NC Flood Resiliency Blueprint Tool

Methods Review

Principal Advisory Group

Date: January X, 2025
Time:
Mode: Hybrid

Introduction

Agenda

Community Profile

- Estimating the Impact of Flooding on People, Environment, Infrastructure, and Economic Sustainability

Flood Risk Management - Flood Resiliency Actions

- Category: Nature-Based Solutions
  - Afforestation
  - Water Farming
  - Flood Storage Wetlands
  - Floodplain Restoration
- Category: Infrastructure & Control Structures
  - Levees
  - Dams

Estimating the Impact of Flooding on People, Environment, Infrastructure, and Economic Sustainability

Afforestation

Resiliency Action Method

Definition:
Afforestation is the practice of planting forest vegetation on land that previously had no tree cover, which can reduce peak-flow flooding.

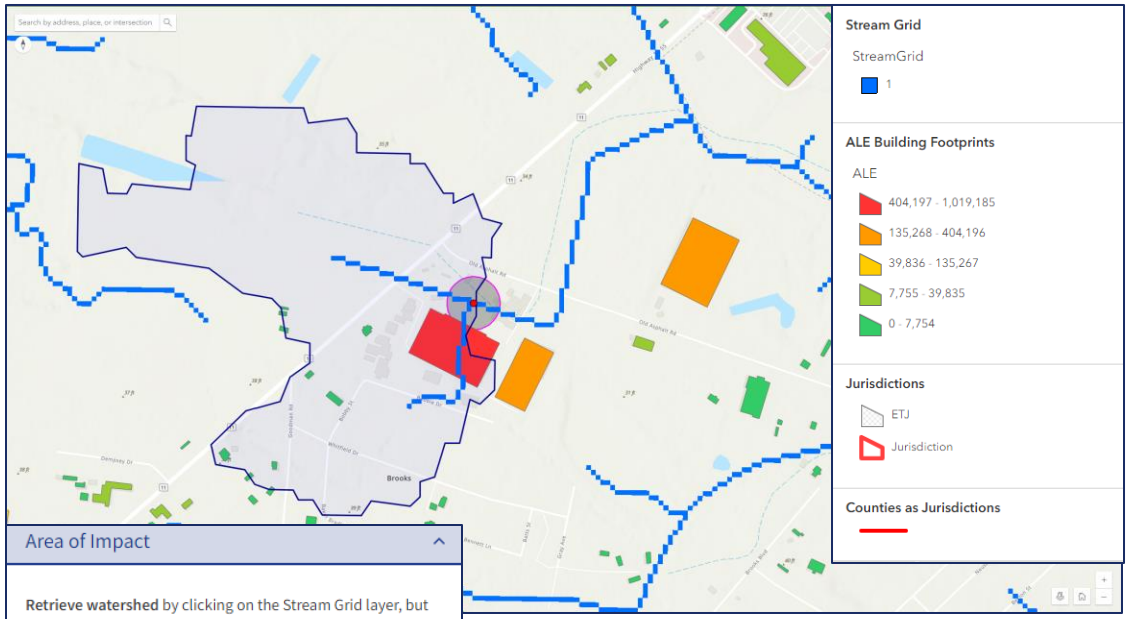
Opportunity Area Mapping

1. Basin-to-Catchment Scale Hydraulic Tracing Tool
2. Area of Interest Pre-Processed Refinements and Multipart Polygon Features

Project Development

1. Project Comparison Table and Related Management Filters
2. Area(s) of Interest Selection
3. Project Development Adjustments and Information

Afforestation Spatial Planning & Feasibility



Area of Impact

Retrieve watershed by clicking on the Stream Grid layer, but avoid main branches.

- Stream Grid
- Point of Interest
- Watershed

Click on the Stream Grid layer to retrieve watershed

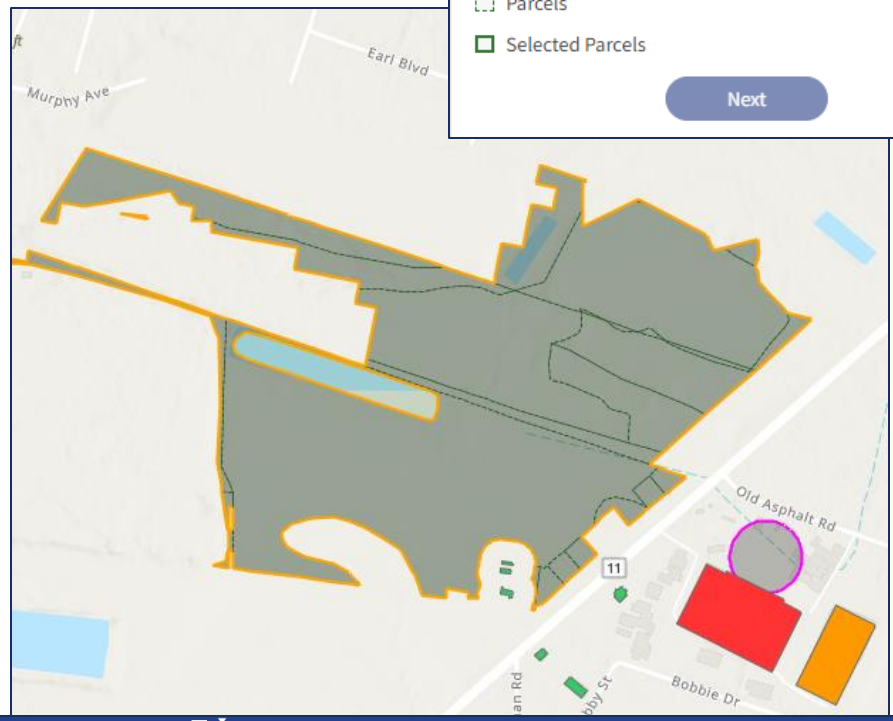
Clear | Next

Resiliency Action Location

Select afforestation parcels by clicking on the map or selection in the table.

- Parcels
- Selected Parcels

Next



Impacted Buildings | **Afforestation Parcels**

Clear Selection | Reset Filters | Show Only Selected

	Parcel No.	City	Acres	FEMA Zone	Soil Erosion	Soil Productivity
		KINSTON		All	All	All
☐	4535-43-5359	KINSTON	88.5	X	Moderate	Medium
☐	4535-43-6620	KINSTON	88.5	X	Moderate	Medium
☐	4535-31-5088	KINSTON	897.5	X	Moderate	Medium
☐	4535-42-5024	KINSTON	343.5	X	Moderate	Medium
☑	4535-42-3982	KINSTON	907.6	X	Moderate	Medium
☐	4535-43-3339	KINSTON	91.8	X	Moderate	Medium

Afforestation Implementation Costs

Lowland Areas - Cherrybark Oak	Cost/Acre (2020)	Cost/Acre (2024)
Mechanical Site Prep	$100	$119
Chemical Control	$95	$113
Planting	$160	$191
Seedlings	$240	$286
Herbicide	$65	$78
Fertilizer	$0	$0
Total Costs	**$660**	**$787**
Total Program Costs*	$396	$472
Maintenance/yr**	$12	$14

*The conservation program would cover 40% of establishment costs for Loblolly and 60% for Hardwood for landowners to get an acceptable rate of return.

** 30-year rotation for Pine and 60-year rotation for Hardwood.

***Source**: Fred Cubbage, Forest Economists, NCSU*

Upland Areas - Loblolly Pine	Cost/Acre (2020)	Cost/Acre (2024)
Mechanical Site Prep	$100	$119
Chemical Control	$80	$95
Planting	$100	$119
Total Costs	**$280**	**$334**
Total Program Costs*	$112	$134
Maintenance/yr**	$10	$12

Afforestation Costs For Volume of Water Stored

	Pine	Hardwood
Costs Per Acre	$334	$787
Water Storage Potential (acre-ft/acre)	0.10 - 0.33	0.10 - 0.33
Cost Per Unit Water Stored ($/acre-ft)	$404 - $1,336	$1,432 - $4,724

Afforestation Method Data

Description	Data Source	Key Variables
Parcels	NC OneMap	Area
Municipal Boundaries	NC OneMap	Jurisdictional limits
Road Data	NCDOT	• Interstates • Primary Roads • Secondary Roads • Other System Roads • Non-System Roads
Rail Tracts	NCDOT	All standard gauge freight and passenger railroad tracks in NC
Buildings	NCEM	Footprint Area
Stream Grid	Description: StreamStats - NHDPlus Organization: USGS	Gridded representation of the stream network
Open Space Land Cover (NLCD)	USGS	• Hay/Pasture • Cultivated Crops • Herbaceous (Grasslands) • Shrub/Scrub
Duke Energy electric and natural gas easements	Duke Energy and Piedmont Natural Gas	Transmission Lines
Regulatory Floodplain	FEMA	• Flow • 100-YR • 500-YR • X
Soil Survey Geographic Database	USDA-NRCS	• Soil Productivity • Soil Erodibility (K-Factor) • Hydric Soil Score
Project Development	Report: Improving North Carolina's Resilience to Coastal Riverine Flooding Organization: NC Policy Collaboratory	• Annual Maintenance & Management Costs • Design and Construction Costs • Water Storage Potential • Cost per Unit Volume of Water Stored • Useful Life

Resiliency Action Profile

Category: **Nature Based Solutions**
Type: **Afforestation**

Area Type: Lowlands
Afforestation Type: Cherrybark Oak

Acres: 1,030.5
Cost per Acre: $ 787

Total Cost
$ 811,000

Cost to Jurisdiction: $ 324,400
Paid by Conservation: $ 486,600

Annual Maintenance Cost per Acre: $ 14
Total Annual Maintenance Cost: $ 14,427

Water Storage (ac-ft) From: 103
To: 344

Cost per Acre-Foot From: $ 2,361
To: $ 7,866

Save Resiliency Action

1 **General Details**
2 Questions for Ranking
0 of 15 completed
3 Project Complexity
0 of 17 completed

Resiliency Action Name *
Afforestation Kinston

Resiliency Action Description
Add description...

Qualitative Information
Add any additional information not included in your action profile. This can include a description of key assumptions, barriers to implementation, action objectives, available resources, status of stakeholder collaboration efforts, etc.

Resiliency Action Details

Resiliency Action Category	Nature Based Solutions
Resiliency Action Type	Afforestation
Losses Avoided	$0
Cost Effectiveness	0
Buildings Impacted	1
Building Damages	$1,555,000

Cancel
Save Action

Water Farming
Methodology

Definition:
Water Farming projects are designed to retain and slowly release water to reduce downstream flooding and water quality impacts. Projects accomplish this by storing onsite runoff during anticipated significant flood events behind berms or terraces less than five feet high and with flashboard weirs or similar flexible control structures.

Opportunity Area Mapping

1. Basin-to-Catchment Scale Hydraulic Tracing Tool
2. Area of Interest Pre-Processed Refinements and Multipart Polygon Features

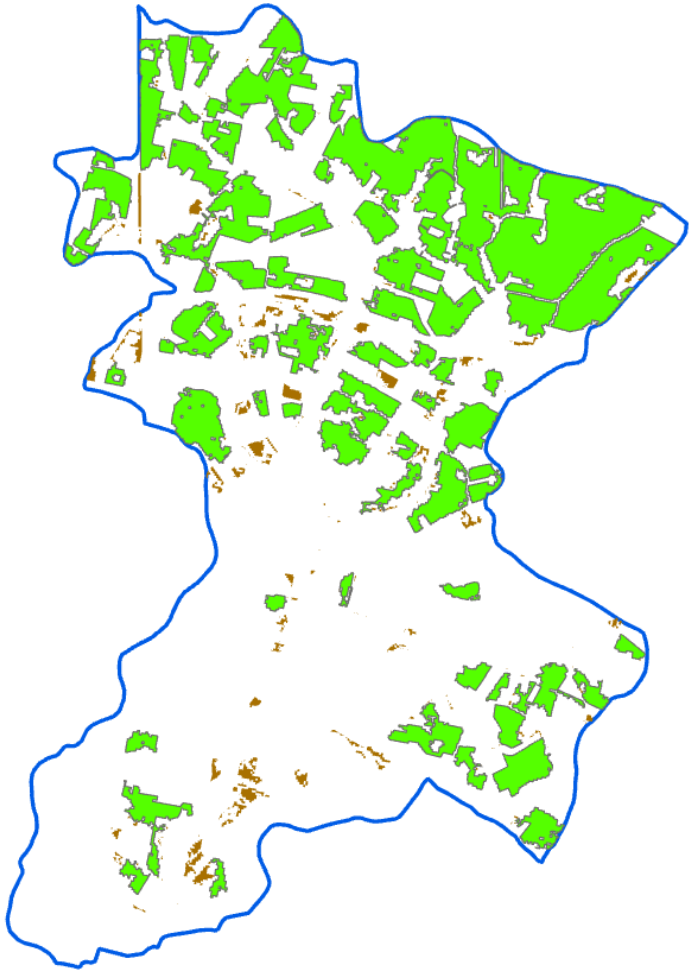
Project Development

1. Project Comparison Table and Related Management Filters
2. Area(s) of Interest Selection
3. Project Development Adjustments and Information

Water Farming

Pre-Processed Data

- Parcel-based opportunities will consist of several **500'x500'** grids, or partial grids, within a project boundary. No grids are shown in areas with parcel sizes **less than 10 acres**.
- The Nature Conservancy has developed a landforms dataset, which was used to eliminate areas modeled as wetter or side-sloped landforms that are less suited to this nature-based solution. In general, land areas with a **slope of >2%** may be unsuitable for implementation and have been removed during opportunity modeling.
- The modeled sites target **forested** and **open land types** from the NLCD database and identify the land type for each eligible grid-based opportunity cell.
- Sites in the floodplain or that conflict with a **100 ft railroad buffer** have been removed from the eligible sites.



Water Farming

Key Variables

Variable	Value
Construction Costs	$6,478 per Acre
Maintenance Costs	$60 per Acre per Year
Practice Life	50 Years
Water Storage Volume	1 Acre-Feet per Acre

User Entered Information

- Final catchment area for water farming opportunity
- Final forested catchment area for water farming opportunity
- Estimated area to be flooded by water farming berm and associated outlet structures
- Average ponding depth behind water farming berm
- How many landowners will be part of the project?
- What is the type of land acquisition mechanism?
- What is the estimated cost per acre for land acquisition?
- For annual payments, calculate the sum product of the total payment period multiplied by the duration of the practice.

Water Farming Method Data

Description	Data Source	Variable(s)
Parcels	NC OneMap	Area in Acres
Municipal Boundaries	NC OneMap	Jurisdictional limits
20ft. DEM Raster	NC OneMap	Slope: • Most Suitable < 1% • Possible = 1% - 2% • Not Suitable > 2%
Regulatory Floodplain	NCEM	• Flow • 100-YR • 500-YR • X
Railroads	NCDOT	Polyline Features
Open Space Land Cover (NLCD)	USGS	• Hay/Pasture • Cultivated Crops • Herbaceous (Grasslands) • Shrub/Scrub
Forested Land Cover (NLCD)	USGS	• Deciduous Forest • Evergreen Forest • Mixed Forest
Stream Grid	Description: StreamStats - NHDPlus Organization: USGS	Gridded representation of the stream network
Landforms	The Nature Conservancy	• Upper Flat • Dry Flat • Pluvial Flat
Project Development	Report: Improving North Carolina's Resilience to Coastal Riverine Flooding Organization: NC Policy Collaboratory	• Annual Maintenance & Management Costs • Design and Construction Costs • Water Storage Potential • Useful Life

Water Farming
Results

The water farming site you have selected is in X County on an X-acre parcel (list PIN). Adjacent parcels have/don't have water farming opportunities and/but do/don't have other nature-based solution potential.

The selected water farming project site has a catchment footprint of XXXX acres. It is typical for parcels to consist of multiple sub-catchments that drain to different low points and outlets, upgradient of which water farming berms and control structures can be established.

Output	Unit
Estimated footprint of ponding	Acres
Estimated berm footprint for specified height with 2' top width	Acres
Total burdened land	Acres
The estimated total easement (land) cost	Dollars
The anticipated annual maintenance and management cost	Dollars per Year
The anticipated duration of this practice	Years
Total maintenance cost	Dollars
The total water farming design and construction cost	Dollars
The total estimated cost for the project, including establishment and maintenance, land acquisition, and other proposed work.	Dollars
The anticipated water storage potential of this wetland creation project	Cubic Feet
The anticipated water storage potential of this wetland creation project	Cubic Feet
The estimated cost of water storage potential of this wetland creation project, in cubic-feet	Dollars per Cubic-Feet
The estimated cost of water storage potential of this wetland creation project, in acre-feet	Dollars per Acre-Feet

Flood Storage Wetlands Methodology

Definition:

Engineered or restored wetlands designed to reduce flood risk by capturing, storing, and gradually releasing floodwaters. These wetlands are strategically sited in watersheds with drainage areas over 40 acres, using open lands to maximize water storage, improve water quality, and mitigate downstream flooding impacts.

Opportunity Area Mapping

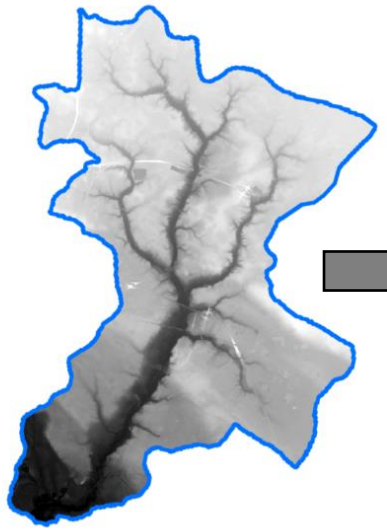
1. Basin-to-Catchment Scale Hydraulic Tracing Tool
2. Area of Interest Pre-Processed Refinements and Multipart Polygon Features

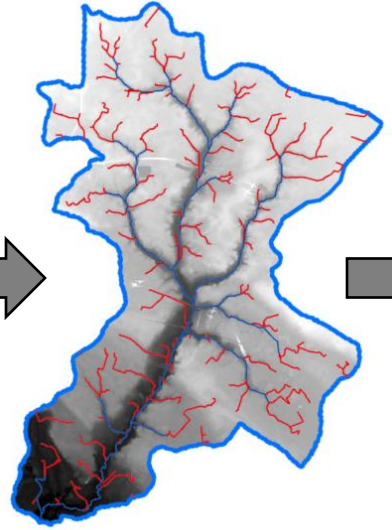
Project Development

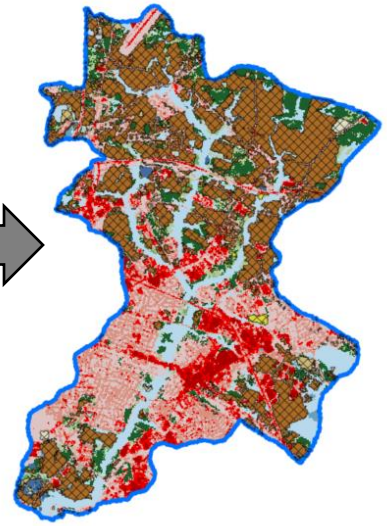
1. Project Comparison Table and Related Management Filters
2. Area(s) of Interest Selection
3. Project Development Adjustments and Information

Flood Storage Wetlands Method Data

Description	Data Source	Variable(s)
Parcels	NC OneMap	Area
Municipal Boundaries	NC OneMap	Jurisdictional limits
Stream Grid	Description: StreamStats - NHDPlus Organization: USGS	Gridded representation of the stream network
Culverts	NCDOT	Area
Open Space Land Cover (NLCD)	USGS	• Hay/Pasture • Cultivated Crops • Herbaceous (Grasslands) • Shrub/Scrub
Buildings	NCEM	Footprint Area
500-YR Regulatory Floodplain	NCEM	0.2% Annual Chance of Flooding
3ft. DEM Raster	NCEM	Elevation
Project Development	Report: Improving North Carolina's Resilience to Coastal Riverine Flooding Organization: NC Policy Collaboratory	• Annual Maintenance & Management Costs • Design and Construction Cost • Water Storage Potential • Useful Life



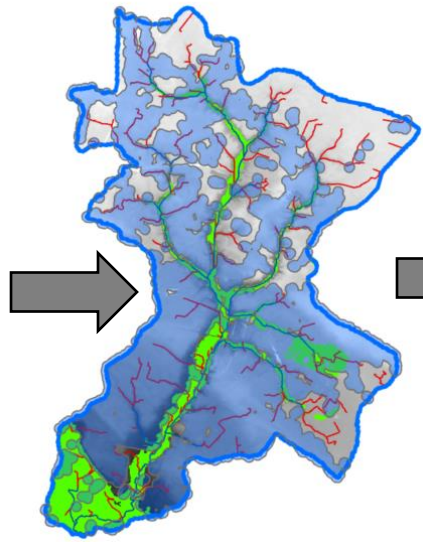


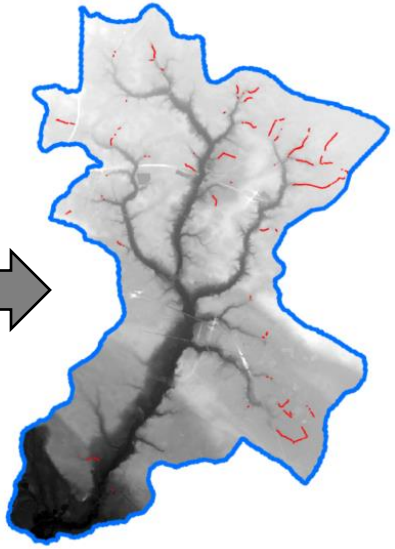


NLCD Land Cover Classification Legend

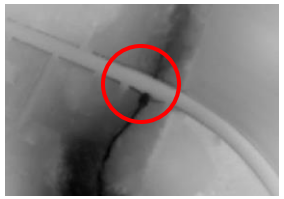
- 11 Open Water
- 12 Perennial Ice/ Snow
- 21 Developed, Open Space
- 22 Developed, Low Intensity
- 23 Developed, Medium Intensity
- 24 Developed, High Intensity
- 31 Barren Land (Rock/Sand/Clay)
- 41 Deciduous Forest
- 42 Evergreen Forest
- 43 Mixed Forest
- 51 Dwarf Scrub*
- 52 Shrub/Scrub
- 71 Grassland/Herbaceous
- 72 Sedge/Herbaceous*
- 73 Lichens*
- 74 Moss*
- 81 Pasture/Hay
- 82 Cultivated Crops
- 90 Woody Wetlands
- 95 Emergent Herbaceous Wetlands

* Alaska only

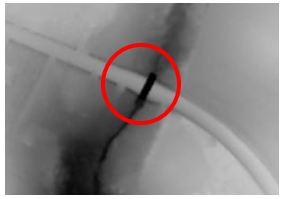




Missing NCDOT Culvert



“Hydro-Correct” DEM



1st and 2nd Order Stream

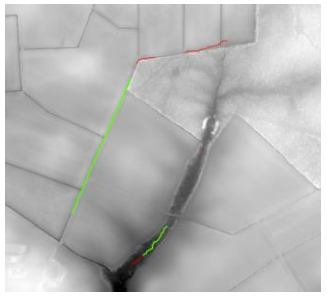
< 2nd Order Stream

Land Cover: Grassland, Shrub, Pasture, and Cultivated Cropland

500’ Building Buffer

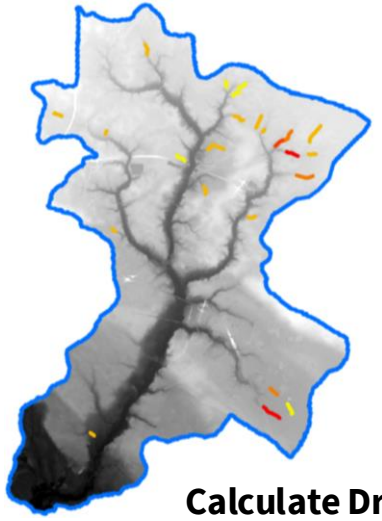
500-yr Floodplain

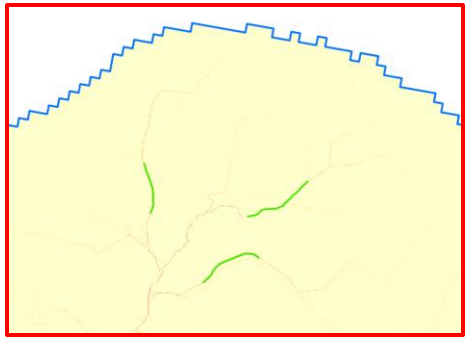
Segment Length > 300ft

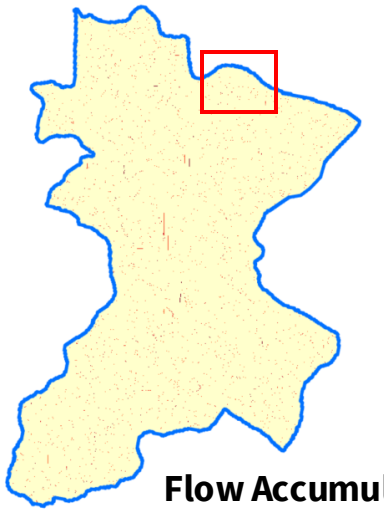


Ditch vs. Max TOB Elevation Difference > 2ft

$$DA = \frac{Raster\ Value\ at\ DS\ end\ of\ reach}{Cell\ size^2} * \frac{43560\ ft^2}{1\ acre} * \frac{640\ acres}{1\ mi^2}$$







Calculate Drainage Area

Flow Accumulation Raster

Flood Storage Wetlands
Key Variables

Variable	Value
Construction Costs	$191,643 per Acre
Annual Maintenance Costs	0.1% of the Dollar per Acre Construction Costs per Year
Useful Life	50 Years
Water Storage Volume	3 Acre-Feet per Acre

User Entered Information

- How many acres of wetland creation are being proposed for this project?
- How many landowners will be part of the flood storage wetland cell(s) being proposed?
- How many acres of land acquisition are required for this project?
- What is the temporary footprint anticipated by the project beyond the footprint of the wetland cells and dams?
- What is the type of land acquisition mechanism?
- What is the estimated cost per acre for land acquisition? For annual payments, calculate the sum product of the total payment period multiplied by the duration of the practice.
- What is the primary crop or farming activity in the area? If you answered yes to the prior question, enter the action ID and sub-ID if known
- Is the parcel currently being farmed?
- How many years in the past decade was the site actively farmed?
- Are you doing any other proposed work on the subject parcels or other parcels related to this specific project?
- How many dams do you plan to construct?
- Are you planning to implement riparian planting within the flood storage wetland cell(s)? Note that access for maintenance of the dam and outlet structure should be maintained.

Flood Storage Wetlands
Tool Generated Action Profile

Design Factors	
Number of parcels involved	Count
Watershed drainage area	Square Miles
Length of drainage segment targeted	Feet
Grade drop over drainage segment	Feet
Predicted number of dams / wetland cells	Count
Effective length of drainage segment considering dams	Feet
Average width required	Feet
Ponding depth	Feet
Predicted preliminary design footprint available for flood storage wetland cell(s)	Acres
Target footprint area in acres (equal to ten percent of the watershed area)	Acres
Percent design footprint to target footprint	Percent
Volume storage	Cubic Feet
Volume storage	Acre Feet

Cost Factors	
Area of land disturbance	Acres
Earthwork volume	Cubic Yards
Number of dams	Count
Dam1 length	Feet
Length of drainage segment for Dam 1	Feet
Dam2 length	Feet
Length of drainage segment for Dam 2	Feet
Dam3 length	Feet
Length of drainage segment for Dam 3	Feet

Flood Storage Wetlands
Tool Generated Action Profile

Flood storage wetlands (FSW) are located on drainage pathways that **exceed 40 acres** of drainage area, but which are **not heavily forested** or in existing **FEMA floodplains**. FSW may be on jurisdictional streams and require permitting to implement. They are intended to flow freely under normal conditions and pond during flooding when the low flow outlet would be closed or otherwise restrictive to outflow. FSW volume storage potential is based on a typical design for **3.0 feet of ponding** within the footprint of the wetland.
The opportunity you have selected is in X County and is for work on (**list #**) parcel(s) X, X, and X (**list PINs**). The anchor parcel is **PIN XXXX**.
The selected flood storage wetland has an estimated footprint of **X** and treats an **XXX** square mile (**XXX** acre) watershed.

Results	
The estimated cost per acre for wetland creation construction without land acquisition or design costs	$191,643
The total wetland creation cost	Dollars
The anticipated annual maintenance cost (as 0.1% of Construction Cost in dollars per acre per year)	Dollars per Year
The anticipated duration of this practice (years)	50 Years
The total wetland creation cost for the project, including initial establishment and maintenance.	Dollars
The land cost for the project.	Dollars
The total estimated cost for the project, including establishment and maintenance, land acquisition, and other proposed work.	Dollars
The anticipated water storage potential of this wetland creation project, in cubic feet.	Cubic Feet and Acre-Feet per Acre

Floodplain Restoration Methodology

Definition:

Floodplain Restoration is a flood resiliency action aimed at rehabilitating degraded floodplain areas to enhance their natural ability to store and slow floodwaters, reducing downstream flood risk. This involves reshaping floodplain topography, improving vegetation, and reconnecting floodplains to their waterways to restore hydrological functions.

Opportunity Area Mapping

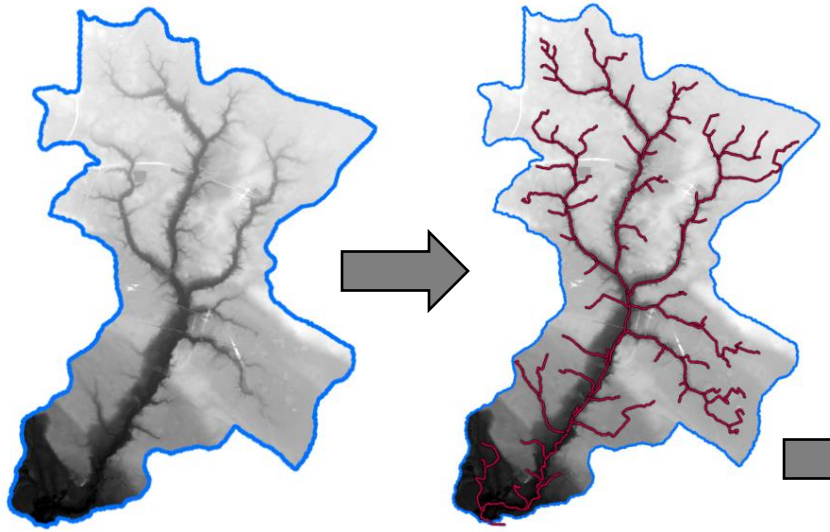
1. Assess stream drainage area
2. Predict stable bank height
3. Calculate departure from stable bank height value using LiDAR DEM data and zonal statistics

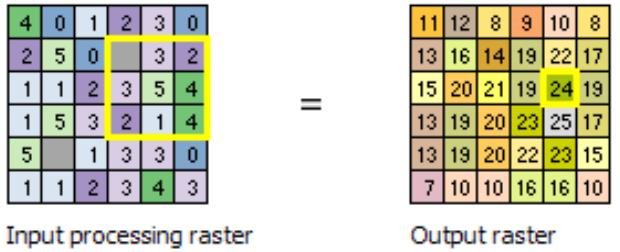
Project Development

1. Project Comparison Table and Related Management Filters
2. Area(s) of Interest Selection
3. Project Development Adjustments and Information

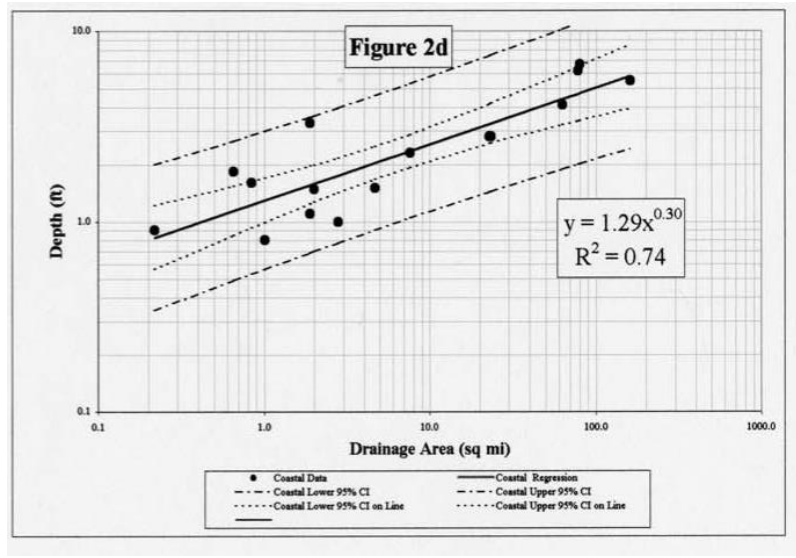
Floodplain Restoration Method Data

Description	Data Source	Variable(s)
Municipal Boundaries	NC OneMap	Jurisdictional limits
Parcels	NC OneMap	Area
3ft. DEM	NCEM	Elevation
Culverts	NCDOT	Area
Open Space Land Cover (NLCD)	USGS	• Hay/Pasture • Cultivated Crops • Herbaceous (Grasslands) • Shrub/Scrub
Stream Grid	Description: NHDPlus Organization: USGS	Gridded representation of the stream network
Project Development	Report: Improving North Carolina's Resilience to Coastal Riverine Flooding Organization: NC Policy Collaboratory	• Annual Maintenance & Management Costs • Design and Construction Costs • Useful Life • Regional Curve Equations for Bankfull Width and Depth



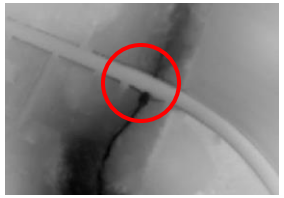


Focal Statistics – Quasi-Bank Height (max-min)

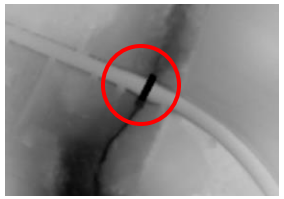


Estimate Mean Depth for Each Channel Segment

Missing NCDOT Culvert

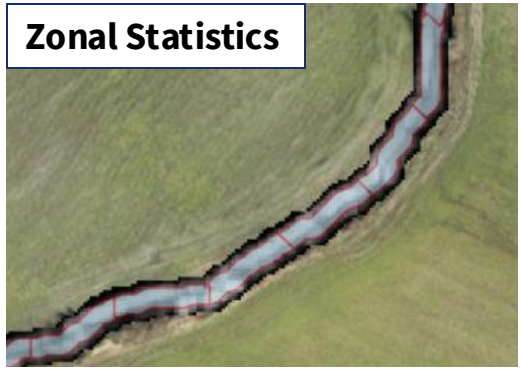


“Hydro-Correct” DEM

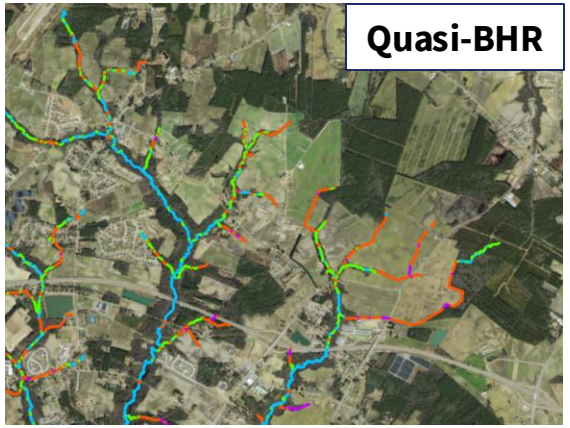


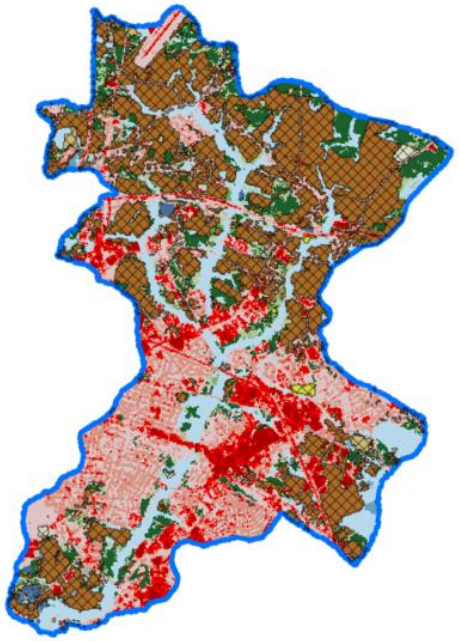
- **Delineate Drainage Network (> 40 acres)**
- **Split into 150ft segments**
- **Buffer Segments by Channel Width from Regional Curves**
- **Extract by Mask**

Zonal Statistics



Mean and Max of Range from Focal Stats



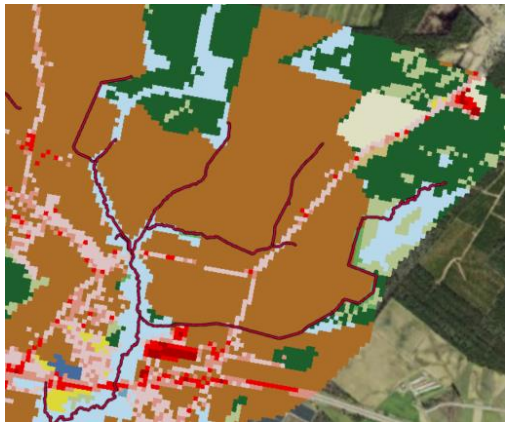


NLCD Land Cover Classification Legend

- 11 Open Water
- 12 Perennial Ice/ Snow
- 21 Developed, Open Space
- 22 Developed, Low Intensity
- 23 Developed, Medium Intensity
- 24 Developed, High Intensity
- 31 Barren Land (Rock/Sand/Clay)
- 41 Deciduous Forest
- 42 Evergreen Forest
- 43 Mixed Forest
- 51 Dwarf Scrub*
- 52 Shrub/Scrub
- 71 Grassland/Herbaceous
- 72 Sedge/Herbaceous*
- 73 Lichens*
- 74 Moss*
- 81 Pasture/Hay
- 82 Cultivated Crops
- 90 Woody Wetlands
- 95 Emergent Herbaceous Wetlands

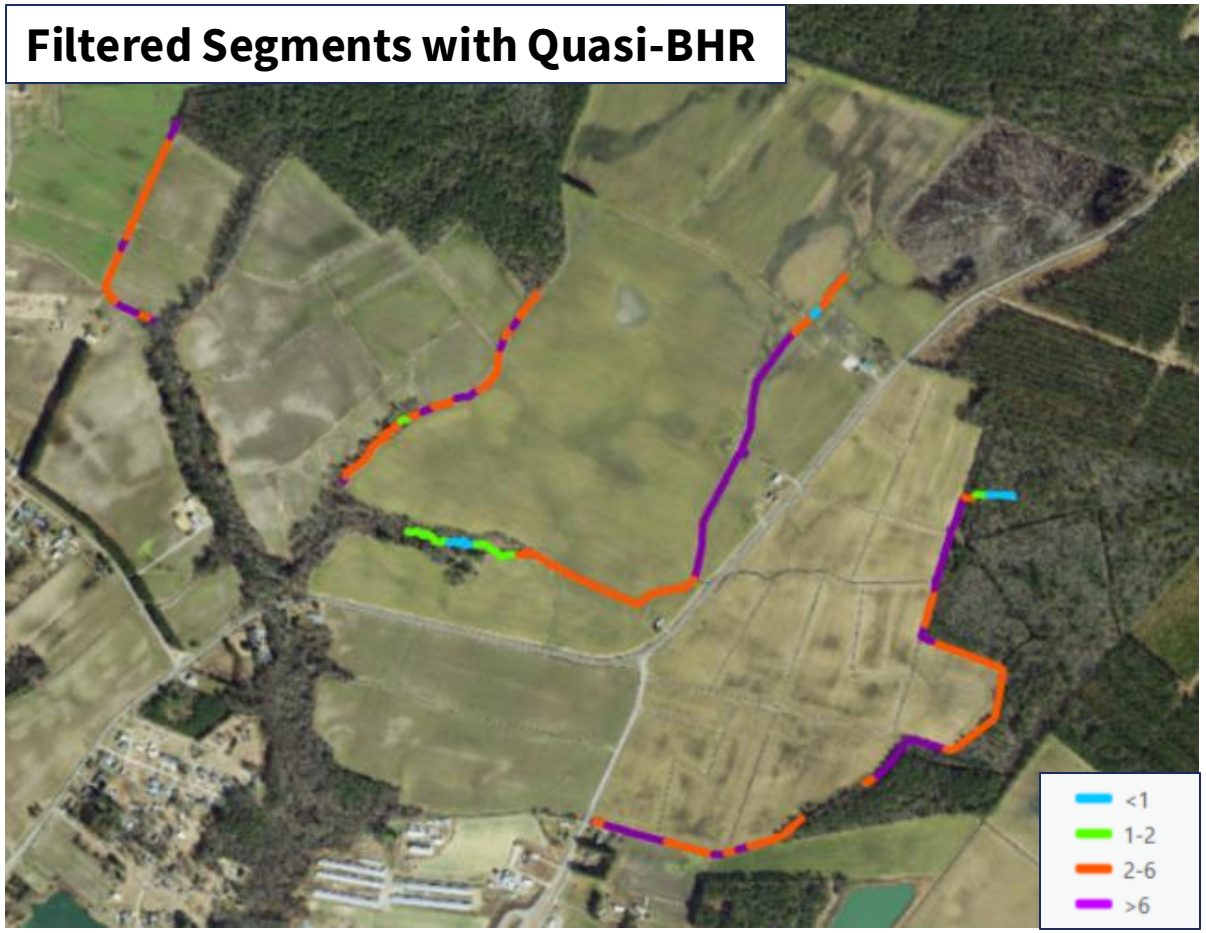
* Alaska only

Filter Segments for Land Cover: Grassland, Shrub/Scrub, Pasture, and Cultivated Cropland



Eliminate Segments < 750 ft

Filtered Segments with Quasi-BHR



Levees

Dams