map. Public Engagement Location: Columbus County DREAM Center.

This meeting was structured to facilitate conversations between neighborhood residents, area stakeholders, and the project team. Workshop materials focused on the topics of community life, existing challenges, and future desires. The project team guided and documented these conversations through an interactive poster display that guided feedback. By the end of the workshop, all community participants had the opportunity to voice their opinions on the aforementioned topics as they relate to the City's changing landscape.

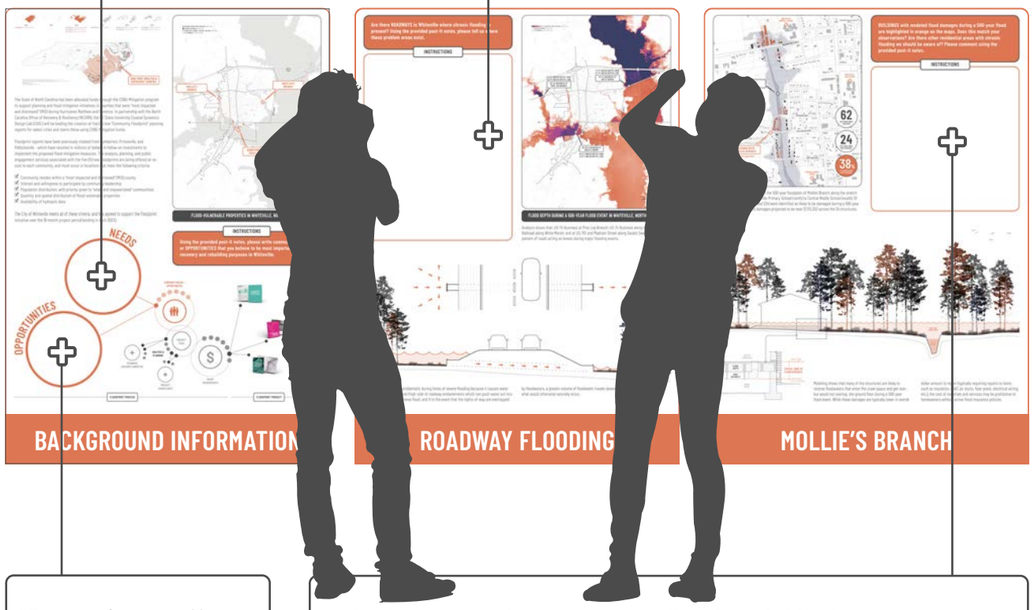
Photo. Whiteville Floodprint public engagement event (CDDL, 2022).

NEEDS

"Ensure that residents of the impacted areas are heard."... "Increased open space where existing development is located."... "Increased retention areas."

CHRONIC FLOODING: ROADS

"Downtown near Chef & Frog, Ward's Grill, etc."..."300 Block of E. Oliver St."..."200 Block of E. College St."..."300 Block of E. Main St."... "701 Bypass at bridge"..."600 Block of W. Franklin St."...



"**Ecotourism** in affected areas near downtown."

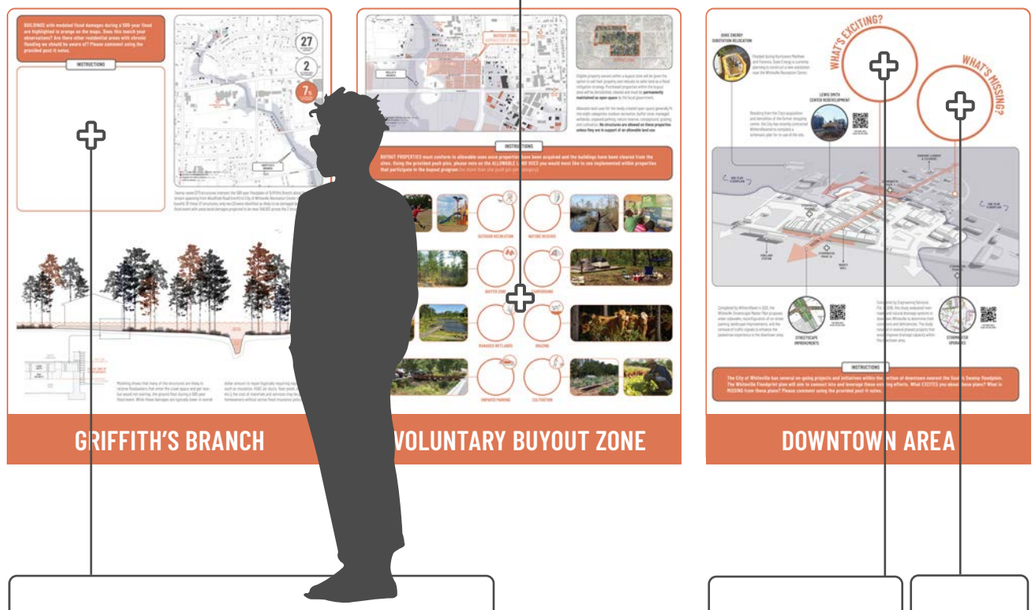
OPPORTUNITIES

"Our home experiences extreme flooding, 18-20" of rain during down pours. We would like to be considered for a buyout or extreme restoration."

CHRONIC FLOODING: HOMES

ALLOWABLE LAND USE PREFERENCES

MANAGED WETLANDS	NATURE RESERVE	CULTIVATION	BUFFER ZONE	OUTDOOR RECREATION	CAMPGROUND	UNPAVED PARKING	GRAZING
17 VOTES	17 VOTES	10 VOTES	8 VOTES	8 VOTES	1 VOTES	1 VOTES	0 VOTES



"Increased construction and new roads have **increased flooding concerns."**

CHRONIC FLOODING: HOMES

"There will be an actual plan."

WHAT'S EXCITING

"Action!"

WHAT'S MISSING

WHAT WE HEARD

+ Overall Findings and Feedback: The community shared that the modeled scenarios matched the lived experience of flooding in Whiteville. They identified the need to include all City residents with communication and education efforts, with a special emphasis on working directly with residents in the impacted areas. The community expressed a need for safe, open space. Suggestions were shared on how to enhance the stormwater drainage, including increasing retention areas and paying special attention to drainage and outlets. Residents saw opportunities in employing a regionally connected design approach that leveraged newly created open space for potential ecotourism opportunities.

Participants expressed excitement about the analysis and planning efforts that will result in the creation and implementation of a forward-looking comprehensive framework for the City of Whiteville.

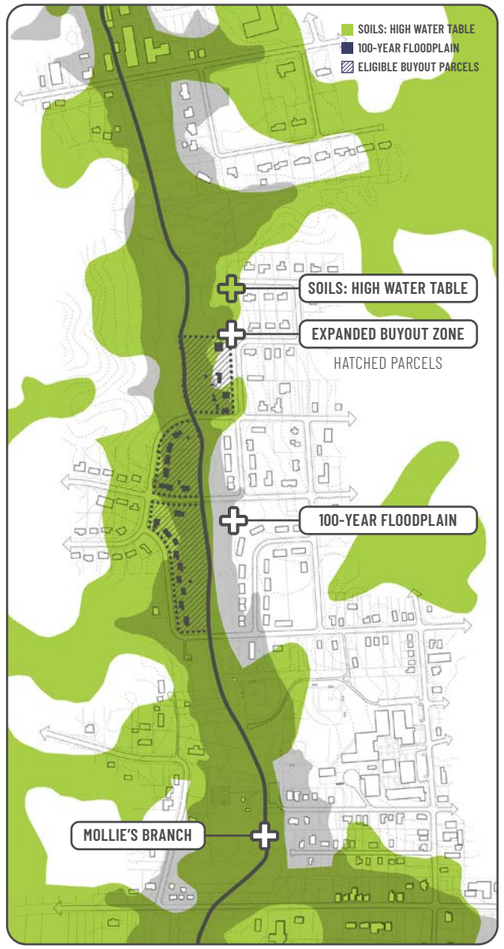
FOLLOW UP ACTIONS

Initial analyses and stakeholder feedback during the first public engagement event confirmed Mollie's Branch and the downtown Central Business District as the top two priority areas for further analysis, planning, and future project recommendations as part of the Whiteville Floodprint.

Mollie's Branch: Stream Restoration + Expanded Buyout Zone Program. The need for expanded flood mitigation offerings in the neighborhood surrounding Mollie's Branch was expressed by multiple stakeholders who participated in the first public engagement event (April 2022). Specifically, testimonies (including photo and video evidence) of flooding on properties, in roadways, and around the foundations of homes was stated to happen during even more commonplace, unnamed storm events -- both within and outside of the floodplain.

This feedback prompted additional analysis, as it was clear that flooding issues are being compounded by factors other than the stream channel over-topping it's banks. This follow-up analysis revealed that many residents around Mollie's Branch own property characterized as "not suitable for dwellings" (USDA, 2022) due to high water tables in the soil profile -- expected to be between 0-12 inches beneath the ground surface. The dominant soil type in the area fitting this description is listed as: Meggett Fine Sandy Loam ('Me').

Structures placed in soils with elevated water tables can lead to unstable foundation conditions around the base of homes. More specifically, during times when the water table may already be elevated (saturated), this can cause severe ponding -- observed significantly above the ground surface -- during subsequent rainfall events. Impassable and dangerous road conditions, and damage to crawl spaces (including home foundations, flooring / floor joists, HVAC systems, surrounding landscape, etc.) on a frequent basis was noted by stakeholders during the first public engagement. Geographically, these descriptions of property damage match with the aforementioned soil condition (green) more so than the demarcated floodplain boundary (gray). In total, there was now a body of evidence established that illustrates elevated levels of flood vulnerability for specific areas around Mollie's Branch.



Key Map. Soils with a Water Table 0-12 inches Beneath the Surface (USDA, 2022).

In response, the project team began assessing various combinations of stream restoration techniques, infrastructure improvements, and public programs in effort to reduce future flood losses in this area. While initial analysis conducted via hydraulic modeling revealed that significant flood reduction benefits could be realized by utilizing nature-based and culvert-focused upgrades, the threat of floodwaters – particularly during larger storm events (e.g., 500-year) – was still present for many homeowners. As such, the CDDL, City, and NCORR used the aforementioned vulnerability data and findings to: i) determine additional clusters of properties most vulnerable to flood damages; and ii) identify properties to include within an expanded 'buyout zone'. The twenty-five (25) parcels indicated on the key map generally meet the following criteria:

+ the greatest risk of receiving property damage (due to expected flood depths relative to first floor elevations)
+ are within the 100-year floodplain
+ are most likely to have high water tables in the soil profile
+ are contiguously connected along the stream channel

Initial analyses and stakeholder feedback during the first public engagement event confirmed Mollie's Branch and the downtown Central Business District as the top two priority areas for further analysis, planning, and future project recommendations as part of the Whiteville Floodprint.

Photo. Field measurements as part of the elevation assessment (CDDL, 2022).

Downtown: Elevation Assessment + "De-Pave" Program. It was also evident during the April 2022 engagement event that more precise, building-by-building recommendations for potential interior retrofits / elevations and floodproofing were needed in order for property owners to better understand available mitigation options. As such, team members from the CDDL and staff from the City conducted field measurements for buildings that are in both the Central Business District (CBD) and Special Flood Hazard Area (SFHA; 100-year floodplain) in May 2022 so that more precise recommendations for each address could be determined.

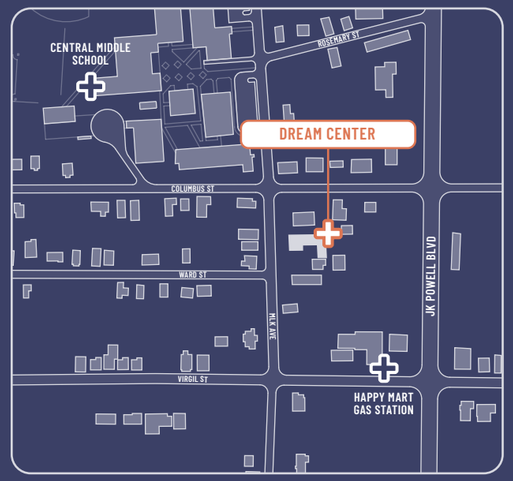
Additionally, April 2022 stakeholder testimonial of "nuisance flooding" in the roadways and outside businesses — believed to be, in part, due to large swathes of impervious surface, also prompted the exploration of programs and/or constructed interventions that may be able to combat more everyday flooding and ponding in the downtown area.

PUBLIC ENGAGEMENT #2
AUGUST 2022

MOLLIE'S BRANCH: VOLUNTARY BUYOUT ZONE EXPANSION

Residents within the expanded buyout zone were provided an opportunity to meet with team members in August 2022 to introduce NCORR's Strategic Buyout Program via one-on-one consultations. In addition to informing residents of the new mitigation offering that would become available to them, these meetings provided an opportunity for homeowners to consider their personal positions toward a buyout prior to an upcoming public engagement event (September 2022) where the expanded buyout zone would be discussed in a more public format and setting.

These one-on-one consultations offered residents within an expanded buyout zone the opportunity to learn more about program prior to a more public-facing event in September 2022, where the boundaries of the expanded buyout area would be visually represented.



Key Map. Public Engagement Location: Columbus County DREAM Center.

+ Format, Setup, and Goals: Prior to hosting the consultation-focused event, door-hangers were printed and placed on the front doors of each of the twenty-five (25) homes being included in the expanded buyout zone. The door-hangers included: a brief explanation of the buyout program, and the date, time, as well as the location of the consultation event at the Dream Center.

Advertised as a "drop-in" style event, residents were able to come to the Dream Center during a range of available evening hours, where staff from the City and CDDL met with attendees. Stakeholders that attended were presented with: i) the data, analysis, and first-hand testimonials of property damages that ultimately led to the expansion of buyouts being offered to include the area around Mollie's Branch; and ii) specific details, provided by NCORR (as the program administrator), regarding: fair market value, timeline expectations, and supplemental benefits of the buyout program.

The goals of this event were met, as the majority of properties within the expanded buyout zone were represented during the event, and homeowners were able to ask specific questions about the program prior to the information being displayed more publicly.

Photo. Whiteville Floodprint public engagement event (CDDL, 2022).

CHAPTER
03

PROJECT PORTFOLIO + ALTERNATIVES ASSESSMENT

Multiple planning alternatives within each of this study's primary focus areas are included in this section of the report. The Mollie's Branch focus area includes two different stream restoration and infrastructure conditions ('Scenarios A + B') that served as the basis for: i) public feedback; ii) hydraulic modeling; and iii) plan refinement exercises that ultimately yielded a third design condition ('Scenario C'). Scenario C was further assessed via hydraulic modeling and benefit-cost analysis. The second focus area includes findings from the elevation and floodproofing feasibility assessment, and also presents how these mitigation recommendations can be blended with a broader "de-pave" program throughout the Central Business District.

Collectively, these scenarios and alternatives presented for Mollie's Branch and the Downtown Core study areas were used as part of multiple neighborhood-scale public engagements in Whiteville, where feedback from stakeholders was considered as part of an iterative revision process to create final recommendations for each location.

STREAM RESTORATION + INFRASTRUCTURE IMPROVEMENTS

MOLLIE'S BRANCH

PUBLIC ENGAGEMENT #3 (A)

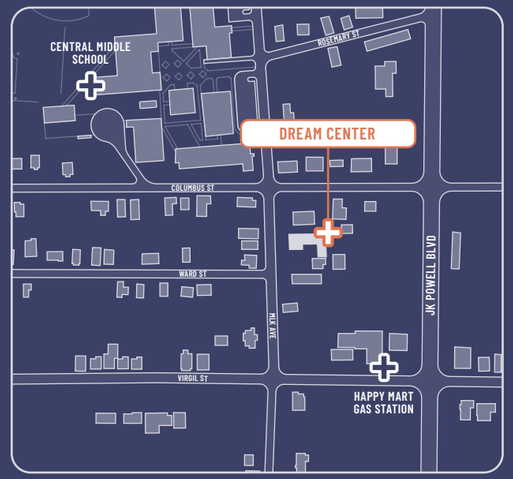
SEPTEMBER 2022

MOLLIE'S BRANCH: HYDRAULIC MODELING + PLAN ALTERNATIVES

Also hosted at the DREAM Center (in the same neighborhood as the Mollie's Branch project area), this engagement event focused on getting feedback from first-hand stakeholders regarding their preferences for various stream restoration and infrastructure improvement scenarios being presented to them.

This event ask first-hand stakeholders around Mollie's Branch to vote on their preferences for various stream restoration alternatives (60-foot versus 100-foot width) and infrastructure conditions (e.g., road crossing removal versus upgraded culvert) modeled to improve flooding severity in the neighborhood.

Posters that were on display presented: i) previously completed analysis; ii) outlined how feedback during this event would be used in plan refinement processes; and iii) provided details as to the hydraulic performance and efficacy of the various restoration width (60-foot versus 100-foot) and infrastructure changes (e.g., road crossing removal versus culvert upgrade) alternatives that were displayed across various plan-view scenarios ("Existing Conditions," "Scenario A," and "Scenario B").



Key Map. Public Engagement Location: Columbus County DREAM Center.

Representatives from the City, CDDL, NC State University Department of Biological and Agricultural Engineering (responsible for the hydraulic modeling scope of the project) and NCORR were all present to engage with stakeholders during the event.

During the engagement session, attendees were asked to place push-pins (as a voting mechanism) on the various stream restoration and infrastructure improvement conditions that they preferred. The results from these voting exercises were then used by the project team as part of an iterative process to ultimately arrive at a single, preferred alternative for Mollie's Branch: 'Scenario C.'

Photo: Whiteville Floodprint public engagement event (CDDL, 2022).

EXISTING CONDITIONS

Mollie's Branch is a stream located within the Lumber River Basin (HUC-4), Waccamaw Subbasin (HUC-8), White Marsh Watershed (HUC-10), and Lower Soule's Swamp Subwatershed (HUC-12).

"Mollie's Branch is a heavily modified stream channel that has been straightened and entrenched, enabling surrounding development to take place (e.g., housing and roadways). Water flows are now constricted to narrow ditches, and much of the supporting infrastructure are outdated and undersized."

Mollie's Branch is classified by the NC Division of Water Resources (DWR) as Class C, which means that it supports aquatic life, secondary contact recreation, and freshwater. This classification indicates that the stream is protected for uses such as aquatic life propagation, survival and maintenance of biological integrity, wildlife, agriculture, and recreation activities not involving (or infrequently involving) human body contact with water. Mollie's Branch also carries the DWR supplemental classification as "swamp waters," which recognizes its natural characteristics of low velocity, dissolved oxygen, or pH. In its current state, Mollie's Branch presents a heavily modified stream channel that has been straightened and entrenched – enabling surrounding development to take place (e.g., housing and roadways). Water flows are now constricted to narrow ditches, and much of the supporting infrastructure (i.e., pipes and culverts) are outdated and undersized.

Overall, this is a significant divergence from the more naturalized "swamp waters" condition that would otherwise exist, and has resulted in the loss of floodplain capacity within and around the stream. As heavy rainfall events become more frequent, many of the properties and public infrastructure adjacent to Mollie's Branch are becoming increasingly susceptible to recurring flood damage – commonly manifested by roads that overtop and lower portions of buildings being damaged.

The potential for expanded flood mitigation alternatives for approximately 5,100 linear feet of Mollie's Branch from Washington Street (north) to Virgil Street (south) was assessed through geospatial analysis and hydraulic modeling, and was vetted by resident stakeholders and local leadership in attempt to determine a cost-effective solution for reducing water surface elevations (WSE) during heavy rainfall events.

Mollie's Branch: Existing Stream Condition.

Map. Existing Conditions Map (Aerial Imagery: NC CGIA, 2023).

Washington Street:
Existing Culvert Condition

Williamson Street:
Existing Culvert Condition

Burkhead Street:
Existing Culvert Condition

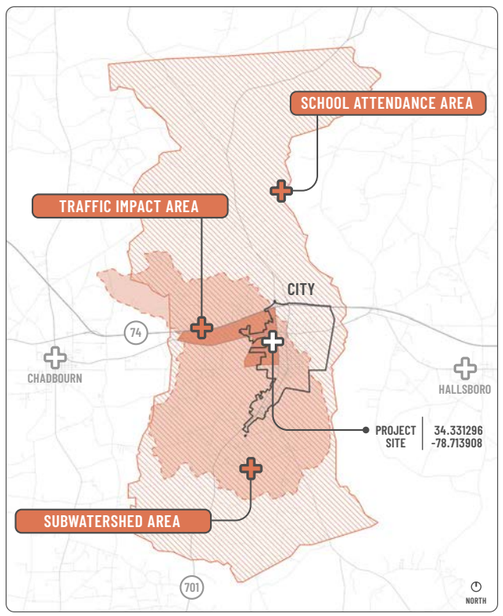
Lewis Street:
Existing Culvert Condition

West Whiteville Park:
Existing Pedestrian Bridge

POTENTIAL IMPACT + BENEFITING AREA

Populations expected to benefit from this project are those that would be directly impacted by: i) reductions in the severity of future flood events on their property; ii) reductions in the frequency of roadways being overtopped by floodwaters; and iii) the social and ecological benefits provided by the nature-based improvements.

Populations expected to see these direct day-to-day benefits are spatially representative of parcels that either intersect the anticipated limits-of-work boundary, or are shown to have reductions in water surface elevation during flooding events (based on the results of hydraulic modeling analyses that have been completed). The **Project Benefiting Area** encompasses an approximately 15.07 acre area, and includes forty-one (41) single-family residential units, forty-eight (48) multi-family residential units (Whiteville Housing Authority), nine (9) businesses, and four (4) public / private entities (Central Middle School, North Whiteville Academy, T.W. Apostolic Church, and a City of Whiteville Pump Station).



Map. Project Impact Area (Vehicular + Watershed + School District).

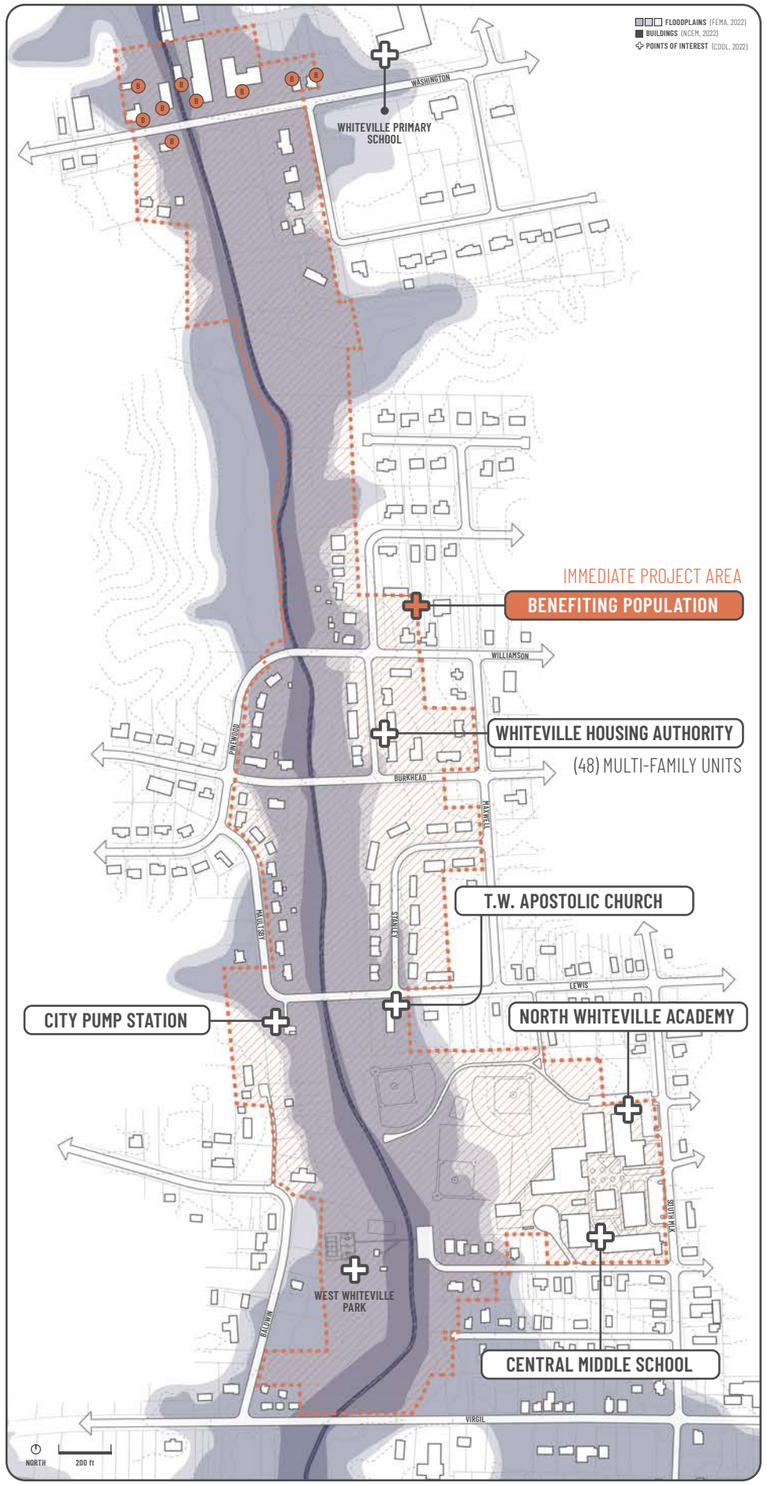
The **Project Impact Area** constitutes three geographic areas defined by environmental and social characteristics of the project that overlap and extend beyond the Project Benefiting Area. Collectively, these areas encompass the entire municipal boundary of the City of Whiteville, meaning the project is expected to yield city-wide benefits. These areas include:

+ Lower Soule's Swamp Subwatershed Area. This data layer is representative of the 12-Digit HUC Subwatershed (North Carolina Department of Environmental Quality, 2022) that includes Mollie's Branch, and includes both upstream and downstream portions of the subwatershed from the proposed limits of work.

+ Traffic Impact Area. This data layer illustrates a buffer area around segments of roadway (North Carolina Department of Transportation, 2022) that are anticipated to be either: i) temporarily impacted during construction of the project (e.g., temporary re-routing of traffic); or ii) permanently impacted post-construction through increased safety and accessibility during flood events (North Carolina State University, 2022).

+ Central Middle School Attendance Area. This data layer represents the Unified School District area for Central Middle School (Columbus County, 2022). This area is included in the Project Impact Area because of the significant scope of work proposed on the Central Middle School property, and the anticipated ancillary benefits that nature-based solutions will have on the quality of recreational and educational amenities afforded to students during the projected useful life of the project (30 years, minimum). Central Middle School enrolls approximately 500 students per year, on average.

Map. Project Benefiting Area (on top of Floodplain Areas, FEMA 2022).



Quantity totals of households, public / private entities, and businesses that are anticipated to receive direct benefits from this project include:

HOUSEHOLDS: 89
+ (41) Single-Family Units
+ (48) Multi-Family Units
  - Whiteville Housing Authority

PUBLIC/PRIVATE ENTITIES: 4
+ Central Middle School
+ North Whiteville Academy
+ T.W. Apostolic Church of Christ
+ City of Whiteville Pump Station

BUSINESSES: 9
B = Businesses

FLOODING FREQUENCY

The proposed location of this project has been specifically identified because it correlates with areas in Whiteville modeled to receive damaging floodwaters on a frequent, recurring basis. Specifically, hydraulic analysis conducted for Mollie's Branch indicates that the even the extent of a 25-year flood event intersects at least thirty (30) buildings, and the expected flood height would overtop three (3) of the four (4) roadway crossings in the study area (Williamson, Burkhead, and Lewis streets).

The concentration of homes within the modeled flood extents of these smaller, more frequent storm events triggers elevated flood risks because most of the homes in this area have either slab-on-grade foundations, or the first floors are only 2-3 steps above the surrounding grade. These conditions lead to substantial property damages during commonplace storm events, and has been validated by stakeholder testimonials during multiple public engagement events as part of the Whiteville Floodprint effort. This neighborhood has suffered multiple catastrophic flood events in recent years (e.g., Hurricane Florence (2018) and Tropical Storm Hermine in 2022)), as well as numerous heavy rainfall events not affiliated with tropical systems (e.g., June 2020) that have caused substantial flooding.

> "Hydraulic analysis indicates that the extent of a 25-year flood event intersects with thirty (30) buildings, and the expected flood height would overtop three (3) of the four (4) roadway crossings in the study area (Williamson, Burkhead, and Lewis streets)."

Preliminary benefit-cost analyses that evaluated the anticipated cost of damages for each building calculated that a single, major storm event would likely result in an excess of $1.4M in property damages (buildings only). These figures do not include the additional monetary impacts and threats to public safety from roadways overtopping with floodwaters (accountable for approximately 8,000 daily vehicular trips, NCDOT, 2019), or the increased operating costs on governmental services to conduct water rescues in the area during major storm events.

SEPTEMBER 2018: Washington Street

Photo: Flooding along U.S. 74 / Washington St. during Hurricane Florence (image credit: Duke Energy).

JUNE 2020: Burkhead Street

Photo: Flooding near Burkhead St. during an unnamed storm event (image credit: The News Reporter).

SEPTEMBER 2022: Virgil Street

Photo: Flooding along Virgil St. during Tropical Storm Hermine (image credit: The News Reporter).

Map. Flooding Frequency Map.

LOW ELEVATION STRUCTURES

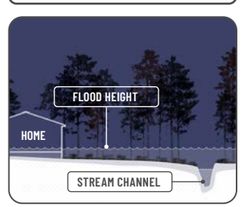


Diagram: Typical flood height relative to building first floor elevations for structures along Mollie's Branch.

PLAN ALTERNATIVES + PUBLIC ENGAGEMENT PROCESS

Recommendations included in the final concept design for Mollie's Branch considered: i) the causes of flooding within and around the project area; ii) the impacts of flooding in high-risk areas surrounding the stream; and iii) stakeholder preferences for various flood mitigation alternatives presented.

Multiple flood mitigation alternatives were presented to community stakeholders ("Existing Condition," "Scenario A," and Scenario B"). Elements from each alternative that received the most votes from stakeholders were combined with public comments to inform a single, revised schematic plan ("Scenario C").

As part of the public engagement process for the refinement of Mollie's Branch recommendations, multiple flood mitigation alternatives were presented to community stakeholders for review, comment, and push-pin voting ("Existing Condition," "Scenario A," and "Scenario B"). Primary features of each plan include:

+ "Existing Condition" Alternative: No Change to the present conditions.

+ "Scenario A" Alternative: Two-Stage Ditch (at a consistent 60-foot width; equal to the size of the existing stream width and City-maintained access easement) and Larger Culverts (at Washington, Williamson, Burkhead, and Lewis Streets; all road crossings remain).

+ "Scenario B" Alternative: Stream and Floodplain Restoration (variable width, typically between 60 and 100 feet, inclusive of properties within the Expanded Buyout Zone) + Road Crossing Modifications (upgraded culvert at Washington Street, removal of the road crossings at Williamson and Lewis Streets, and an upgraded bridge condition at Burkhead Street).

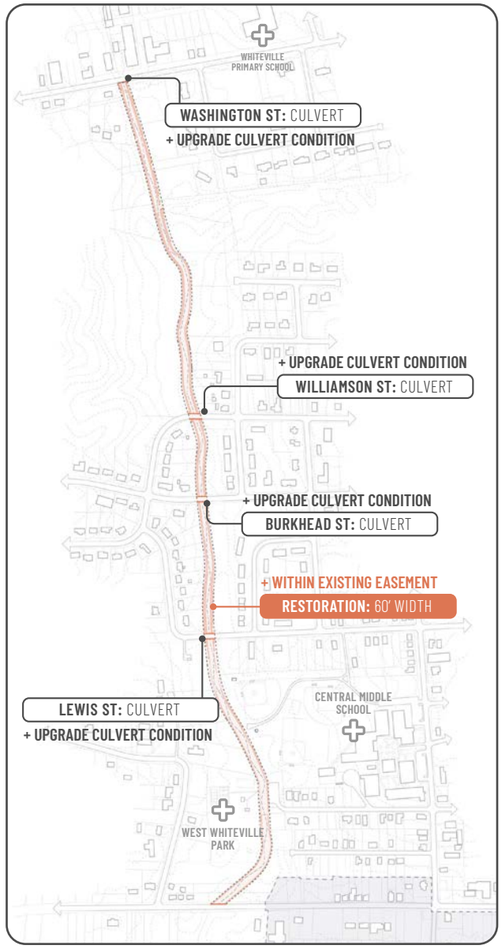
Hydraulic modeling for Scenarios A and B both showed substantial reductions in Water Surface Elevation (WSE) during smaller storm events (e.g., 10- and 25-year floods) compared to the Existing Condition, however, Scenario B offered greater flood protection during larger storm events (e.g., 50- and 100-year floods). Of the 46 votes recorded for the various elements in these scenarios during a September 2022 public engagement session, 67.3% (31 votes) were in support of the features presented in Scenario B.

Feedback received from stakeholders that preferred elements other than what was included in Scenario B primarily concerned the specific routing and width of the stream restoration component of the project at specific locations. Revisions to the alignment of the stream that directly address this feedback include: i) creating more buffer area between private properties and the proposed scope of work; and ii) removing any and all overlaps between the restoration scope of work and the Expanded Buyout Zone.

+ "Scenario C" Alternative: Stream and Floodplain Restoration + Road Crossing Modifications (same as Scenario B but with alterations to the stream alignment and limits-of-work boundary that reflect preferences expressed during public engagement activities).

In total, Scenario C features approximately 5,100 linear feet of floodplain restoration, four (4) roadway modifications, and an expanded area of restored floodplain area within the Central Middle School recreational complex. The Scenario C plan was then subsequently vetted for effectiveness via hydraulic modeling, benefit-cost analysis, and through additional opportunities for public feedback prior to the finalization of recommendations.

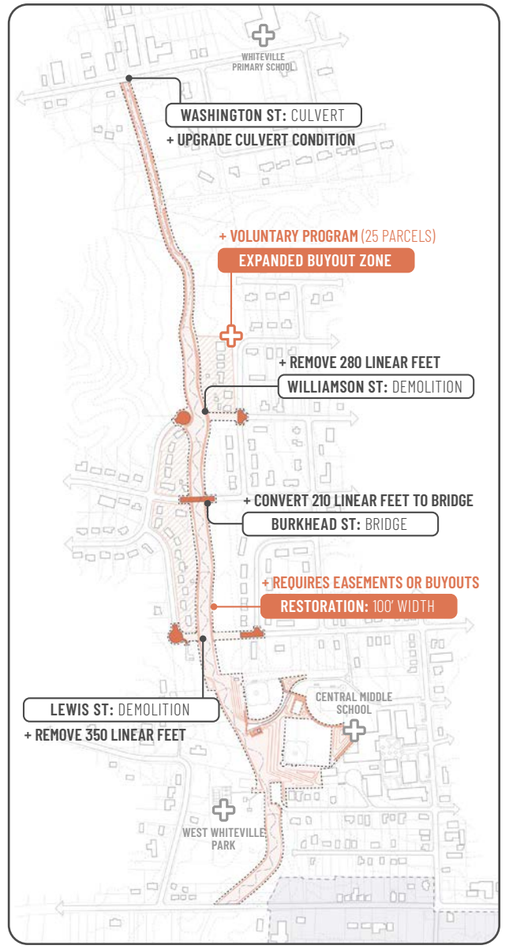
SCENARIO A
60-FOOT RESTORATION WIDTH + MODIFY ROAD CROSSINGS



15 VOTES (32.7%)

(#) VOTES RECEIVED:
SCENARIO 'A' DESIGN COMPONENTS

SCENARIO B
100-FOOT RESTORATION WIDTH + MODIFY ROAD CROSSINGS + BUYOUT ZONE



31 VOTES (67.3%)

(#) VOTES RECEIVED:
SCENARIO 'B' DESIGN COMPONENTS

FINAL SCHEMATIC PLAN: SCENARIO ‘C’

The specific combination of nature-based solutions and infrastructure improvements included in the Scenario C plan offers the greatest combination of modeled flood risk reduction and stakeholder support. As such, this proposal draws upon FEMA guidance (2021) for implementing several “watershed scale” practices (e.g., “floodplain restoration” and “stormwater park”) as part of an interconnected suite of nature-based solutions. The cumulative benefits of these practices are primarily intended to better control and manage floodwaters throughout the project area, but will also offer a wide breadth of ancillary benefits, such as: improving water quality, increasing the amount of available habitat for wildlife, and addressing existing inequities in access to recreational amenities. Furthermore, by upgrading roadway infrastructure and restoring a critical stretch of floodplain area to a more natural state, the proposed project offers a series of environmental and social benefits that stretch far beyond the immediate project area.

> “The cumulative benefits of these practices are primarily intended to better control and manage floodwaters, but will also offer a wide breadth of ancillary benefits, such as: improving water quality, increase available habitat, and addressing existing inequities in access to recreational amenities.””

Environmental Benefits. By improving stream sinuosity and increasing the total area of vegetated floodplain, this project will be able to: i) better capture and treat surrounding stormwater runoff; and ii) reduce excessive sediment and pollutant loads that exit Mollie’s Branch. Together, these project outcomes will help support a wide range of flora and fauna populations whose survival relies on the long-term protection of habitat in the Lumber River Basin.

Social Benefits. The project’s location also offers opportunities for recreational and educational enhancements that will benefit visitors of West Whiteville Park and the 500+ students and teachers who attend Central Middle School and North Whiteville Academy. The proposed schematic plan for Mollie’s Branch embeds various design elements, such as outdoor classrooms and trail networks, that will enrich existing amenities at the park while also expanding curricular offerings for current and future generations of students at the two schools.

Photo (#1): September 2022 Public Engagement Event

SCENARIO C

100-FOOT RESTORATION WIDTH + MODIFY ROAD CROSSINGS + BUYOUT ZONE (NON-CONTINGENT)

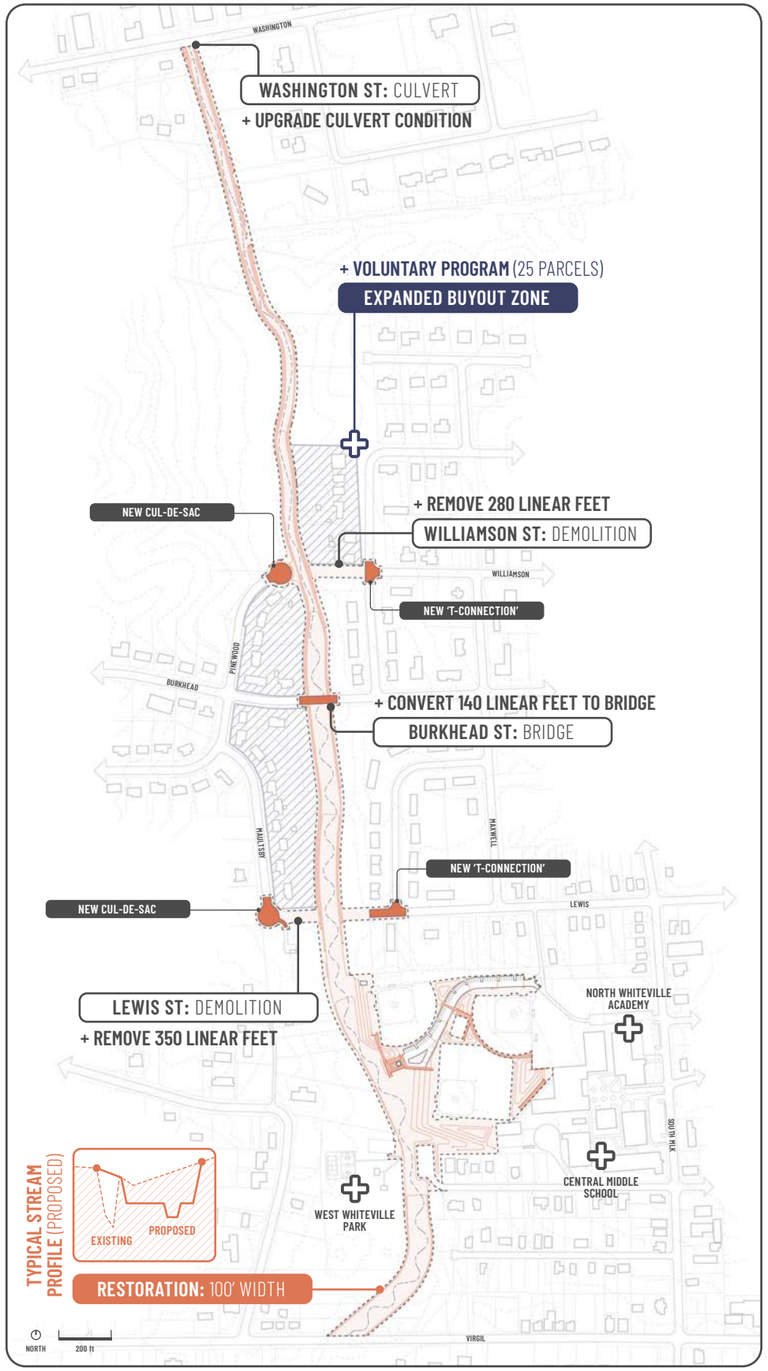
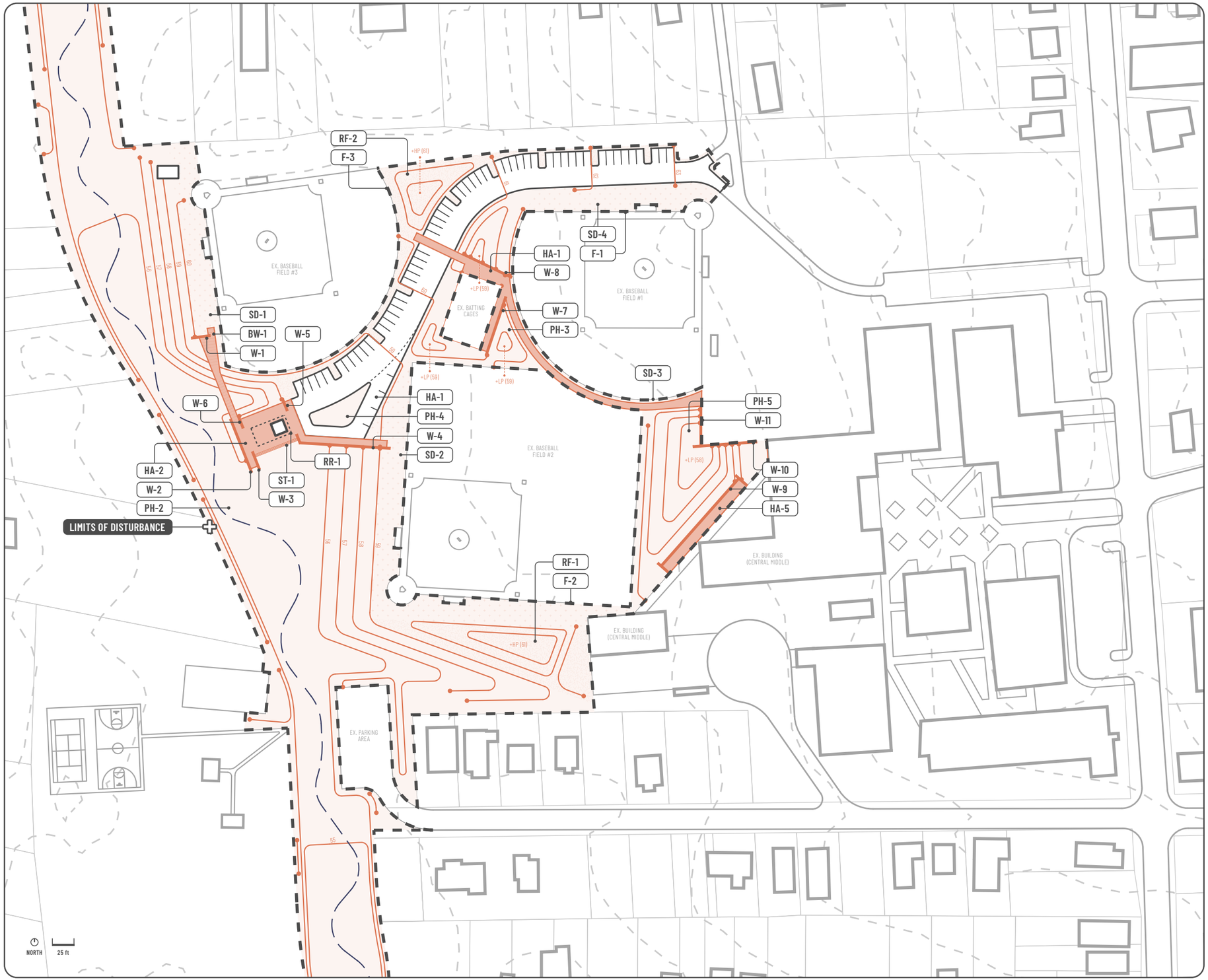


Photo (#2): September 2022 Public Engagement Event

Photo (#3): September 2022 Public Engagement Event

Photo (#4): September 2022 Public Engagement Event

Map. Enlargement Area: Central Middle School Recreational Complex.



COST ESTIMATE SUMMARY

A concept-level opinion of probable cost was generated for the Mollie's Branch project that reflects the scope of work illustrated in the Scenario C plan. The data used to prepare the projected cost of construction included, but was not limited to: RS Means Wilmington 2022 (Q3), NCDOT Bids, and recently completed construction projects with similar components. Consultation with a team of licensed landscape architects, civil engineers, and structural engineers regarding the feasibility and constructibility of specific components of the Scenario C plan also guided the refinement of specific aspects of the schematic design, and are represented in the overall opinion of probable cost.

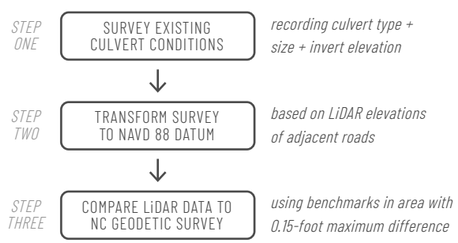
The most detailed aspect of the Mollie's Branch project, which required the greatest amount of detail for cost estimation purposes, was within the expanded floodplain restoration area at the Middle School recreational complex. While the project, more broadly, includes scope of work categorized as: Erosion and Sediment Control, Site Demolition, Clearing and Grubbing, Earthwork, Utility Relocation, Roadway Repair and Resurfacing, Roadway Infrastructure Improvements, Planting and Stabilization, and Design / Engineering and Permitting Services, the Middle School site also calls for additional line items pertinent to: Walkways and Trails, Site Walls and Fencing, and Educational Signage.

The total cost of construction (not including additional potential costs associated with grant administration, local project management, and long-term maintenance) was estimated to be: **$4,927,533.00** as of December 2022.

HYDRAULIC MODELING: METHODS OVERVIEW

Hydraulic models use stream data and mathematical inputs to analyze existing capabilities and predict future effectiveness of changes to stream systems. This study used a hydraulic model to evaluate existing and proposed flooding conditions along the Mollie's Branch corridor from Washington Street (north) to the abandoned railroad embankment near Main Street (south) in Whiteville. Model outputs visualized the flood depth and inundation extents from two different stream restoration conditions in comparison to the existing flood conditions associated with various rainfall return periods (10-, 25-, 50-, and 100-year flood events) in the study area.

Existing Conditions Model: The U.S. Army Corps of Engineers Hydraulic Engineering Center River Analysis System (HEC-RAS) model (USACE, 2022) was used to evaluate flooding and test the impacts of stream and floodplain restoration along Mollie's Branch. The existing condition HEC-RAS model for Mollie's Branch was obtained from the North Carolina Flood Risk Information System (NC FRIS) database (NCFMP, 2019). Validation of the existing conditions HEC-RAS model included the following steps:



The effective model was subsequently updated to show more accurate conditions for overbank areas, roadway elevations, and culverts. These updates to the model resulted in culvert and road surface elevations that were lowered between 1.1- and 1.4-feet based on LiDAR data and survey findings, which ultimately yielded narrower and shallower flood inundation extents and elevations (approximately 0.5- to 1-foot lower) than currently shown in published flood maps (FEMA, 2022) of the Mollie's Branch study area.

Restoration Concept Design: The horizontal alignment, vertical alignment, width, and depth of proposed restoration scenarios considered the following:

① Parcel Context:

+ Stream Adjacent Properties: properties and associated parcel lines that adjoin the existing stream channel.

+ Buyout Zones: properties included in proposed 'buyout zones' via State-administered hazard mitigation programs.

+ Access Easements: locations of City-maintained access easements for Mollie's Branch (30-feet width, typical).

② Locations of Existing Infrastructure:

+ Invert Elevations: culverts at existing road crossings.

+ Road / Bridge Stream Crossing Locations: existing points of intersection with Mollie's Branch.

③ Model Conditions:

+ Sizing: using the bankfull areas regional curve for the Coastal Plain (Doll, et al., 2003).

+ Width to Depth Ratio of 12: width of the channel to mean depth of the channel.

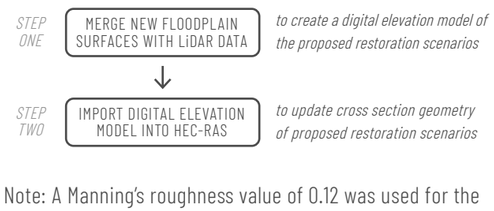
+ Sinuosity Ratio of 1.2: channel length to valley length; a sinuosity ratio of 1.2 is considered moderate-to-low for Coastal Plain streams.

+ Stream Bend Curvature: using relatively large radii for curvatures to limit bank shear stress.

+ Entrenchment Ratio of 5: width of the floodplain to width of the channel; an entrenchment ratio of 5 is assumed to allow for adequate floodplain conveyance.

+ Maximum Slopes of 3:1: horizontal to vertical grade; side slopes to meet the existing surface at no greater than 3:1.

AutoCAD Civil3D was then used to develop a three-dimensional surface of two proposed stream and floodplain restoration scenarios. For both of the modeled scenarios, the following steps included:



Note: A Manning's roughness value of 0.12 was used for the floodplain and a value of 0.05 was used for the restored channel (Chow, 1959), which are the same Manning's roughness values used in the existing effective model.

Model Simulations: Initial analysis indicated that neither crossing modifications nor channel and floodplain restoration alone would substantially reduce flooding along Mollie's Branch. Therefore, two scenarios that combined both stream restoration and infrastructure modifications were evaluated using the HEC-RAS model. The modeling scenarios that were evaluated include:

Ⓐ Scenario A: Two Stage Ditch + Crossing Modifications

This scenario enhances the hydraulic performance of Mollie's Branch without additional property acquisitions or major modifications to roadways in the project area. This is accomplished through: i) the use of a a two-stage ditch approach with floodplain bench that occupies the existing channel footprint (approximately 30-feet wide) and an existing 30-foot access easement maintained by the City of Whiteville (60-feet in total width); and ii) upgrading culverts at locations where Mollie's Branch intersects Washington, Williamson, Burkhead, and Lewis Streets.

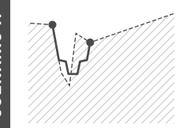
SCENARIO A	EXISTING & PROPOSED STREAM PROFILE	EXISTING CULVERT (ROAD CROSSING)	MODELED CULVERT REPLACEMENT
		(1) 6'H x 8"W RCBC **(WASHINGTON ST)**	(1) 6'H x 10'W RCBC + (2) 48" RCP
		(2) 60" CMP **(WILLIAMSON ST)**	(1) 6'H x 20'W RCBC
		(2) 60" CMP **(BURKHEAD ST)**	(1) 6'H x 20'W RCBC
	60'W PROFILE TYPICAL CONDITION	(2) 60" CMP **(LEWIS ST)**	(1) 6'H x 20'W RCBC

Table 1. Scenario A: Proposed Restoration and Infrastructure Conditions.

Ⓑ Ⓒ Scenarios B + C: Stream and Floodplain Restoration + Crossing Modifications

Scenario B assumes homeowner participation in State-administered buyout programs immediately adjacent to Mollie's Branch, and utilizes a wider restoration footprint to further enhance hydraulic performance. This condition allows for the channel and floodplain restoration to widen to 100-feet in total width. Scenario C uses a similar floodplain width, but with a different alignment that does not overlap with the expanded buyout area. Both scenarios (B and C) upgrade the infrastructure conditions at Washington (via culvert) and Burkhead (via bridge), and also remove the road crossings at Williamson and Lewis Streets (either terminating the roads as cul-de-sacs or connecting back into the existing street grid).

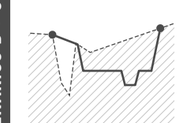
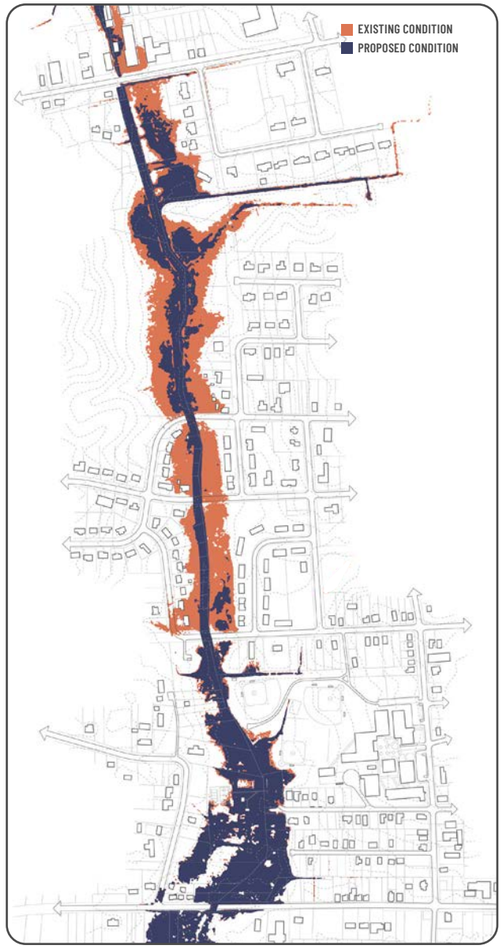
SCENARIOS B + C	EXISTING & PROPOSED STREAM PROFILE	EXISTING CULVERT (ROAD CROSSING)	MODELED CULVERT REPLACEMENT
		(1) 6'H x 8"W RCBC **(WASHINGTON ST)**	(1) 6'H x 10'W RCBC + (2) 48" RCP
		(2) 60" CMP **(WILLIAMSON ST)**	REMOVED
		(2) 60" CMP **(BURKHEAD ST)**	40'L BRIDGE
	100'W PROFILE TYPICAL CONDITION	(2) 60" CMP **(LEWIS ST)**	REMOVED

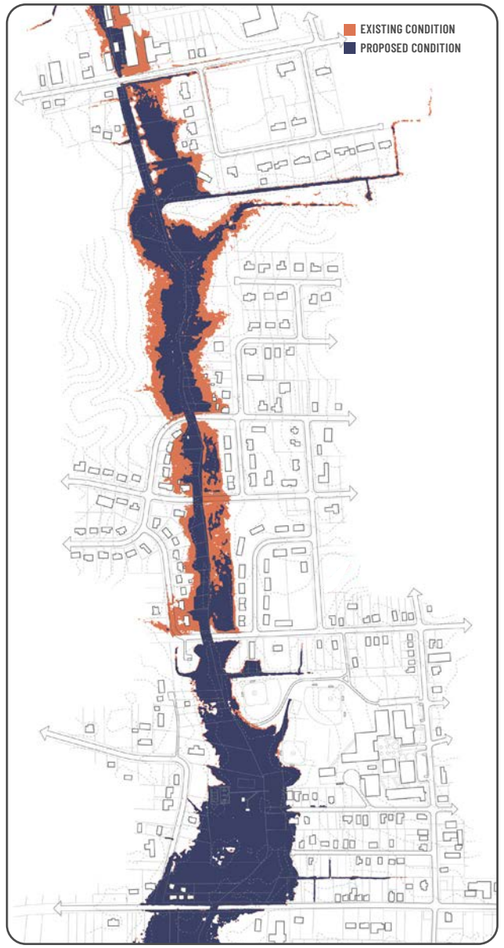
Table 2. Scenarios B + C: Proposed Restoration and Infrastructure Conditions.

10-YEAR FLOOD EVENT
EXISTING + PROPOSED FLOOD EXTENTS



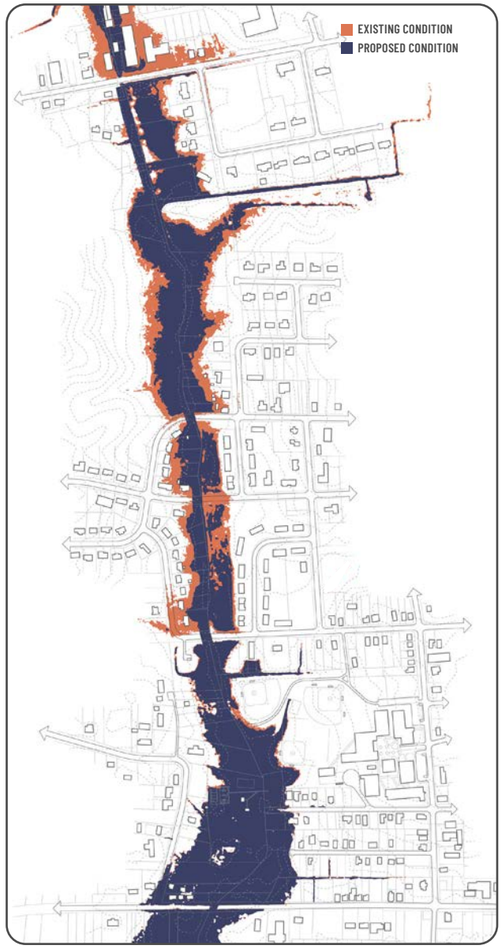
(#) STRUCTURES INTERSECTING MODELED FLOOD EXTENTS		(#) ROADS OVERTOPPED DUE TO MODELED FLOOD DEPTH	
20 EXISTING	4 PROPOSED	3 EXISTING	0 PROPOSED

25-YEAR FLOOD EVENT
EXISTING + PROPOSED FLOOD EXTENTS



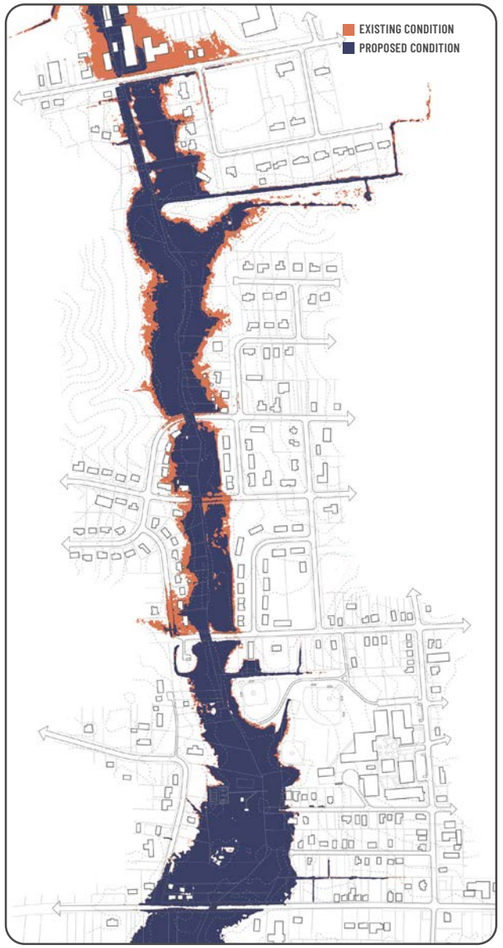
(#) STRUCTURES INTERSECTING MODELED FLOOD EXTENTS		(#) ROADS OVERTOPPED DUE TO MODELED FLOOD DEPTH	
30 EXISTING	13 PROPOSED	3 EXISTING	0 PROPOSED

50-YEAR FLOOD EVENT
EXISTING + PROPOSED FLOOD EXTENTS



(#) STRUCTURES INTERSECTING MODELED FLOOD EXTENTS		(#) ROADS OVERTOPPED DUE TO MODELED FLOOD DEPTH	
32 EXISTING	16 PROPOSED	4 EXISTING	1 PROPOSED

100-YEAR FLOOD EVENT
EXISTING + PROPOSED FLOOD EXTENTS



(#) STRUCTURES INTERSECTING MODELED FLOOD EXTENTS		(#) ROADS OVERTOPPED DUE TO MODELED FLOOD DEPTH	
37 EXISTING	19 PROPOSED	4 EXISTING	1 PROPOSED

SCENARIO 'A' HYDRAULIC MODELING RESULTS

The modeling results for Scenarios A & B were evaluated by examining the decrease in water surface elevation (WSE) and spatial extent of flooding for the range of rainfall return periods (10-, 25-, 50-, 100-year flood events). The existing condition of Mollie's Branch results in some extent of roadway flooding at all of the studied crossings: Washington, Williamson, Burkhead, and Lewis Street. Burkhead Street overtops even during 5-year flood events (4.97 inches over 24 hours). Lewis and Williamson Streets overtop during 10-year flood events. Washington Street overtops during 100-year flood events. Much of this roadway flooding is relieved by increasing the culvert size at each of these roadway crossings. In Scenario A, Washington Street's single 6' H x 8" W RCBC culvert is replaced by one 6' H x 10' W RCBC and two 48" RCP. Williamson, Burkhead, and Lewis's two 60" CMP's are replaced by 6' H X 20' W RCBC. With these changes, none of these roadways overtop during even 100-year flood events, with the exception of Burkhead Street.

10-YEAR FLOOD EVENT
EXISTING + PROPOSED FLOOD EXTENTS

(#) STRUCTURES INTERSECTING MODELED FLOOD EXTENTS		(#) ROADS OVERTOPPED DUE TO MODELED FLOOD DEPTH	
20 EXISTING	4* PROPOSED	3 EXISTING	0 PROPOSED

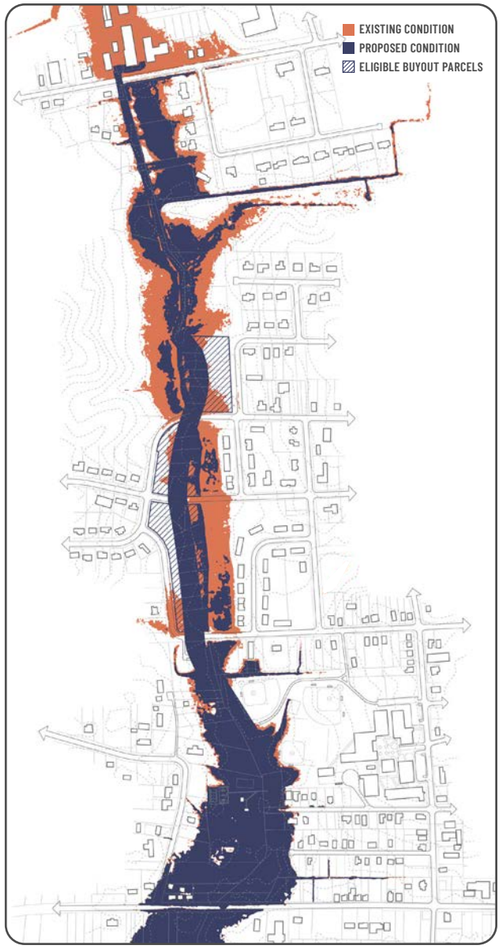
25-YEAR FLOOD EVENT
EXISTING + PROPOSED FLOOD EXTENTS

(#) STRUCTURES INTERSECTING MODELED FLOOD EXTENTS		(#) ROADS OVERTOPPED DUE TO MODELED FLOOD DEPTH	
30 EXISTING	12* PROPOSED	3 EXISTING	0 PROPOSED

50-YEAR FLOOD EVENT
EXISTING + PROPOSED FLOOD EXTENTS

(#) STRUCTURES INTERSECTING MODELED FLOOD EXTENTS		(#) ROADS OVERTOPPED DUE TO MODELED FLOOD DEPTH	
32 EXISTING	12* PROPOSED	4 EXISTING	0 PROPOSED

100-YEAR FLOOD EVENT
EXISTING + PROPOSED FLOOD EXTENTS



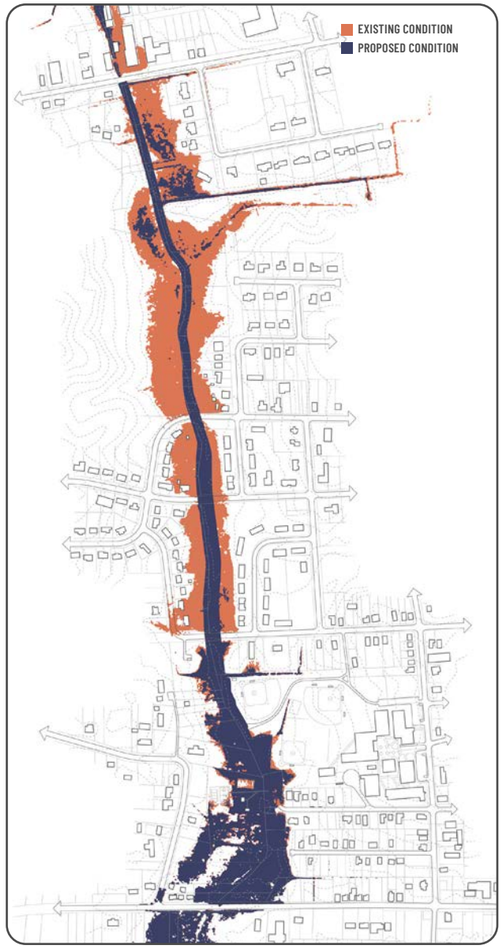
(#) STRUCTURES INTERSECTING MODELED FLOOD EXTENTS		(#) ROADS OVERTOPPED DUE TO MODELED FLOOD DEPTH	
37 EXISTING	14* PROPOSED	4 EXISTING	0 PROPOSED

* does not include properties within the expanded Voluntary Buyout Zone

SCENARIO 'B' HYDRAULIC MODELING RESULTS

With a wider restoration footprint, upgraded culverts for Washington and Burkhead Street, and the removal of road crossings at Williamson and Lewis Streets, Scenario B results in even greater flooding reductions when compared to Scenario A. Like Scenario A, Washington Street's single 6' H x 8" W RCBC culvert is replaced by one 6' H x 10' W RCBC and two 48" RCP. Burkhead Street's two 60" CMP's are replaced by a bridge spanning 40 feet (minimum) across Mollie's Branch, allowing for water to flow more freely in Mollie's Branch. With Scenario B's conditions, the remaining roadway crossings of Washington and Burkhead Street will not overtop during even 100-year flooding events, preserving residents' ability to use these roadways during emergency conditions. All vehicular threats relating to floodwaters at Williamson and Lewis Streets are removed, since these two roads terminate at cul-de-sacs or tie back into the existing road network prior to intersecting the restored floodplain bench.

10-YEAR FLOOD EVENT
EXISTING + PROPOSED FLOOD EXTENTS

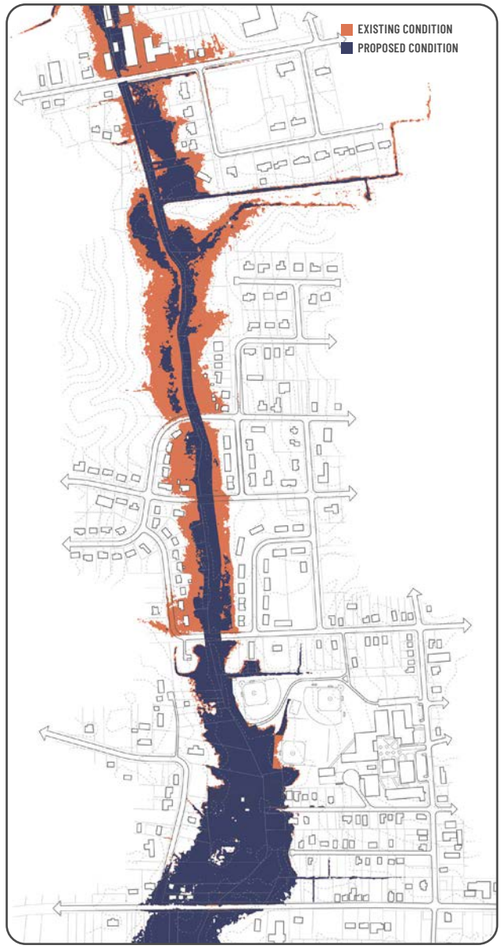


(#) STRUCTURES INTERSECTING MODELED FLOOD EXTENTS		(#) ROADS OVERTOPPED DUE TO MODELED FLOOD DEPTH	
20 EXISTING	4 PROPOSED	3 EXISTING	0 PROPOSED

25-YEAR FLOOD EVENT
EXISTING + PROPOSED FLOOD EXTENTS

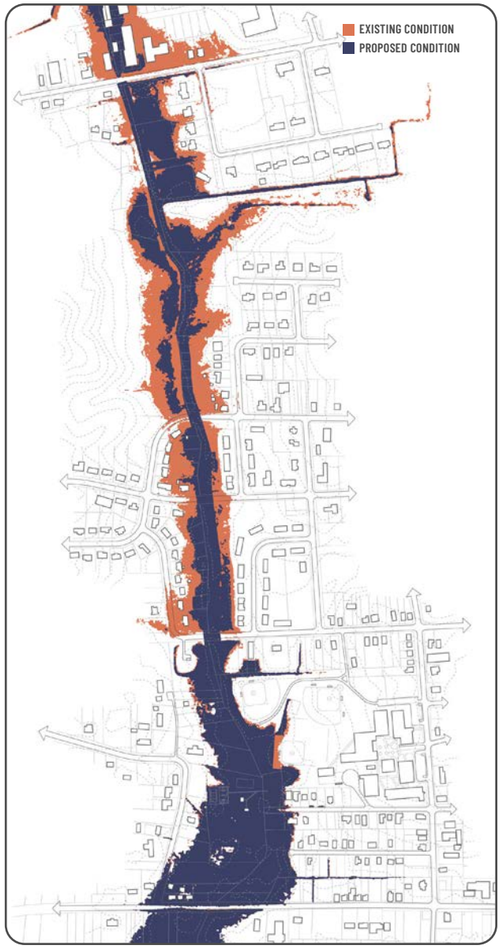
(#) STRUCTURES INTERSECTING MODELED FLOOD EXTENTS		(#) ROADS OVERTOPPED DUE TO MODELED FLOOD DEPTH	
30 EXISTING	12 PROPOSED	3 EXISTING	0 PROPOSED

50-YEAR FLOOD EVENT
EXISTING + PROPOSED FLOOD EXTENTS



(#) STRUCTURES INTERSECTING MODELED FLOOD EXTENTS		(#) ROADS OVERTOPPED DUE TO MODELED FLOOD DEPTH	
32 EXISTING	12 PROPOSED	4 EXISTING	0 PROPOSED

100-YEAR FLOOD EVENT
EXISTING + PROPOSED FLOOD EXTENTS



(#) STRUCTURES INTERSECTING MODELED FLOOD EXTENTS		(#) ROADS OVERTOPPED DUE TO MODELED FLOOD DEPTH	
37 EXISTING	14 PROPOSED	4 EXISTING	0 PROPOSED

SCENARIO 'C' HYDRAULIC MODELING RESULTS

The Scenario C plan is similar in design to Scenario B, with only minor revisions to reflect public feedback received. Compared to Scenario B, the floodplain in Scenario C is slightly narrower and more closely follows the existing stream alignment. To accommodate the resulting impacts to water surface elevations (WSE) due to this narrower floodplain, the channel bed and floodplain elevations were dropped by 0.5 - 1.0 feet relative to Scenario B. This change allows for similar flood reduction benefits as Scenario B (e.g., for the 25-year rainfall event, substantial flooding outside the newly constructed floodplain is mostly eliminated). As in Scenario B, the Scenario C plan includes: one 6' H x 8" W RCBC and two supplemental 48" RCPs at Washington Street. two 60" CMPs are replaced with a 100' length bridge (minimum; including a 50' opening) at Burkhead Street, and the two 60" CMPs located at Williamson and Lewis Streets are removed entirely. In total, about 3 feet of WSE reduction could be achieved for both Scenarios B and C upstream of the school athletic fields. For Scenario C, Burkhead Street would not overtop for the 100-year event, and like Scenario B, all vehicular threats relating to floodwaters at Williamson and Lewis Streets are removed, since these two roads terminate at cul-de-sacs or tie back into the existing road network prior to intersecting the restored floodplain area.

BENEFIT-COST ANALYSIS

FEMA's Benefit-Cost Calculator (V.6.0) was used to estimate the damage reduction for each of the impacted structures and the value of the project's social and ecosystem services. The inputs used to develop the BCA are outlined below and followed by a discussion of the findings:

Modeled Damages: Residential & Non-Residential Structures
Each structure currently impacted by flooding up to the 100-year flood event was input into the Benefit-Cost Calculator as a separate line item. Hydraulic modeling results provided a detailed analysis of the water surface elevations (WSE) for 10-, 25-, 50-, and 100-year flood events for current conditions and conditions after mitigation. The following inputs and sources were used to complete required BCA information for each of the structures:

+ Project Cost: $0 - each impacted structure was included only to estimate damage reduction from the mitigation action. The full cost of the project was included as a separate line item.

+ Lowest Floor Elevation: North Carolina Emergency Management (NCEM) manages a dataset containing all building footprints in the state. The data was developed for the North Carolina Floodplain Mapping Program (fris.nc.gov) as part of its effort to modernize FEMA Flood Insurance Rate Maps (FIRM) statewide. Data for structures located within the SFHA includes accurate measure of FFE collected by laser inclinometer.

+ Hazard Probability Parameters (Flood): Raw data from the hydraulic model was used to identify streambed elevations, WSEs (before and after mitigation), and discharge values for each structure.

+ Building Information: Property tax cards from the Columbus County Online GIS database.

+ Standard Benefits (Building + Contents + Displacement): Property tax cards from the Columbus County Online GIS database, FEMA BCA default values, and a value of one (1) resident was used as a minimum occupancy standard for all non-vacant structures in the study area.

Expected Damages: Floodplain & Stream Restoration
A separate line item was created in the Benefit-Cost Calculator to account for the ecosystem services benefits from the proposed mitigation actions. All of the project costs and maintenance costs were included in this section and the default PUL value (30 years) was used. Since the expected damage reduction for each impacted property had already been calculated as a separate line item, the 'Professional Expected Damages' sections were left blank, and only the 'Standard Benefits - Ecosystem Services' section was completed. The following inputs and sources used to calculate ecosystem service benefits:

+ Project Area (15.07 acres): Calculated from the Limits of Work boundary illustrated in Scenario 'C.'

+ Benefit Category: Values for 'Urban Green Space' and 'Riparian' areas were estimated from the Scenario 'C' plan. The educational constructed wetlands, trails, and recreational open space around the Central Middle School site were considered 'Urban Green Open Space' (1.95 acres; 12.94% of the Project Area). All areas within the widened stream channel and the adjacent low-lying areas were considered 'Riparian' (9.79 acres; 64.96% of the Project Area). 3.33 acres of the Project Area (22.10% of the Project Area) were not included in the estimation of ecosystem service benefits for this project (see Appendix B: Ecosystem Service Areas for a coinciding map of these areas).

Results & Discussion
Using the 3% discount rate per FEMA's memorandum (October 2022), the combined damage reduction and ecosystem service benefits expected from this stream restoration project totaled $7,999,738. With an estimated total project cost of $5,620,826, **the final benefit cost ratio (BCR) for the proposed scope of work was calculated to be 1.42, which establishes cost effectiveness for this project.**

$7,999,738
TOTAL BENEFITS

FFE: 67.23
703 WASHINGTON ST

FLOOD EVENT	WSE: EXISTING	WSE: PROPOSED	Δ WSE
10-YR	64.47	62.91	-1.56
25-YR	64.82	63.45	-1.37
50-YR	65.02	63.83	-1.19
100-YR	65.26	64.16	-1.10

FFE: 66.38
711 BRYCE ST

FLOOD EVENT	WSE: EXISTING	WSE: PROPOSED	Δ WSE
10-YR	64.47	62.88	-1.59
25-YR	64.79	63.42	-1.37
50-YR	65.04	63.79	-1.25
100-YR	65.28	64.12	-1.16

FFE: 68.06
705 BRYCE ST

FLOOD EVENT	WSE: EXISTING	WSE: PROPOSED	Δ WSE
10-YR	64.47	62.83	-1.64
25-YR	64.78	63.42	-1.37
50-YR	65.00	63.79	-1.21
100-YR	65.22	64.11	-1.11

FFE: 67.89
701 BOB WHITE LN

FLOOD EVENT	WSE: EXISTING	WSE: PROPOSED	Δ WSE
10-YR	64.39	62.40	-1.99
25-YR	64.69	63.03	-1.66
50-YR	64.89	63.38	-1.51
100-YR	65.10	63.75	-1.35

FFE: 66.42
305 STANLEY ST

FLOOD EVENT	WSE: EXISTING	WSE: PROPOSED	Δ WSE
10-YR	64.05	59.96	-4.09
25-YR	64.24	60.70	-3.54
50-YR	64.36	61.05	-3.31
100-YR	64.48	61.47	-3.01

FFE: 67.03
301 STANLEY ST

FLOOD EVENT	WSE: EXISTING	WSE: PROPOSED	Δ WSE
10-YR	64.05	59.83	-4.22
25-YR	64.23	60.61	-3.62
50-YR	64.35	60.93	-3.42
100-YR	64.46	61.36	-3.10

FFE: 65.34
613 PINEWOOD DR

FLOOD EVENT	WSE: EXISTING	WSE: PROPOSED	Δ WSE
10-YR	62.29	59.62	-2.67
25-YR	62.55	60.32	-2.23
50-YR	62.71	60.64	-2.07
100-YR	62.88	61.08	-1.80

FFE: 65.96
615 PINEWOOD DR

FLOOD EVENT	WSE: EXISTING	WSE: PROPOSED	Δ WSE
10-YR	62.24	59.48	-2.76
25-YR	62.51	60.22	-2.29
50-YR	62.68	60.47	-2.21
100-YR	62.87	61.00	-1.87

FFE: 65.98
617 PINEWOOD DR

FLOOD EVENT	WSE: EXISTING	WSE: PROPOSED	Δ WSE
10-YR	62.19	59.37	-2.82
25-YR	62.44	60.15	-2.29
50-YR	62.59	60.41	-2.18
100-YR	62.76	60.87	-1.89

FFE: 65.53
619 PINEWOOD DR

FLOOD EVENT	WSE: EXISTING	WSE: PROPOSED	Δ WSE
10-YR	62.11	59.27	-2.84
25-YR	62.31	60.05	-2.26
50-YR	62.43	60.27	-2.16
100-YR	62.63	60.71	-1.92

FFE: 66.11
624 BURKHEAD ST

FLOOD EVENT	WSE: EXISTING	WSE: PROPOSED	Δ WSE
10-YR	62.04	59.17	-2.87
25-YR	62.25	60.03	-2.22
50-YR	62.37	60.26	-2.11
100-YR	62.52	60.69	-1.83

FFE: 64.41
620 BURKHEAD ST

FLOOD EVENT	WSE: EXISTING	WSE: PROPOSED	Δ WSE
10-YR	62.04	59.17	-2.87
25-YR	62.25	60.03	-2.22
50-YR	62.31	60.26	-2.05
100-YR	62.51	60.69	-1.82

FFE: 65.12
619 BURKHEAD ST

FLOOD EVENT	WSE: EXISTING	WSE: PROPOSED	Δ WSE
10-YR	61.12	58.70	-2.42
25-YR	61.47	59.51	-1.96
50-YR	61.69	59.63	-2.06
100-YR	61.95	60.05	-1.90

FFE: 64.41
116 MAULTSBY DR

FLOOD EVENT	WSE: EXISTING	WSE: PROPOSED	Δ WSE
10-YR	60.76	58.34	-2.42
25-YR	61.07	59.22	-1.85
50-YR	61.25	59.35	-1.90
100-YR	61.46	59.69	-1.77

FFE: 64.69
114 MAULTSBY DR

FLOOD EVENT	WSE: EXISTING	WSE: PROPOSED	Δ WSE
10-YR	60.73	58.26	-2.47
25-YR	60.99	59.16	-1.83
50-YR	61.17	59.26	-1.91
100-YR	61.30	59.60	-1.70

FFE: 63.26
104 MAULTSBY DR

FLOOD EVENT	WSE: EXISTING	WSE: PROPOSED	Δ WSE
10-YR	60.57	58.12	-2.45
25-YR	60.78	59.00	-1.78
50-YR	60.90	59.06	-1.84
100-YR	61.06	59.39	-1.67

FFE: 62.26
100 MAULTSBY DR

FLOOD EVENT	WSE: EXISTING	WSE: PROPOSED	Δ WSE
10-YR	60.48	58.03	-2.45
25-YR	60.66	58.93	-1.73
50-YR	60.76	59.00	-1.76
100-YR	60.89	59.28	-1.61

FFE: 63.33
601 LEWIS ST

FLOOD EVENT	WSE: EXISTING	WSE: PROPOSED	Δ WSE
10-YR	58.33	57.81	-0.52
25-YR	59.02	58.74	-0.28
50-YR	59.10	58.74	-0.36
100-YR	59.37	58.96	-0.41

FFE: 67.91
606 WASHINGTON ST

FLOOD EVENT	WSE: EXISTING	WSE: PROPOSED	Δ WSE
10-YR	66.22	63.68	-2.54
25-YR	67.01	64.57	-2.44
50-YR	67.82	65.36	-2.46
100-YR	68.14	65.86	-2.28

FFE: 67.91
610 WASHINGTON ST

FLOOD EVENT	WSE: EXISTING	WSE: PROPOSED	Δ WSE
10-YR	66.22	63.68	-2.54
25-YR	67.01	64.57	-2.44
50-YR	67.82	65.36	-2.46
100-YR	68.14	65.86	-2.28

FFE: 68.57
614 WASHINGTON ST

FLOOD EVENT	WSE: EXISTING	WSE: PROPOSED	Δ WSE
10-YR	66.34	64.45	-1.89
25-YR	67.08	65.43	-1.65
50-YR	67.86	66.01	-1.85
100-YR	68.18	66.41	-1.77

FFE: 68.15
702 WASHINGTON ST

FLOOD EVENT	WSE: EXISTING	WSE: PROPOSED	Δ WSE
10-YR	66.17	64.18	-1.99
25-YR	66.97	64.82	-2.15
50-YR	67.80	65.33	-2.47
100-YR	68.12	65.80	-2.32

FFE: 70.10
706 WASHINGTON ST

FLOOD EVENT	WSE: EXISTING	WSE: PROPOSED	Δ WSE
10-YR	66.00	63.64	-2.36
25-YR	66.93	64.00	-2.93
50-YR	67.77	64.93	-2.84
100-YR	68.09	65.45	-2.64

15.01 ACRE PROJECT AREA
ECOSYSTEM SERVICES

PROPOSED LAND USE (FEMA DESIGNATIONS)	AREA (ACRES)	VALUE / ACRE / YEAR ($)	PROJECT USEFUL LIFE (YEARS)
"RIPARIAN"	9.79	$37,199	30
"URBAN GREEN SPACE"	1.95	$15,541	30
LIMITS OF DISTURBANCE	15.01	- -	- -

$5,620,826
TOTAL COSTS

ESTIMATED CONSTRUCTION COSTS: COST ($) + COST CATEGORY

COST ESTIMATE SUMMARY

$255,000	GENERAL REQUIREMENTS	$487,643	EARTHWORK	$4,160	EDUCATIONAL SIGNAGE	$448,000	DESIGN / ENGINEERING
$195,452	EROSION + SEDIMENT CONTROL	$1,036,497	UTILITY RELOCATION	$135,106	SITE WALLS + FENCING	$25,596	ANNUAL MAINTENANCE (30 YEARS)
$106,092	SITE DEMOLITION	$228,691	ROADWAY REPAIR + RESURFACING	$1,320,000	ROADWAY INFRASTRUCTURE	$246,376	GRANT / PROJECT MANAGEMENT
$19,266	CLEAR + GRUB	$357,854	WALKWAYS / TRAILS	$333,722	PLANTING + STABILIZATION		

Image. Schematic Rendering.

LEVERAGING NATURE-BASED SOLUTIONS

The restoration of Mollie's Branch – and the process connected to its development and refinement – represent a scope of work that reflects the preferences of community stakeholders, has garnered support from local leadership, and has been determined to be a cost-effective solution for reducing flood damages in the project area.

This is an important project for Whiteville in its recovery from Hurricane Florence in that it will deliver much-needed solutions to flooding in an area that is long overdue for mitigation services. However, as a small community in a rural county, projects containing these types of benefits are seldom accessible due to a combination of environmental and demographic vulnerabilities facing the city and its people. This project is a significant opportunity for grantors to demonstrate support for flood mitigation needs and resilience-building measures within this community.

ELEVATION ASSESSMENT + “DE-PAVE” PROGRAM

DOWNTOWN CORE

PUBLIC ENGAGEMENT #3 (B)

SEPTEMBER 2022

ELEVATION ASSESSMENT UPDATE + "DE-PAVE" ALTERNATIVES

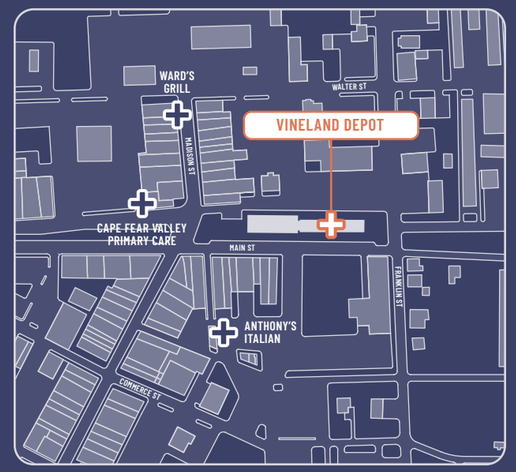
Stakeholders who participated in the first Whiteville Floodprint public engagement event (April 2022) expressed a need for interventions that respond to nuisance flooding experienced along downtown sidewalks, roadways, and business fronts in addition to more substantive mitigation measures, such as the acquisition (and demolition) or elevation of buildings.

+ Format, Steup, and Goals: During a September 2022 public engagement event, representatives from the CDDL and project partners from the City presented posters that communicated: i) an update on progress being made towards the elevation assessment of buildings within the Special Flood Hazard Area (SFHA; "100-Year Floodplain); and ii) a series of potential "de-pave" illustrations that could be applied across various existing conditions in Whiteville's Central Business District (CBD) to help with nuisance flooding concerns.

This engagement event provided stakeholders with an update on progress being made towards the elevation assessment of buildings within the SFHA, and also presented a series of potential "de-pave" conditions to solicit feedback on program direction. All feedback received was used to refine and guide final recommendations.

Engagement activities focused on fielding questions relating to the elevation assessment, and gathering input as to the fit, preferences (ascertained via stakeholder votes), and programmatic opportunities relating to the potential "de-pave" program.

All the feedback received from participating stakeholders was used to both refine and guide final recommendations for both the "de-pave" program as well as the interior retrofit ("floating floor elevations") of buildings satisfying specific assessment criteria.



Key Map. Public Engagement Location: Vineland Depot.

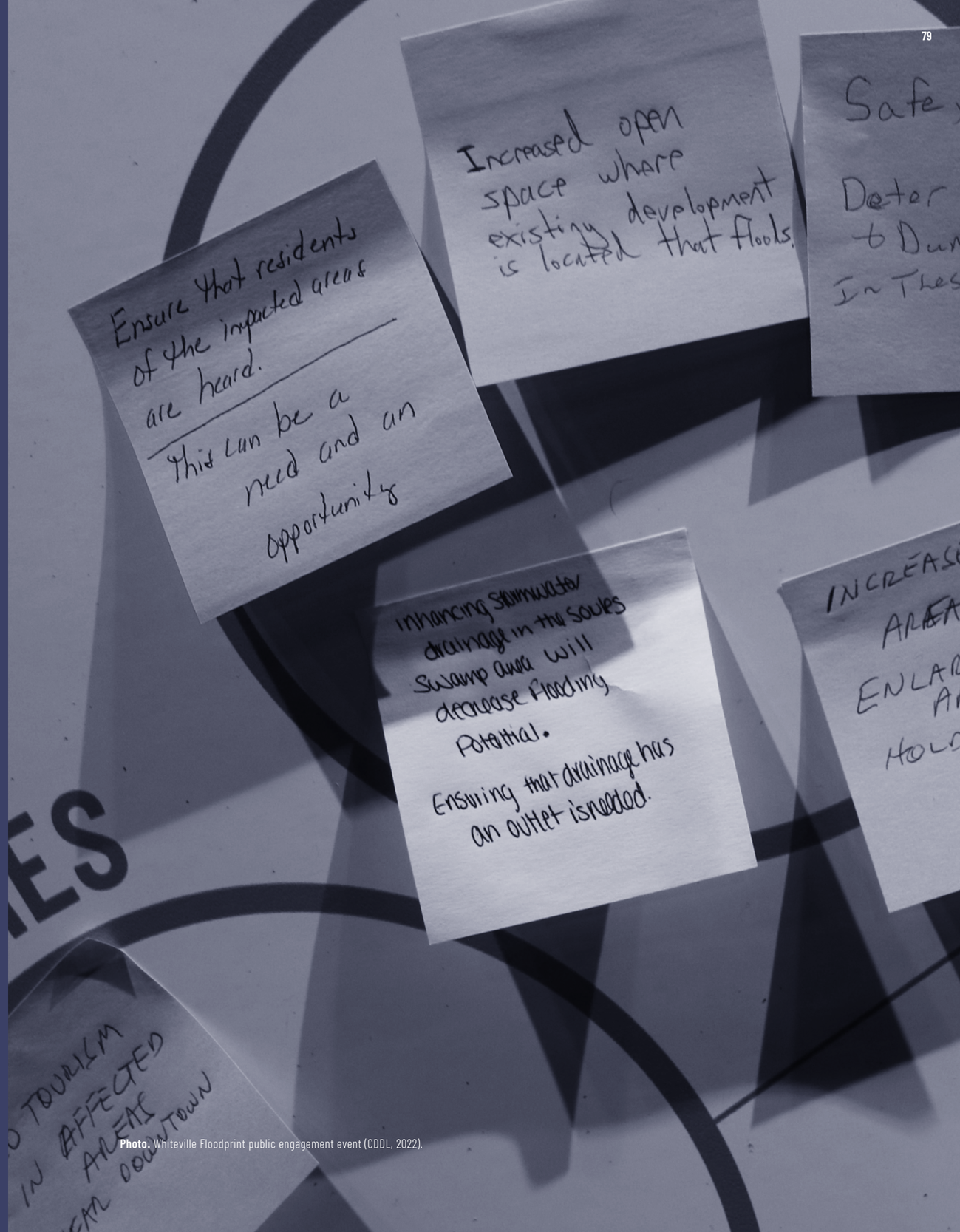


Photo. Whiteville Floodprint public engagement event (CDDL, 2022).

ELEVATION ASSESSMENT: METHODS + FEASIBILITY OVERVIEW

Interior Retrofits: "Floating Floor" Elevations. A combination of geospatial analyses, field measurements, and design considerations were used to identify, assess, and develop recommendations for various elevation techniques in Whiteville's downtown core. A summary of associated processes used in this analysis are illustrated and described below.

STEP ONE	IDENTIFY BUILDINGS WITHIN SFHA	*building footprints that intersect the SFHA (100-year floodplain)*
↓		
STEP TWO (A)	SCREEN FOR FFE'S BELOW THE DESIGN FLOOD ELEVATION	*FFE's lower than the BFE (100-year WSE) + 2-feet of freeboard*
↓		
STEP TWO (B)	SCREEN FOR FEASIBLE STRUCTURAL CONDITIONS	*masonry construction + general integrity + slab-on-grade foundation*
↓		
STEP TWO (C)	SCREEN FOR PRELIMINARY COST-EFFECTIVENESS	*exclude buildings with large areas (e.g., sq ft greater than 3,000 sq ft)*
↓		
STEP THREE (A)	FIELD MEASURE FLOOR-TO-CEILING RATIOS	*from floor to lowest upper constraint (e.g., ceiling or roof structure)*
↓		
STEP THREE (B)	ASSESS ADDITIONAL CONSTRUCTION IMPACTS	*e.g., window and door placement or HVAC / utility locations*
↓		
STEP FOUR	DETERMINE HEIGHT BETWEEN DFE + CEILING	*must maintain a minimum of 8-feet clear for permitted living space*

First, the "Select by Location" geoprocessing tool in ArcGIS Pro was used to identify building footprints within Whiteville's Central Business District that intersect the Special Flood Hazard Area (SFHA). Note: While the extents of Hurricane Florence (2018) in Whiteville exceeded the mapped extent of the SFHA (i.e., 100-year floodplain), floodplain ordinances, regulations, and benefit-cost analysis tools are generally geared toward properties within the SFHA, and thus provided the study area extents for this analysis. Within the Whiteville CBD, sixty-two (62) address points were identified as also being within the SFHA and were further assessed.

Second, a series of screening measures were used to ascertain which structures contain potentially suitable conditions for an interior retrofit ("floating floor") technique of elevation.

This type of elevation was prioritized during this phase of analysis because nearly all of the structures within the CBD and SFHA in Whiteville have physical constraints that would make other forms of elevation (e.g., structural lift via hydraulic jacks) either impracticable or cost-prohibitive. This elevation method leaves the structure on its original foundation but abandons the existing slab floor, and then elevates the primary living area via a newly constructed flooring system that is above designed flood heights (the abandoned lower enclosed area can only be used for storage and subfloor access post-construction). Additional information regarding these methods are referenced in the 2015 Addendum to HMA Guidance E.4.1, with greater detail provided in FEMA P-312: "Homeowner's Guide to Retrofitting" (2014), specifically within Section 3.3.1).

Using data from North Carolina Emergency Management (NCEM), the First Floor Elevation (FFE) of each address point (n = 62) was compared against the designated Base Flood Elevation (BFE; or the water surface elevation of a 100-year flood event) plus two-feet (2'-0") of Freeboard (above the BFE) at each property location. The BFE plus two-feet of Freeboard is equal to the Design Flood Elevation (DFE) in Columbus County (NC) and in Whiteville.

Structures with FFE's below the DFE were then further screened for additional structural and cost-effectiveness measures necessary for this technique of elevation to be feasible. These additional measures included, but were not limited to: building material, foundation type, general structural integrity, existing building use, and the

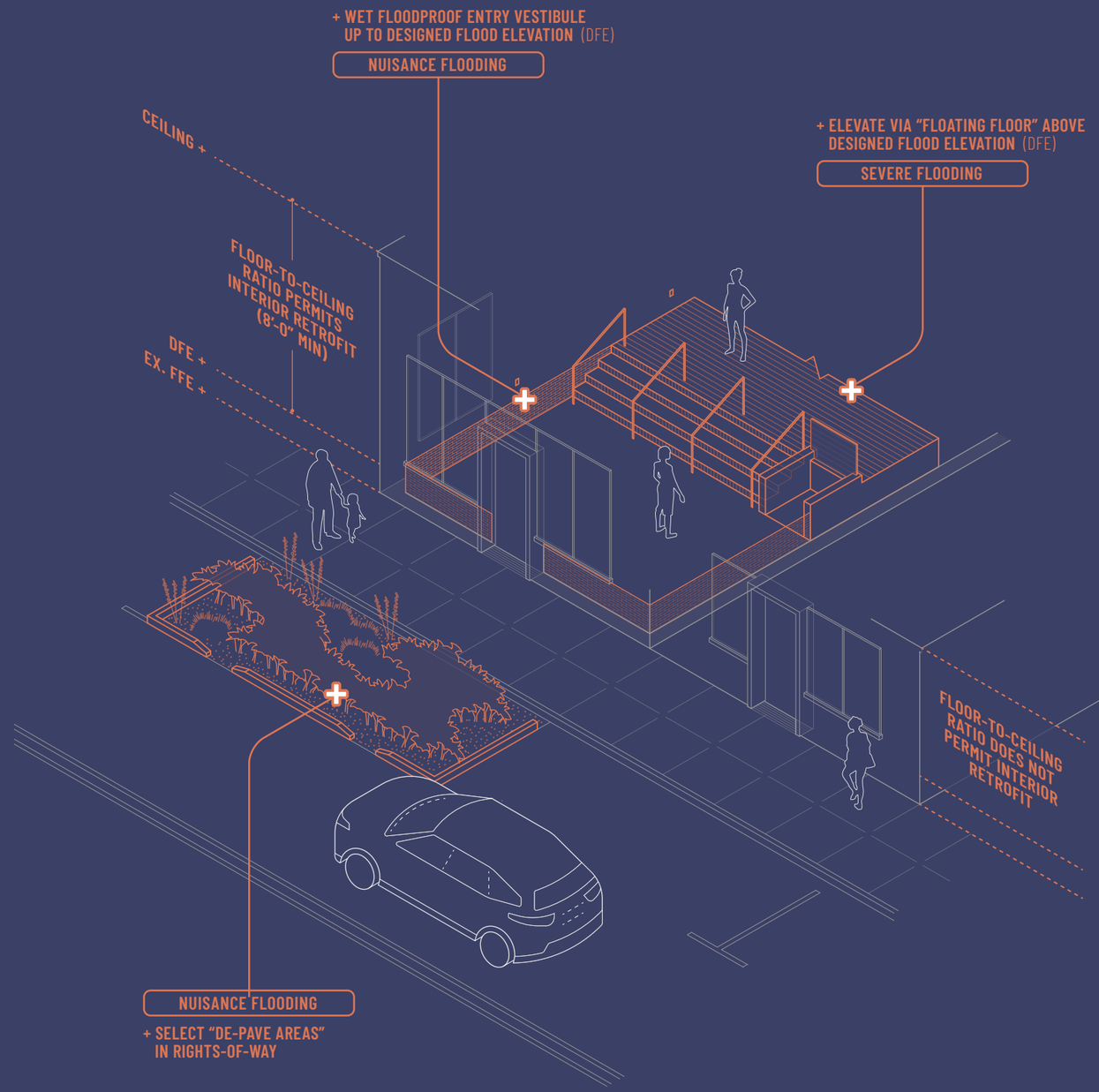


Image. Example of Interior Retrofit via "Floating Floor" Elevation + Example of "De-Pave" Area via Parallel Parking Bulb-Out.

ELEVATION ASSESSMENT: METHODS + FEASIBILITY OVERVIEW

square footage of occupiable / living space. Structures that satisfied all of the screening criteria relied on field-collected data to determine final feasibility for interior retrofit potential.

Third, field measurements for the floor-to-ceiling height (i.e., the FFE to the lowest vertical constraint) were collected, in addition to supplemental building conditions that require consideration for constructibility (e.g., window and door placement, HVAC / utility locations). In total, eighteen (18) address points satisfied all geospatial screening and field-collected criteria. Of these 18, ten (10) address points (five unique structures) were assessed as being the most suitable for the proposed form of elevation ("Step Four"). These addresses include: **916, 918, 920, 922, 924, 1001, 1003, 1015, 107, and 1019 South Madison Street** – elevation and section view illustrations that depict the recommended interior retrofits for each of these structures is provided in the pages that follow.

The remaining eight (8) address points not depicted were determined to be of secondary priority because the amount of vertical space available for an interior retrofit was marginal (e.g., three step risers or less), compared to the other address points shown as being most suitable. These addresses include: **119 Caldis Street, 904, 908, 910, 914, 1018, and 1020 South Madison Street, and 205 West Main Street.**

Cost Effectiveness Considerations. While the processes used during this elevation assessment generally considered cost effectiveness during the screening process, final opinions of construction cost will be required in order to determine the financial feasibility associated with each interior retrofit. These budgets will need to consider unit costs for specific line items associated with the components illustrated for each structure, and are likely to derive from a range of sources (e.g., quotes from licensed contractors, average costs for similar work in the region, published unit costs from cost estimating databases, and industry standards for services as a percentage of anticipated construction costs).

It is recommended that the City of Whiteville, in partnership with individual property owners, consider grant programs offered by FEMA (e.g., Building Resilient Infrastructure and Communities (BRIC), Flood Mitigation Assistance (FMA), or Hazard Mitigation Grant Programs (HMGP)) as potential funding mechanisms for these projects. As it relates to cost effectiveness however, each property must pass a benefit-cost analysis to be eligible for funding.

Currently, FEMA utilizes a dollar figure of $205,000.00 as a pre-calculated benefit for elevation projects. This dollar amount should be viewed, in general, as a budget ceiling. Should any of the depicted elevations be determined to be above this budget threshold, grant funding from agencies such as FEMA will be difficult (if not impossible) to obtain.

Long-Term Maintenance Considerations. While the City of Whiteville is most typically the subapplicant responsible for submitting and administering a grant application for funding consideration to an entity such as FEMA, individual private property owners are responsible for the long-term maintenance associated with the proposed scope of work.

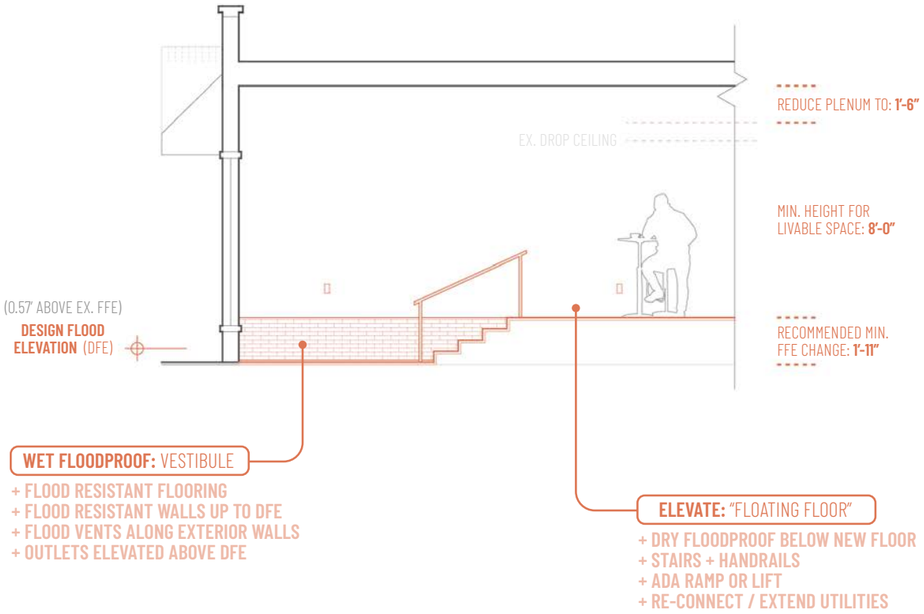
While the illustrated drawings show recommendations for elevation that are both in compliance with Columbus County (and City of Whiteville) floodplain management ordinances (Base Flood Elevation plus two-feet of Freeboard) and are above the Water Surface Elevation (WSE) of a modeled 500-year flood event (source: NC State University Coastal Dynamics Design Lab, 2022), there are some residual flood risks that will remain post-construction.

Specifically, in order to preserve the front facade aesthetic and ground-level accessibility to the front of each building, a combination of stairs, ramps, and/or wheelchair lifts will be required internal to the building shell of each address. As such, each schematic design includes a wet floodproofed vestibule for the first eight-to-twelve horizontal feet, offset from the front door.

Wet floodproofing utilizes: flood resistant flooring and wall materials, flood vents, and elevated utilities in order to reduce property damages during a flood event. Areas that are wet floodproofed are not designed to keep water out of the building, rather, these measures are designed to let water in during a flood event (balancing hydrostatic pressure) and allow for a faster clean up post-flood.

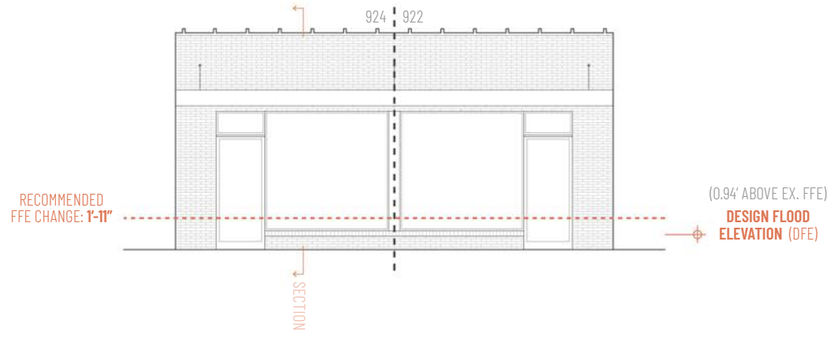
Furthermore, extreme flood events may present flood heights that are greater than the newly proposed FFE for the primary livable space. While events of this magnitude are generally unlikely, risks still remain for events comparable to the scale of Hurricane Florence (1,000-year-plus flood event) to occur. With this in mind, four (4) of the five (5) structures illustrated for interior retrofits in this document, have drop ceilings that could be further minimized – and in doing so – would allow the newly proposed FFE for the primary livable space to be even higher than what is visually depicted as recommendations.

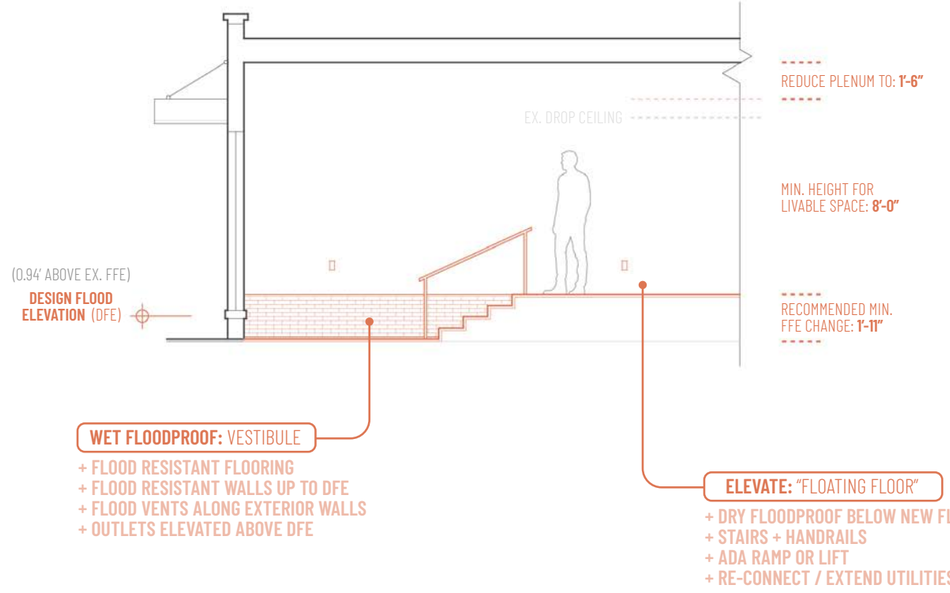
Of the sixty-two (62) address points that are within Whiteville's Central Business District (CBD) and Special Flood Hazard Area (SFHA), ten (10) addresses (five uniques structures, in total) were assessed as having the most suitable conditions for interior retrofit ("floating floor") elevation techniques.



916 + 918 + 920 SOUTH MADISON STREET

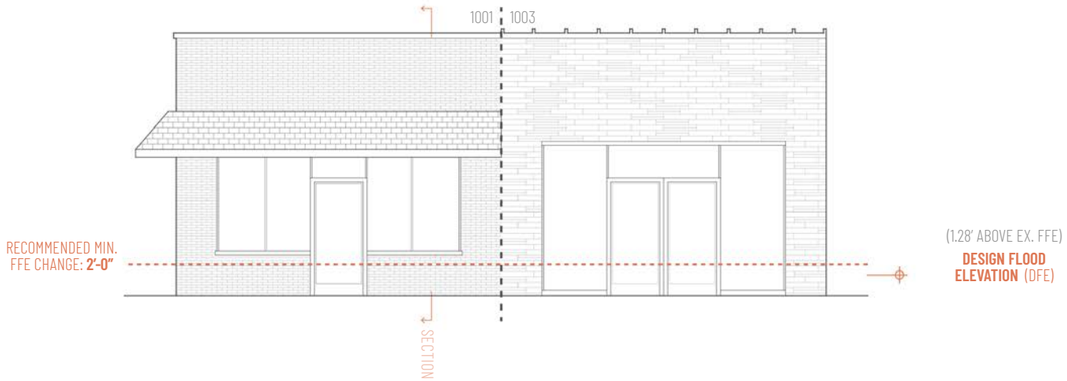
916, 918, and 920 South Madison Street is a masonry, slab-on-grade commercial structure that was constructed in 1947. Located within Whiteville's Special Flood Hazard Area, the Base Flood Elevation (BFE) for this structure is at elevation 56.10-feet, meaning the Design Flood Elevation (DFE) is 58.10-feet. The existing First Floor Elevation (FFE) of the structure is 57.53-feet, which leaves the primary livable space 0.57-feet below the DFE. Field measurements confirm ample space within the interior of the building to raise the FFE by at least 1-feet, 11-inches if the plenum area is reduced to a minimum dimension, and potentially more, if the area above the existing drop ceiling is made available.

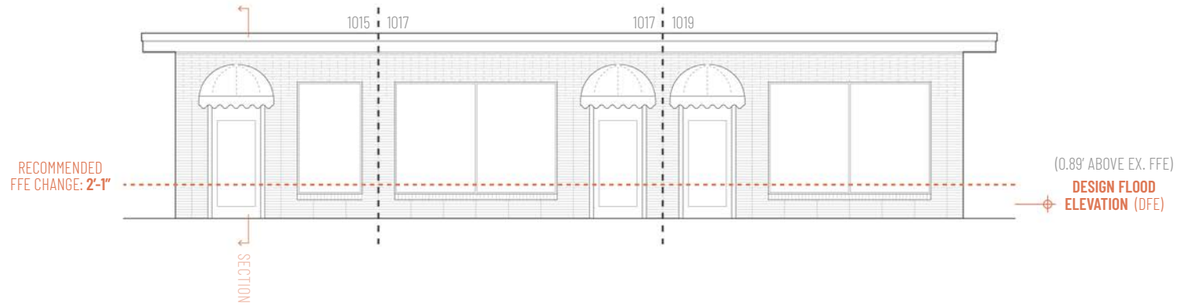


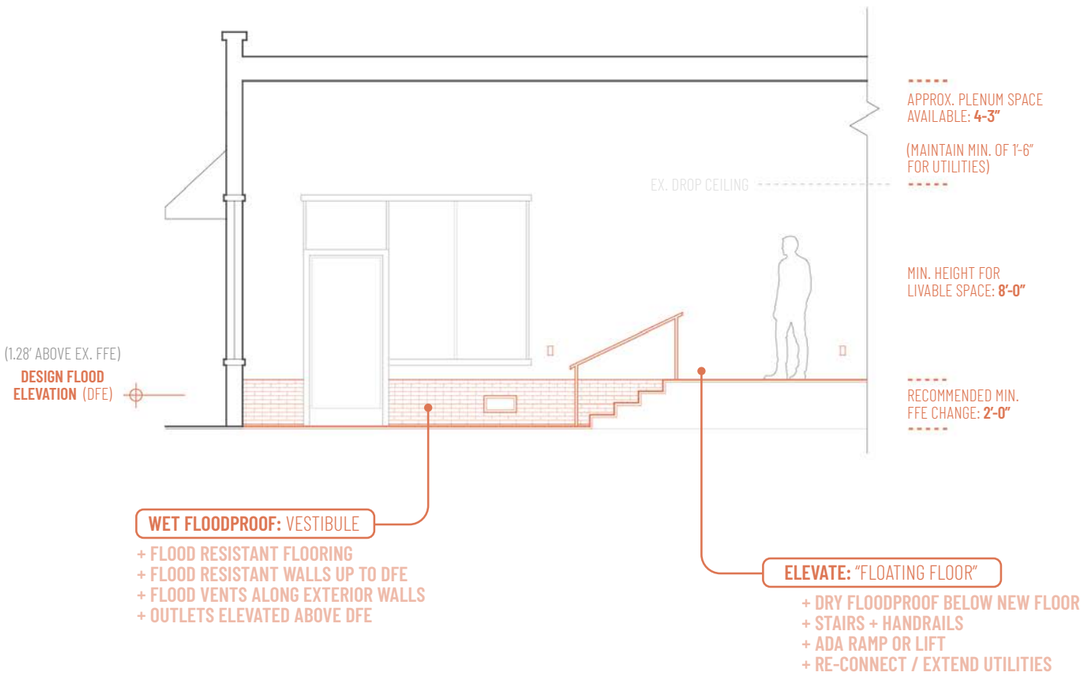


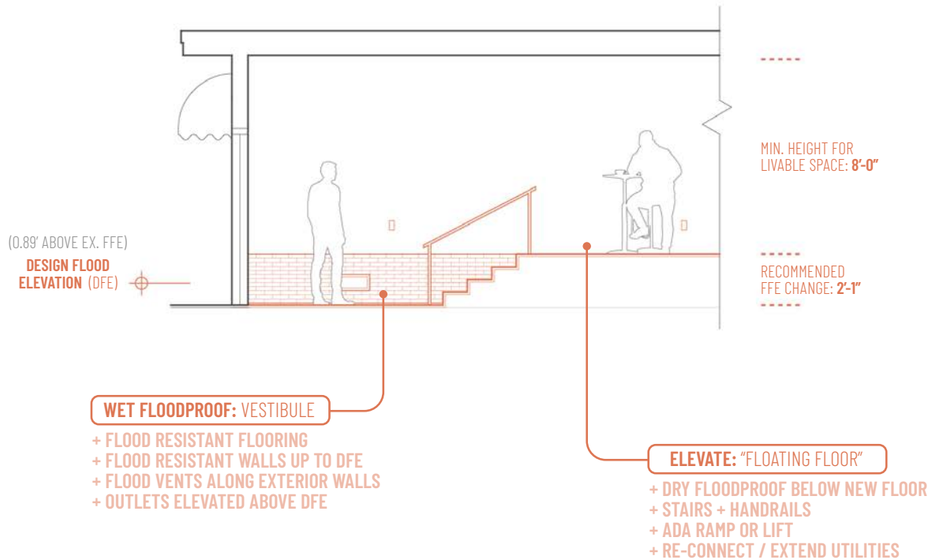
922 + 924 SOUTH MADISON STREET

922 and 924 South Madison Street is a masonry, slab-on-grade commercial structure that was constructed in 1951. Located within Whiteville's Special Flood Hazard Area, the Base Flood Elevation (BFE) for this structure is at elevation 56.10-feet, meaning the Design Flood Elevation (DFE) is 58.10-feet. The existing First Floor Elevation (FFE) of the structure is 57.16-feet, which leaves the primary livable space 0.94-feet below the DFE. Field measurements confirm ample space within the interior of the building to raise the FFE by at least 1-feet, 11-inches if the plenum area is reduced to a minimum dimension, and potentially more, if the area above the existing drop ceiling is made available.









1001 + 1003 SOUTH MADISON STREET

1001 and 1003 South Madison Street are both masonry, slab-on-grade commercial structures that were constructed in 1948 and 1949, respectively. Located within Whiteville's Special Flood Hazard Area, the Base Flood Elevation (BFE) for both structures is at elevation 55.90-feet, meaning the Design Flood Elevation (DFE) is 57.90-feet. The existing First Floor Elevation (FFE) of both structures is 56.62-feet, which leaves the primary livable space 1.28-feet below the DFE. Field measurements confirm ample space within the interior of the buildings to raise the FFE by at least 2-feet, 0-inches, and potentially more, should additional space above the existing drop ceiling be utilized.

1015 + 1017 + 1019 SOUTH MADISON STREET

1015, 1017, and 1019 South Madison Street is a masonry, slab-on-grade commercial structure that was constructed in 1965. Located in Whiteville's Special Flood Hazard Area, the Base Flood Elevation (BFE) for this structure is at elevation 55.90-feet, meaning the Design Flood Elevation (DFE) is at 57.90-feet. The existing First Floor Elevation (FFE) of the structures is 57.01-feet, which leaves the primary livable space 0.89-feet below the DFE. Field measurements confirm ample space within the interior of the building to raise the FFE by approximately 2-feet, 1-inch before reaching the lowest vertical constraint (ceiling / roof substructure).

“DE-PAVE” PROGRAM

While acquisition (and demolition) or elevation techniques geared towards reducing damages to buildings will generally be the most substantive mitigation response for severe flooding events, a com bined approach that also considers nature-based infrastructure in the rights-of-way will help reduce the impacts of smaller-scale flooding and drainage issues in downtown Whiteville.

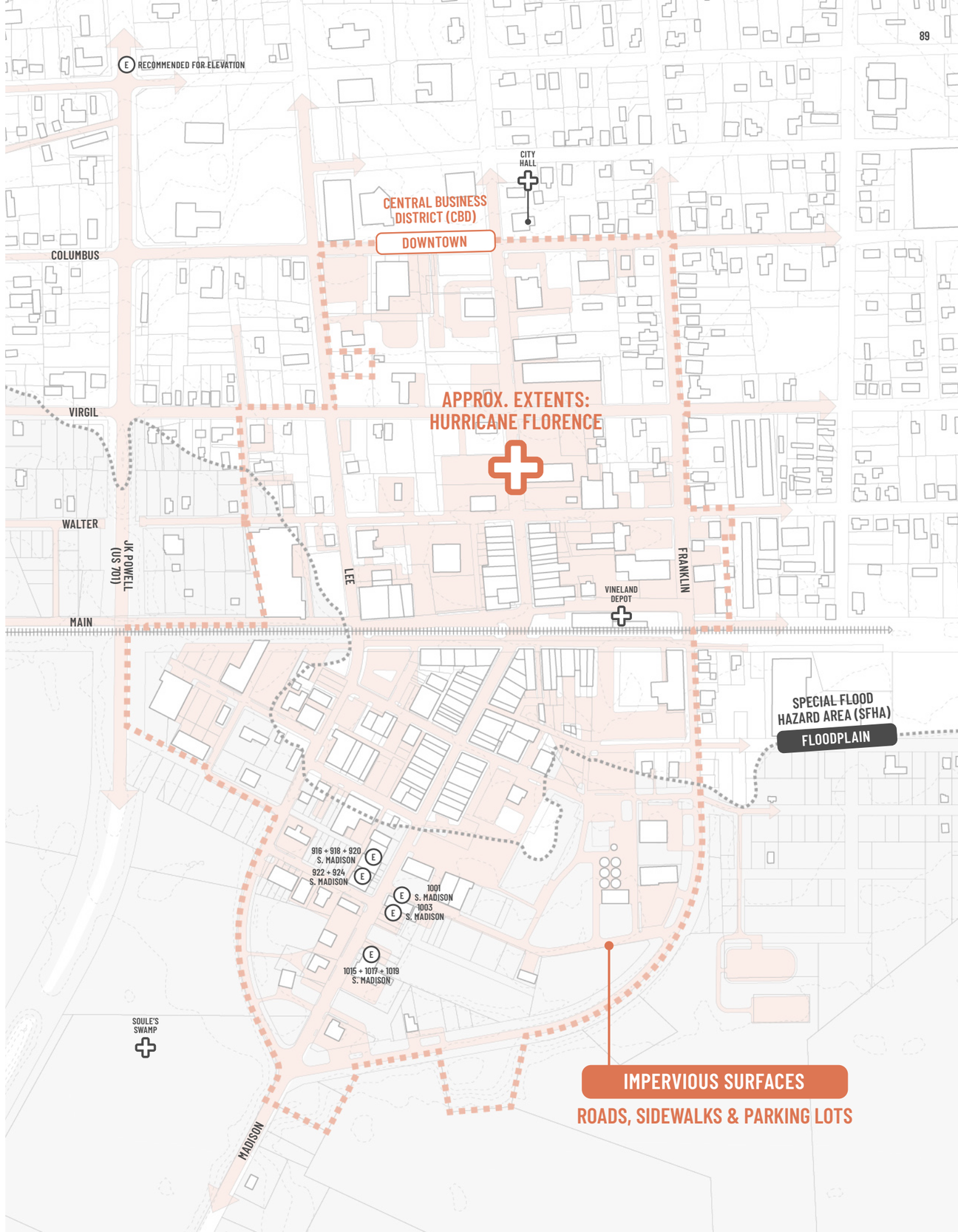
The proposed intervention is to establish a “de-pave” program that decreases paved surfaces in the downtown area by converting underutilized hardscape areas (impervious) into various forms of green infrastructure (pervious) that can better absorb stormwater, such as: planting strips and bulb outs along streets or floating islands in parking lots.

The provided photos show a selection of these existing streetscape conditions in Whiteville’s downtown core (source: Google Earth, 2022), and compare this imagery to examples of a proposed “de-pave” condition for each (sources; from left to right: Center for Neighborhood Technology, 2022; City of Portland, OR, 2023; City of San Carlos, CA, 2022).

“The proposed intervention is to establish a “de-pave” program that decreases paved surfaces in the downtown area by converting underutilized hardscape areas into various forms of green infrastructure that can better absorb stormwater, such as: planting strips and bulb outs along streets or floating islands in parking lots.”

Photos: Existing Street Views

Photos: Green Infrastructure



PUBLIC ENGAGEMENT POSTERS:

"DE-PAVE" PROGRAM ALTERNATIVES

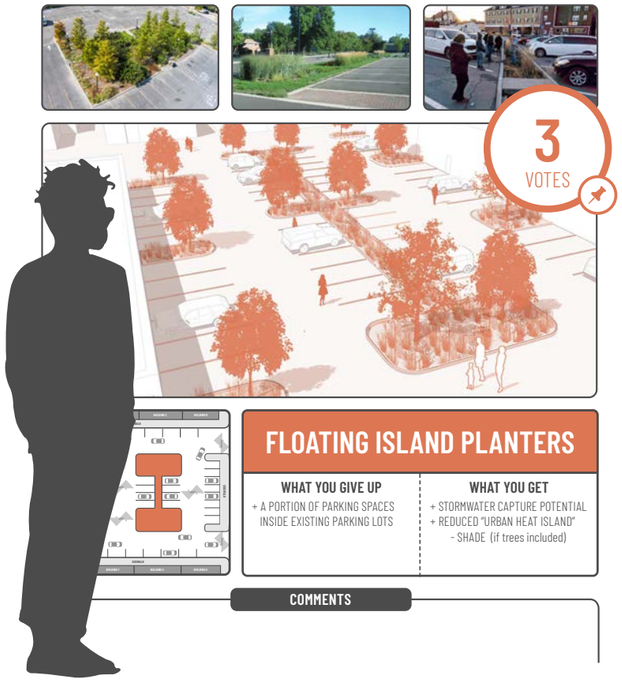
REDUCING NUISANCE FLOODING THROUGH NATURE-BASED INTERVENTIONS

Below are three examples of ways to replace paved areas with green spaces that can reduce nuisance flooding. **Please indicate with a push pin** which of the three alternatives you view as being the top priority in Downtown Whiteville.

EXAMPLE #1 | EXAMPLE #2 | EXAMPLE #3

EXAMPLE #1 | EXAMPLE #2

EXAMPLE #1 | EXAMPLE #2 | EXAMPLE #3



$ INITIAL FUNDING

- EXISTING WHITEVILLE STORMWATER FEE — *leverage as "local match" requirement of bigger grant application (10%-25%)*
- \+
- STATE / FEDERAL GRANT PROGRAM(S) — *primary funding source for design and construction services (75%-90%)*
- ↓
- TOTAL SUM OF MONEY AVAILABLE TO FUND THE PROGRAM

APPLICATION + REVIEW

- PUBLIC PROPERTY (PRIORITIZED LIST)
- \+
- PRIVATE PROPERTY (VOLUNTARY APPLICATION) — *prioritize implementation of potential projects based on scoring metrics (e.g., location within the SFHA, intervention type, etc.)*
- ↓
- TOTAL NUMBER OF PROJECTS THE PROGRAM COULD SUPPORT

DESIGN + CONSTRUCTION + MAINTENANCE

STEP ONE	**ASSESS** THE PROPERTY	*STEP FOUR*	**AGREE** ON TERMS OF MAINTENANCE (AS NEEDED)
STEP TWO	**MATCH** WITH DESIGNER + CONTRACTOR TEAM	*STEP FIVE*	**INSTALL** THE INTERVENTION
STEP THREE	**DESIGN** COLLABORATIVELY	*STEP SIX*	**MAINTAIN** REGULARLY

"DE-PAVE" PROGRAM RECOMMENDATIONS

+ Overall FIndings and Feedback: Of the 21 votes recorded in favor of the three "de-pave" alternatives, there was a clear and distinguishable preference for interventions that focused on green infrastructure enhancements within the public right-of-way (i.e., along major road arteries) as opposed to privately-held properties (i.e., many of the parking lots in downtown Whiteville). Together, "planting strips" and "bulb outs" received 18 votes (85.7%), while the "floating island planters" received only 3 votes (14.3%).

As the City: i) has recently completed design and planning exercises focused on improvements to Madison Street (the primary arterial road through the Central Business District), and ii) has also been actively making progress toward stormwater infrastructure improvements within the downtown area, the results from the "de-pave" exercise present an opportunity to further leverage these investments already being made in the Central Business District. Acting as either its own standalone program or as an additional layer to either Madison Street or stormwater improvements, the "de-pave" initiative is one that can further support Whiteville's environmental, economic, and social needs.

CHAPTER
04

PLANNING LINKAGES + CASE STUDIES

Planning linkages and points of potential financial leverage are present across various scales of impact for the identified projects. The proposals along Mollie's Branch and within the Downtown Core afford the potential to either be connected to each other and/or considered to be a part of existing initiatives that are already underway at the local- and state-level.

This section of the report illustrates these potential connections through a "Linkages Plan" and also provides case studies of each indicated project type: stream restoration, interior retrofits / elevations, and a "de-pave" program (as included in the preceding focus area recommendations).

LINKAGES PLAN

While the recommendations within both focus areas of the Whiteville Floodprint report – Mollie's Branch and the Downtown Core – can progress as independent projects, certain planning decisions could allow these efforts to either: i) leverage momentum from each other; or ii) leverage momentum from existing initiatives.

While the proposed projects along Mollie's Branch and in the Downtown Core can progress independently, additional planning efforts could allow for momentum in one area to be leveraged in the other.

+ Leveraging Momentum from Each Other. If the two focus areas can be physically connected, it may allow for investments in one area to count toward the financial matching requirements of grant programs in the other. Spatially, two pathways for connecting the Mollie's Branch project area to the Downtown Core could be pursued:

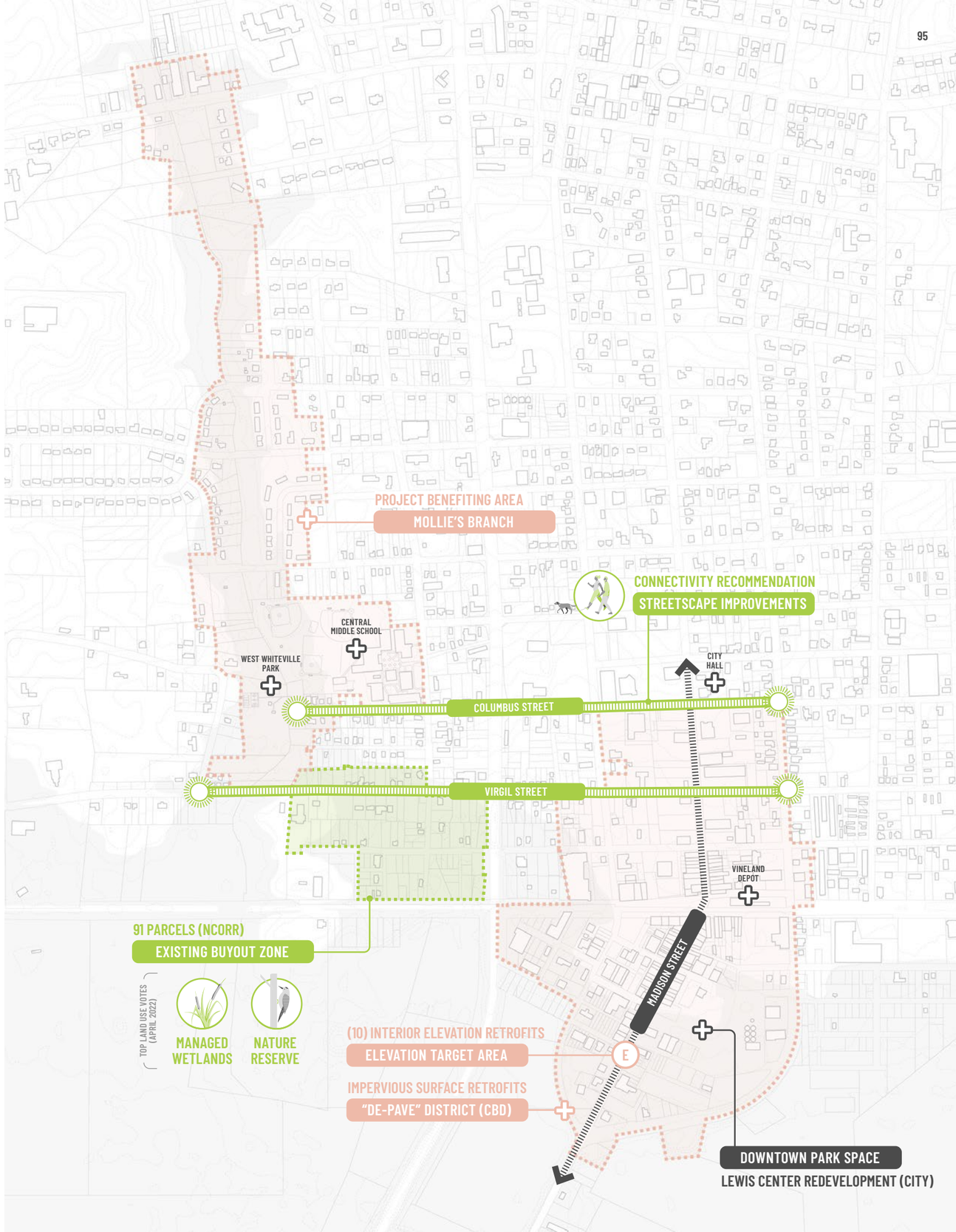
1. Consider streetscape improvements in the public rights-of-way along Columbus Street and/or Virgil Street as part of an expanded project area for Mollie's Branch and the "De-Pave" program. Columbus Street, specifically, provides a direct connection between Whiteville's Central Business District (CBD) and the existing parking area for West Whiteville Park (adjacent to Mollie's Branch). Improving pedestrian access and safety by filling in gaps in sidewalk coverage (approximately two blocks), installing crosswalk striping and pedestrian crossing beacons, and adding vegetative buffers comparable to "de-pave" recommendations (e.g., street trees and bioretention areas) for the four (4) blocks in between Madison Street (at City Hall) and the parking area at West Whiteville Park will make this connection more robust, and potentially allow investments in one area to start building toward matching requirements in the other.

2. Alternatively, the existing ninety-one (91) parcel buyout zone (in between Mollie's Branch and the Downtown Core) could be considered as part of the connecting fabric. Here, challenges currently exist with non-contiguous parcel ownership conditions; however, land uses conforming to post-acquisition regulations (e.g., 44 CFR Part 80): exist within the Mollie's Branch proposal, are required of properties that move through buyout processes (and therefore owned by the City post-acquisition), and can be reflected in public rights-of-way conditions within "de-pave" program areas (e.g., bioretention areas).

+ Leveraging Momentum from Existing Initiatives. Within the Downtown Core, the City has multiple efforts underway that could potentially be enhanced by or considered a part of the "de-pave" program.

Specifically, conversion of the former Lewis Smith Shopping Center into a public parkspace, pedestrian-focused enhancements within the right-of-way along Madison Street, and/or Municipal Drainage District improvements targeted as storm-sewer capacity could all be connected to a "de-pave" initiative.

Lastly, North Carolina Emergency Management (NCEM) has actively been working with both Columbus County and the City of Whiteville in managing and administering various mitigation efforts with funding that is either currently available or will soon be available as a result of the various disaster declarations that have impacted the county in recent years. The City is encouraged to continue working with NCEM to specifically align potential State-level funding opportunities with properties identified as being suitable for interior retrofit forms of elevation in the Special Flood Hazard Area (SFHA).



CASE STUDIES

MOLLIE'S BRANCH: STREAM RESTORATION

Photos: Post-construction condition (Auburn University).

Photos: Pre-construction conditions (left); restoration conditions (right) immediately post-construction (Biohabitats).

LITTLE SHADES CREEK (ALABAMA)

Description: The Little Shades Creek project restored 1,900 linear feet of stream in Vestavia Hills, Alabama. Little Shades Creek is a tributary to Shades Creek in the Cahaba River Basin, with a drainage area of eight square miles.

Goals + Objectives: The purpose of the project was to protect water quality and infrastructure. This was achieved through a variety of means, including: i) controlling erosion and reducing sedimentation by utilizing natural channel design techniques; ii) installing BMPs to remediate runoff from urban sources; and iii) providing educational opportunities regarding non-point source pollution and effective stormwater management techniques. Priorities included reconnecting the floodplain and excavating narrow floodplain benches in a confined corridor.

Community Benefits: Restoration activities involved a 30-to-60-foot wide riparian buffer, a 0.5 acre stormwater wetland, ten (10) stormwater outfall channels, a sewer crossing, a greenway trail, and educational signage. Community engagement activities included workshops on construction, planting, and maintenance. Post-construction project monitoring showed that stream erosion was eliminated, the floodplain and wetlands function as intended, and that vegetation, water quality, and habitats have improved.

Fast Facts:

+ **Project Initiated:** 2009
+ **Construction Complete:** 2011
+ **Design:** GMC and Jennings
+ **Construction:** North State Environmental
+ **Funding:** Alabama Department of Environmental Management and an EPA 319 Grant (Clean Water Act Section 319(h) funds).

GOOSE CREEK (NORTH CAROLINA)

Description: The Goose Creek project restored 1,465 linear feet of stream in downtown Durham, North Carolina. Goose Creek is an urbanized watershed that supplies water to the Falls Lake reservoir, a major source of drinking water for Raleigh. This stream restoration project is adjacent to Eastway Elementary School, the Barnes Avenue Community Redevelopment Project, and the City of Durham Longmeadow Park.

Goals + Objectives: The purpose of the project was to improve habitat and decrease sedimentation within a relatively narrow project corridor. The methods of achieving this objective included: eradicating artificial hardening structures, restoring a more natural channel geometry, and restoring a riparian buffer.

Community Benefits: Restoration activities involved constructing a natural, stable profile for the stream channel, re-establishing the riparian buffer along the stream band, increasing the prominence of riffles and pools, and improving aquatic habitat. The final design included more natural sinuosity, channel features such as riffles, runs, pools, and glides, and a two-stage channel to preserve low flow capabilities (the stream is a low sediment-supply setting). Post-construction monitoring revealed improved aquatic habitat, and successful vegetation establishment and restoration.

Fast Facts:

+ **Project Initiated:** 2005
+ **Construction Complete:** 2009
+ **Design:** Biohabitats
+ **Construction:** Shamrock Environmental
+ **Funding:** North Carolina Ecosystem Enhancement Grant Program (NC EEG)

CASE STUDIES

DOWNTOWN CORE: INTERIOR RETROFITS / ELEVATIONS

Photos: Floodproofed vestibule with elevated primary livable space in Darlington, Wisconsin (U.S. Army Corps of Engineers).

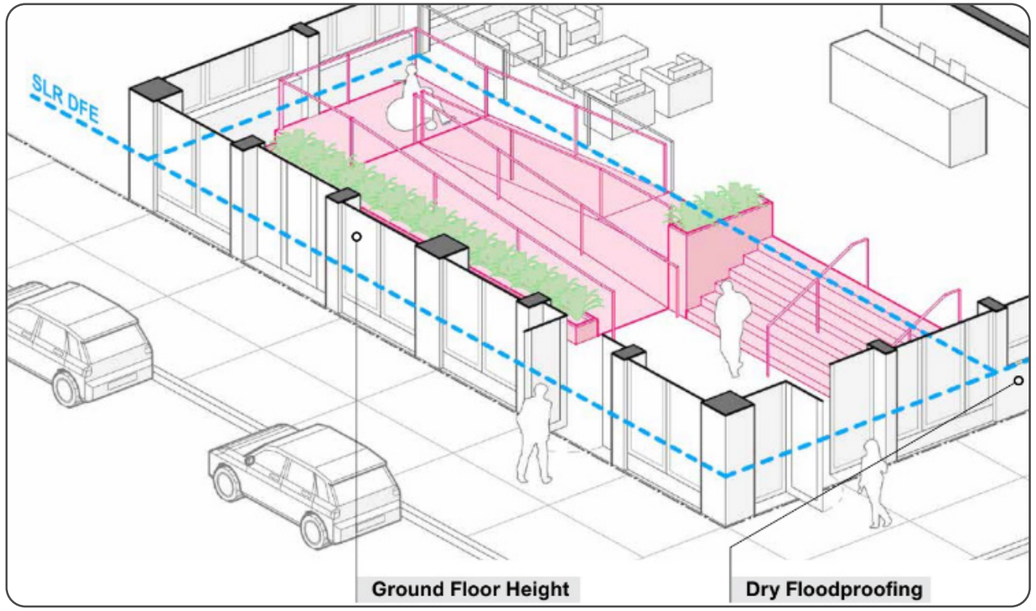


Image: Example of desing guidelines for interior retrofits / elevations (Boston Planning and Development Agency).

DARLINGTON HISTORIC DISTRICT (WISCONSIN)

Description: After intense flooding of the adjacent Pecatonica River in 1990 and 1993, the City of Darlington, Wisconsin adopted a flood mitigation plan which included provisions for the interior elevation of at-risk historic buildings.

Goals + Objectives: The mitigation plan held the simultaneous goal of reducing the flood impact while maintaining the historic downtown character. The plan called for the interior elevation of nineteen (19) downtown businesses, all within Darlington's Main Street Central Business District listed on the National Registrar of Historic Places. Each at-risk business building was renovated with a hardened-concrete vestibule with stairs leading to a newly elevated first floor. These floodable entryways hold water with reinforced concrete walls and removable aluminum flood shields set into steel stanchions cast into the top step.

Community Benefits: The mitigation program funded the first floor improvements, although property owners were responsible for building rehabilitation. In conjunction with the flood mitigation benefits, the property values of the elevated buildings nearly doubled. The elevations maintained the historic character of the Darlington downtown, leaving existing windows, doors, and other façade elements untouched.

Fast Facts:

+ **Project Initiated:** 1993
+ **Design:** Vierbircher
+ **Funding:** Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program (HMGP), with local match through Wisconsin Division of Emergency Management (WEM) and Wisconsin Department of Commerce.

BOSTON DESIGN GUIDELINES (MASSACHUSETTS)

Description: In response to major coastal flood challenges spanning a city with diverse building typologies, the City of Boston, Massachusetts developed the "Coastal Flood Resilience Design Guidelines" as a resource to help property owners and developers adapt to future climate change conditions.

Goals + Objectives: The document outlines a suite of flood mitigation strategies for different building types and conditions. These strategies deploy a range of best practices for wet and dry floodproofing, and structural elevation techniques while still remaining specific to Boston's building stock and surrounding context. The guidelines contribute to the overall enhancement of the public realm, improve urban sustainability, and connect individual upgrades to larger-scale resilience initiatives.

Community Benefits: The public-facing document visualizes a wide range of various elevation and floodproofing typologies so that they can be accessible and easily understood by a diverse audience. Furthermore, by embedding these resilience strategies within an official municipal document, this project provides a streamlined pathway for owners or developers to pursue these mitigation responses in a unified manner consistent with City standards and expectations.

Fast Facts:

+ **Project Initiated:** 2016
+ **Design:** Boston Planning and Development Agency
+ **Funding:** City of Boston

CASE STUDIES

DOWNTOWN CORE: "DE-PAVE" PROGRAM

Photo: Conversion of a vacant lot into a stormwater management device (New Orleans Redevelopment Authority).

Photo: Landscaped planters cleaning and absorbing stormwater along the street (Kevin Robert Perry / Urban Rain Design)

GENTILLY RESILIENCE DISTRICT (LOUISIANA)

Description: The City of New Orleans and the New Orleans Redevelopment Authority (NORA) launched the city's first ever Resilience District in the Gentilly neighborhood (GRD) in 2014. The program provides funding for the design and installation of a range of small-scale stormwater management interventions that help manage flooding around homes and within the neighborhood. Typical project types include: rain gardens, stormwater planter boxes, rain barrels, detention basins, planted trees, reductions in impervious surface, and infiltration trenches.

Goals + Objectives: The GRD is meant to introduce and study green infrastructure projects that could be used throughout the city in the future. These projects are intended to reduce localized flooding, improve public health, increase awareness about stormwater management impacts, improve economic well-being, and lessen future loss from excess stormwater.

Community Benefits: The program covers up to $25,000 in design and construction costs for each eligible household in the Gentilly neighborhood (which typically yields 'no-cost' projects to the households), with designers and general contractors creating custom proposals for each property based on interests and needs.

Fast Facts:

+ **Project Initiated:** 2014
+ **Design:** Various
+ **Construction:** Various
+ **Maintenance:** Private
+ **Funding:** Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program (HMGP), and the U.S. Housing and Urban Development (HUD) National Disaster Resilience Competition (NDRC).

SW 12TH AVENUE GREEN STREET PROJECT (OREGON)

Description: The SW 12th Avenue Green Street project, located in Portland, Oregon, transforms the pedestrian zone of the street to sustainably manage street stormwater runoff. This urban green street project converts the previously underutilized landscape area between the sidewalk and street curb into a series of landscaped stormwater planters designed to capture, slow, cleanse, and infiltrate street runoff.

Goals + Objectives: The design of the SW 12th Avenue Green Street has met three important goals: i) it is low-cost in its design and execution (approximately $30,000 to construct / retrofit); ii) it benefits the environment and embodies community livability; and iii) it provides a model for other jurisdictions in addressing important national and local stormwater regulations. These stormwater planters are well integrated into the urban streetscape and bring natural hydrologic functions back into the City.

Community Benefits: Over one-third of Portland's 2,500 miles of sewer pipes are more than 80 years old. Green infrastructure protects the aging sewer system and makes it operate more efficiently by keeping stormwater out of sewers, while also: enhancing wildlife habitat, improving mental and physical health, increasing property value, conserving energy, and saving money on more costly pipe infrastructure.

Fast Facts:

+ **Construction Complete:** 2005
+ **Design:** Kevin Robert Perry, Bureau of Environmental Services, City of Portland
+ **Construction:** City of Portland, Department of Transportation
+ **Maintenance:** City of Portland, Department of Parks & Recreation
+ **Funding:** City of Portland

CHAPTER

05 | APPENDICES + RESOURCES

APPENDIX A: HUD / NCORR DEFINITION OF "MOST IMPACTED AND DISTRESSED" (MID) COMMUNITIES

Qualifying for a Most Impacted and Distressed (MID) designation by the North Carolina Office of Recovery and Resiliency (NCORR) is a result of a combination of three components: i) location; ii) qualities demonstrating that the area is "most impacted;" and iii) qualities demonstrating the area is "most distressed."

The location of the area is critical to the MID designation. It must be a sub-county area within a county declared by the President to be a major disaster area under the Stafford Act. This sub-county area can be a census-designated place, a tribal area, or a census tract.

The sub-county area must demonstrate that it is "most impacted" by qualifying under at least one of these factors: i) housing; ii) infrastructure; iii) economic revitalization; and/or iv) environmental degradation. To qualify under the "housing" factor, there must be damage to either a minimum of 100 homes or there must be serious damage to a minimum of 20 homes. To qualify under the "infrastructure" factor, there must be damage to permanent infrastructure estimated at $2 million or greater. To qualify under the "economic revitalization" factor, there must be significant employment loss and extended harm to the local economy. To qualify under the "environmental degradation" factor, the damage must threaten the long-term recovery of critical natural resources.

In addition to qualifying as "most impacted," the area must also demonstrate that it is considered "most distressed" by qualifying under at least one of these factors: i) low- and moderate-income households; ii) loss of affordable rental housing; iii) it is a federal target area or economically fragile area; and/or iv) the area has prior documented environmental distress. To qualify under "low- and moderate-income households," greater than 50% of the people living in the area must make less than 80% of the Area Median Income (AMI). To demonstrate that the area qualifies under "loss of affordable rental housing," there must be a minimum of 100 renters with less than 50% of the median income. 60% or more of these renters must have a severe housing problem. To qualify as a federal target area or economically fragile area, the area must be: i) a tribal area; and/or ii) is a Strong Cities Strong Communities site; and/or iii) the area's unemployment rate is more than 125% of the national average unemployment rate. To qualify under "prior documented environmental distress, the area must contain a contaminated property that has been cleaned, or is undergoing cleanup, or is proposed for cleanup.

Another avenue for qualifying for MID designation by NCORR is by simply being a county that was previously determined by the US Department of Housing and Urban Development (HUD) to be "most impacted."

APPENDIX B: ECOSYSTEM SERVICE AREAS FOR THE MOLLIE"S BRANCH PROJECT AREA

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