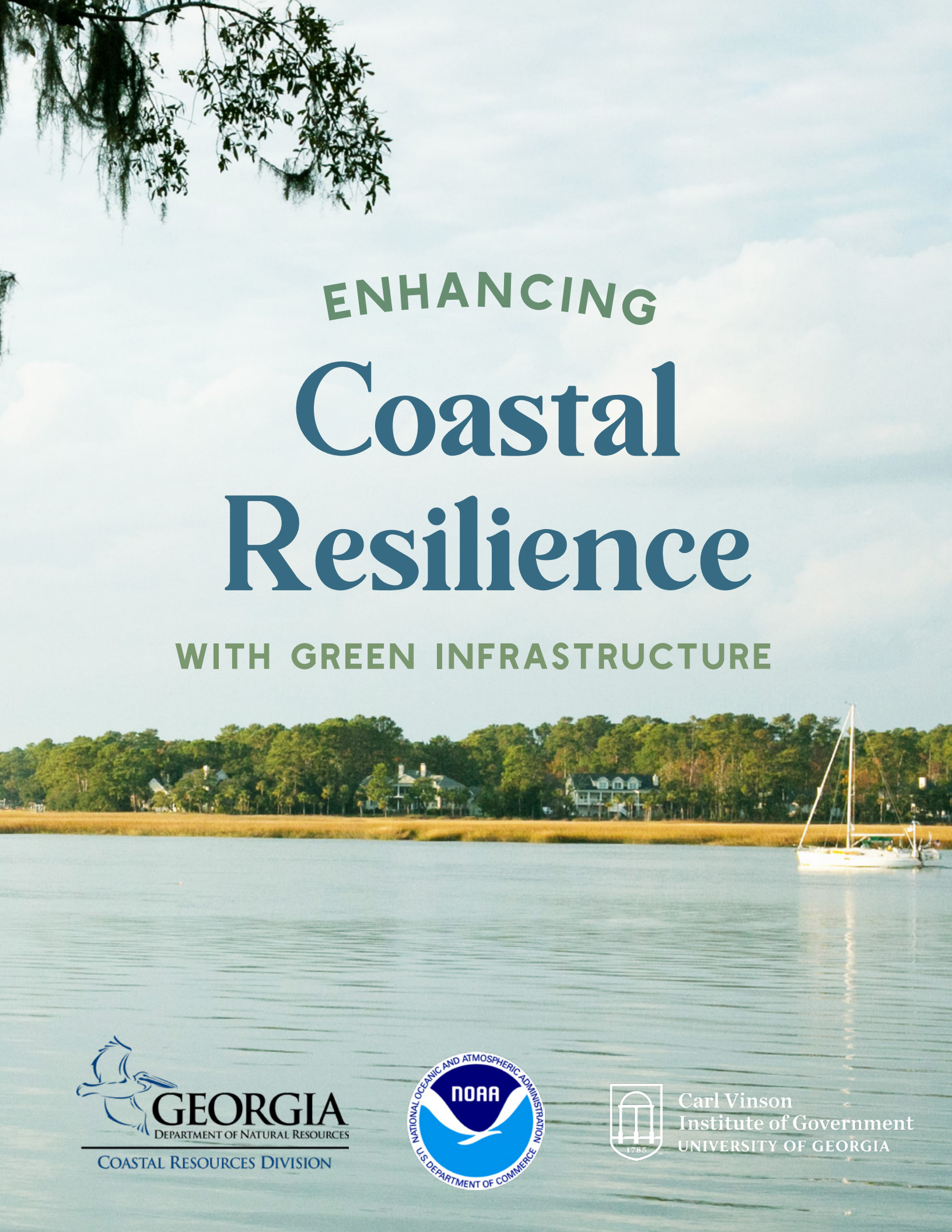


ENHANCING

Coastal Resilience

WITH GREEN INFRASTRUCTURE

GEORGIA
DEPARTMENT OF NATURAL RESOURCES
COASTAL RESOURCES DIVISION

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Carl Vinson
Institute of Government
UNIVERSITY OF GEORGIA

About the Project

Funding for this guide was made possible by the Office of Coastal Management, National Oceanic and Atmospheric Administration (NOAA). We are very grateful to NOAA for this support. The development of this guide was led by the Georgia Coastal Management Program at the Georgia Department of Natural Resources, Coastal Resources Division and is part of a larger project funded under this grant that included the following partners: Kevin Mickey with the Polis Center at Indiana University- Purdue University Indianapolis; Shane Hubbard with the University of Wisconsin-Madison; Scott Pippin and Shana Jones with the University of Georgia's Carl Vinson Institute of Government; Liberty County; City of Hinesville; City of Tybee Island; the Coastal Regional Commission; Jessica Brown with the University of Georgia Marine Extension and Georgia Sea Grant; Craig Landry with the University of Georgia; and Kelly Hill and Jennifer Kline with the Georgia Coastal Management Program. We thank Karen DeVivo, who provided valuable editing assistance, and Allison Cape, who designed the guide, for their contributions as well. Both are with the Carl Vinson Institute of Government. Robert Hines, a research assistant at the Carl Vinson Institute of Government, and Ben Wilde, a Georgia Sea Grant Law Fellow, provided excellent research support.

This guide is built upon the many efforts of dedicated public servants working in federal, state, and local government as well as university researchers and extension professionals. Their work is featured throughout this document.

This report is funded under grant award #NA18NOS4190146 to the Georgia Department of Natural Resources from the Office for Coastal Management, National Oceanic and Atmospheric Administration. The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the views of DNR, OCM, or NOAA.

TABLE OF Contents

Background and Purpose

This guide provides communities in Coastal Georgia and surrounding areas direction to improve community resilience to flooding hazards. More specifically, this guide aims to decrease the vulnerability many communities face from sources such as riverine and coastal flooding, stormwater overflows, and storm surge. Communities can protect life and safety, reduce costs, and protect public and private property by integrating natural ecological systems and processes into their planning, site design, and construction. This guide describes a number of practices and policies communities can adopt to make better use of these natural systems and capitalize on the related environmental services, which in turn will make them less susceptible to flood damages. This guide is designed to be a resource for local governments, regional planners, developers, property owners, and anyone else interested in promoting the use of these practices to increase community resilience to the shocks of natural hazards.

This guide was developed as part of the project titled *Enhancing Coastal Resilience with Green Infrastructure,* which demonstrates the practicality and cost effectiveness of utilizing green infrastructure approaches to mitigate impacts from flooding and wind. This project was directed by the Georgia Coastal Management Program, which is housed in the Coastal Resources Division of the Georgia Department of Natural Resources. Funding for this project was provided by the National Oceanographic and Atmospheric Administration (NOAA).

This project involved numerous partners that modeled potential riverine and coastal flood damages, ran damage assessment models, conducted economic assessments, identified pilot green infrastructure projects, and performed legal and policy analysis. It also included the invaluable assistance of the local government staff and officials who enthusiastically supported the development of this project.[1] This guide reflects the integration of law and policy research with the results of damage assessments, and it emphasizes practices that will reduce damages from the coastal hazards modeled in this study. As communities implement these policies and practices to address existing flooding, rainfall, and storm events, it will be important to keep in mind that future conditions may require more and/or different policies and practices. Indeed, the guide recommends considering, whenever possible, future rainfall, flooding, and sea level rise projections as part of overall resilience planning and green infrastructure implementation, and it includes several recommendations for doing so.

Two pilot areas were studied to demonstrate the efficacy of these nature-based or green infrastructure practices in Coastal Georgia: Hinesville/Liberty County and the City of Tybee Island. To capture a range of possible current and future conditions, a total of 118 wind and flood scenarios were modeled in these two Georgia communities using HAZUS-MH, which is a powerful flood and wind damage and loss modeling

For more information about the project, see https://coastalgadnr.org/ResiliencewithGreenInfrastructure.

THIS GUIDE FOCUSES ON "COMMUNITY RESILIENCE" AND HOW THIS CONCEPT OF RESILIENCE CAN BE BUILT INTO HUMAN POPULATIONS THROUGH GREEN INFRASTRUCTURE, CONCENTRATING ON PROTECTING HUMAN LIFE AND PROPERTY FROM EXTERNAL HAZARDS.

software developed by the Federal Emergency Management Agency (FEMA). The results of this analysis show the monetary loss from the flood scenarios based on damages to buildings and structures identified in the flooded area.

This modeling considered future hazards stemming from shifts in climate (e.g., precipitation, sea level rise, and temperature), urban development, and land-use changes by incorporating future sea levels, winds, and precipitation estimates into future scenarios. Implementation of green infrastructure was simulated by making reductions to riverine flooding scenarios that were intended to represent the effects of increased water infiltration and evapotranspiration, resulting in reduced downstream flows. In the coastal flooding scenarios, green infrastructure was simulated by enhancing coastal dunes. For the wind scenarios, researchers modeled the implementation of shuttering ordinances. Damage assessments were completed for "business as usual" scenarios and for those incorporating green infrastructure practices, allowing the researchers to calculate the potential reduction in damages that would occur if these practices and policies were implemented.

The selection of green infrastructure and nature-based resilience practices described in this guide are those that relate to the green infrastructure scenarios modeled in the larger study. While no single practice or technique will equate to the full reduction in impacts modeled, **the data clearly show that green infrastructure and nature-based resilience practices can have a significant impact on a community's long-term resilience if strategically implemented.**

In addition, the benefits of these practices go far beyond the reduction in flood damages. While this guide emphasizes flooding resilience, long-term community resilience in a rapidly changing environment involves many other threats beyond flooding, such as extreme heat, water supply issues, invasive species, and many other issues. Community resilience also involves factors beyond physical impacts, such as economic impacts and threats to community identity, social networks, political structures, and cultural connections. The use of green infrastructure in community development has been shown to have positive impacts on these and other topics, which should be considered as co-benefits of implementing the green infrastructure features described.

Ultimately, this guide should serve as a resource to improve overall community resilience, although it focuses primarily on projects that are directly designed to reduce flooding impacts. It lays out a selection of policies, practices, and infrastructure projects that may be used to enhance green infrastructure in a community, along with providing links to additional resources and examples of the policies and practices described. The following themes run throughout this guide:

Resilience Themes

Promoting green infrastructure requires policies and practices that affect both how we build and where we build. Community planning and regulations can direct development to areas that are less vulnerable to hazards, while site design practices and construction can be required to reduce those vulnerabilities.

Communities save money by using green infrastructure to reduce damages to existing structures.

Communities save money through reduced flood damages and flood response costs in the future by ensuring that human development does not occur in areas prone to flooding now and in the future as flood risks change.

Even in areas at relatively low risk for flooding, protecting and promoting natural functions and green infrastructure services of undeveloped land can reduce flooding elsewhere. This increases community resilience and saves money.

Creating denser development through zoning and open space preservation may often be the most efficient and best way to promote overall resilience to flood hazards.

Managing coastal flooding hazards and improving community resilience will require a variety of large and small policies and practices that occur at different scales and in different parts of the community.

Policies and practices will involve many different governmental departments and involve a number of different code sections. This will require comprehensive planning and coordination.

Increasing community resilience is not easily done in an ad hoc or piecemeal manner. Instead, resilience needs to be incorporated into most basic planning and decision-making activities of the community.

Long-term resilience cannot be based on historical data. Communities must consider projected future conditions, including planning for increasing numbers of high tide flooding events and rates of sea level rise.

Future flooding projections make it evident that current development patterns abutting current regulatory floodplain boundaries put those areas at increased risk of flooding. Encouraging higher regulatory standards in such areas could be beneficial, while also resulting in flood insurance discounts for property owners.

Because no single policy or ordinance will result in the kind of green infrastructure implementation necessary to bring about broad-based community resilience, promoting green infrastructure at the local level will require analyzing existing policies, regulations, and ordinances to identify implementation opportunities. Policies and practices that promote green infrastructure are described in this guide on a series of user-friendly **"Best Management Practice"** cards that provide an overview of policies and practices to promote the use of green infrastructure. These cards also connect these policies to relevant sections of FEMA's Community Rating System (CRS) and to relevant parts of a selection of model ordinances that were also prepared as part of this project.

Appendix A **of this guide contains five model ordinances that communities may adopt.** While these ordinances promote green infrastructure and nature-based practices, they are not intended to represent a comprehensive program to address community resilience. Such an effort requires intensive local analysis and planning so that the resulting program truly recognizes the vulnerability, opportunities, and needs present in the community. The Model Coastal Resilience Ordinance is intended to provide a framework for communities to aggressively engage in a resilience planning process, and the other ordinances identify a limited set of specific measures a community can take to improve its resilience. They are meant to be relatively simple actions that are applicable to many communities, but certainly not all, and the provisions in all of them need to be carefully tailored to the needs of a local government with the advice and direction of that government's legal counsel.

1. MODEL FLOOD RESILIENT DEVELOPMENT AND BUILDING ORDINANCE

The Model Flood Resilient Development and Building Ordinance augments the provisions of existing floodplain management regulations to enhance specific elements of residential building design in flood-prone areas. Specifically, it requires that structures built in Coastal A Zones meet the construction standards of Coastal V Zones. It also expands the regulations that are applicable in the 1% annual chance floodplain to the 0.2% annual chance floodplain. Under this ordinance, new structures associated with critical facilities cannot be located in the 0.2% floodplain. All new development must be built to an elevation that is 2 feet above the 0.2% flood elevation, measured from the bottom of the lowest horizontal structural member. Finally, it requires that real estate agents inform prospective buyers of the documented flood risk of the property.

2. MODEL ENHANCED STORMWATER RESILIENCE

The Model Enhanced Stormwater Resilience Ordinance focuses on two elements that are generally not addressed in stormwater management regulations. The ordinance limits the amount of impervious cover that can be used in new development, based on the zoning classification of the project. It also mandates that stormwater from rooftop runoff be directed through an infiltrative area or structure before it is discharged into a conveyance system or a surface water body. These regulations enhance existing regulations by reducing stormwater runoff, and thus reducing the likelihood of flooding caused by peak flows that overwhelm the downstream infrastructure.

3. MODEL SEA LEVEL RISE ORDINANCE

The Model Sea Level Rise Ordinance is intended to be the most basic of the model ordinances presented in this guide. It implements two distinct actions focused on using future sea level rise projections and establishing a minimum protective buffer to protect new development from rising tide levels. First, it requires the use of future sea level rise projections, based on NOAA's

Intermediate-High projected rate, in all future plans, regulations, ordinances, policies, public infrastructure investments, and future land use decisions. This is also the same minimum projection that should be used to earn credit under FEMA's Community Rating System. Second, it creates a protective buffer around tidally influenced waters to ensure a sufficient setback is maintained as water levels rise.

4. MODEL TIDAL FLOODING RESILIENCE ORDINANCE

The Model Tidal Flooding Resilience Ordinance recognizes that the most at-risk coastal properties are those that are vulnerable to damage from regular tidal flooding events. Therefore, it creates a regulatory district called the Area of Coastal Tidal Vulnerability (ACTV) in which there are additional land-use regulations, oversight over infrastructure investments, and investments in land conservation. The boundary of the ACTV is meant to be "rolling" in that it moves upland as sea levels rise. Thus, in every new decade, an additional area is added to the ACTV based on the anticipated rate of sea level rise.

5. MODEL COASTAL RESILIENCE ORDINANCE

The Model Coastal Resilience Ordinance is intended to provide a ready framework for local governments to improve community resilience. It directs the community to establish a team that will develop a local understanding of "community resilience," develop data needed to understand their local vulnerabilities and opportunities to improve community resilience, define goals for community resilience, and identify projects to achieve those goals. This ordinance directs local governments to identify officials and staff to consider the basic community resilience concepts laid out in the guide and in its supporting documents, ideally with cooperation from private-sector and nongovernmental partners. Together, these stakeholders should then develop actions and programs to implement them and improve their community's resilience.

Definitions

BASE FLOOD ELEVATION (BFE). Base flood is the flood that has a 1% chance of occurring or being exceeded in any given year, and the base flood elevation is the height of that flood event. Communities participating in the National Flood Insurance Program must ensure that all new residential buildings constructed in the floodplain are elevated to or above base flood elevation.

COASTAL A ZONE. That portion of the Special Flood Hazard Area landward of Zone V (or landward of a coastline without a mapped Zone V) in which the principal source of flooding is coastal storms, and that is likely to see damaging waves between 1.5 and 3.0 feet high.

COASTAL SPECIAL FLOOD HAZARD AREA (SFHA). The portion of the SFHA where the source of flooding is coastal surge or inundation. It includes Zone VE and Coastal A Zone.

COMMUNITY RATING SYSTEM (CRS). The Community Rating System is part of the National Flood Insurance Program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements.

COMMUNITY RESILIENCE. Community resilience is a measure of the sustained ability of a community to utilize available resources to withstand and recover from external shocks and other adverse situations while improving the community's physical and social health, and concentrating on protecting human life and property.

FLOOD INSURANCE RATE MAP (FIRM). An official map prepared by FEMA that delineates both the Special Flood Hazard Areas and the risk premium zones applicable to the community.

FLOODPLAIN. Any land area susceptible to being inundated by flood waters from any source. The term is often used to describe the Special Flood Hazard Area defined by the local Flood Insurance Rate Map or FIRM.

FLOODWAY. The channel of a river and the portion of the overbank floodplain that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation by a designated height.

Definitions

FREEBOARD. The vertical distance structures are required to be built above the base flood elevation. It provides a margin of safety added to the base flood elevation to account for waves, debris, miscalculations, lack of data, or changes in climate.

GREEN INFRASTRUCTURE. Policies and practices to reduce stormwater and flooding impacts from the built environment and land development that generally focus on natural systems and environmental services of ecological systems.

GLOBAL MEAN SEA LEVEL (GMSL). The average elevation of all the Earth's oceans measured from the center of the Earth. It is based on averages from a variety of data sources including satellites and tide stations around the world.

HAZUS. A nationally applicable standardized methodology that contains models for estimating potential losses from earthquakes, floods, and hurricanes. HAZUS uses geographic information systems (GIS) technology to estimate physical, economic, and social impacts of disasters.

NATIONAL FLOOD INSURANCE PROGRAM (NFIP). A federal program administered by FEMA that aims to reduce the impact of flooding on private and public structures by providing access to flood insurance to property owners, renters, and businesses and by encouraging communities to adopt and enforce floodplain management regulations.

SPECIAL FLOOD HAZARD AREA (SFHA). The area on a Flood Insurance Rate Map that is predicted to have a 1% chance, or greater, of flooding in any given year. Commonly referred to as the extent of the 100-year floodplain.

REGULATORY FLOODPLAIN. The portion of a community's floodplain that is deemed to be at a high risk of flooding and thus subject to additional building and land use regulations. This is generally synonymous with the Special Flood Hazard Area, but a community may adopt other regulatory boundaries.

Definitions

RELATIVE SEA LEVEL RISE (RSL). Reflects changes in local sea level in relation to the adjacent land.

RESILIENCE. The ability of a natural or built system to successfully prepare for a variety of threats and then survive and recover from the impacts of disasters or other adverse events.

SPECIAL FLOOD HAZARD AREA (SFHA). The area on a Flood Insurance Rate Map that is predicted to have a 1% chance, or greater, of flooding in any given year. This is commonly referred to as the extent of the 100-year floodplain.

ZONE A. Portion of the SFHA in that is likely to be inundated by the 1% annual chance flooding and for which a base flood elevation has been determined.

ZONE V. In coastal areas, the portion of the SFHA that is likely to be inundated by the 1% annual chance flooding that is subject to additional hazards due to storm-induced waves exceeding 3 feet in height, but for which no base flood elevation has been determined.

ZONE VE. In coastal areas, the portion of the SFHA that is likely to be inundated by the 1% annual chance flooding that is subject to additional hazards due to storm-induced waves exceeding 3 feet in height for which a base flood elevation has been determined.

SECTION 1
Resilience and Green Infrastructure

This section introduces the basic concepts behind the guide's development: community resilience and green infrastructure. The concept of green infrastructure has been around for some time in efforts to improve water quality and manage stormwater, and it is increasingly understood that green infrastructure is also a crucial way to improve community resilience to flooding and other hazards. The relationship between these two concepts is demonstrated by the findings from a modeling study associated with this project. This study, which is discussed in detail in this section, found that there is significant monetary value in using green infrastructure systems to enhance community resilience.

COMMUNITY RESILIENCE: THE LOCAL PLANNING CONTEXT

The concept of "resilience" can be applied across many fields and disciplines. Broadly stated, resilience refers to the ability of a natural or built system to successfully prepare for a variety of threats and then efficiently recover from the impacts of an event.[2]

Put another way, resilience is a set of qualities, characteristics, and practices that contribute to a community's ability to have long-term success in the face of external and internal threats. A large body of research has examined how social, political, economic, and cultural systems can be threatened by external climate change and general environmental variability as well as how natural and ecological systems and habitats demonstrate resilience or vulnerability to these changes.

In this guide, we focus on "community resilience" and how this concept of resilience can be built into human communities through green infrastructure practices and policies that focus on protecting human life and property from external hazards. However, even in this relatively limited context, resilience is a complex and multidimensional idea. In part, this complexity stems from the variability seen in various aspects of our communities. Therefore, discussions of resilience require an understanding of the social, political, economic, and environmental context in which individual communities exist and function. To understand a community's resilience, one must consider the relative resilience of the various interrelated systems that make up each aspect of that community and the impacts that feature has on the overall resilience of the whole. All of this makes planning and building for community resilience an extremely local process that must consider local conditions and be driven by local goals.

Recognizing that the idea of resilience is a multiscalar concept that will apply differently in every community, this guide presents approaches for improving community resilience. The policies and practices highlighted in this guide share the common goal of reducing damages from major flood events through the use of green infrastructure practices. While preventing structural damage is one component of improving community resilience, reducing exposure of the built environment to damage is a foundational first step. Moreover, when future conditions are considered, it becomes evident that maintaining current development patterns along the fringe of present-day regulatory floodplain boundaries puts those areas at risk. Limiting development in these area and encouraging higher regulatory standards will help reduce future damages, while also creating stronger, healthier, and more resilient communities.

PLANNING AND BUILDING FOR COMMUNITY RESILIENCE IS AN EXTREMELY LOCAL PROCESS THAT MUST CONSIDER LOCAL CONDITIONS AND BE DRIVEN BY LOCAL GOALS.

GREEN INFRASTRUCTURE: NATURE-BASED RESILIENCE

NATURAL FEATURES IN COMMUNITIES: ADDING ECONOMIC, SOCIAL, AND AESTHETIC VALUE

In community planning terms, the concept of incorporating nature and natural functions into urban development dates back to the 1800s in the United States. While trees, parks, gardens, and other natural features have been integrated into urban areas for as long as there have been cities, the formal consideration of these natural elements in urban planning is generally linked to the development of landscape architecture as a discipline and a profession. These ideas were highlighted by the work of practitioners such as Fredrick Law Olmsted, Ian McHarg, and Patrick Geddes, who attempted to reconnect cities with the natural environment.

Recognition of the importance of natural features in urban systems grew throughout the 19th and 20th centuries. Open spaces, undeveloped areas, and urban vegetation began to be perceived as more than urban amenities and aesthetic additions to the urban form. Natural and nature-based features make important contributions to the physical function of the urban environment, and they provide tremendous benefits to public health, social well-being, and environmental quality. Rural areas, in contrast, have many of these nature-based features precisely because of their lower levels of development. When rural populations grow, preserving these features and their functionality protects the rural character of the community, while also avoiding some issues connected to environmental degradation found in urban areas such as increased flooding and stormwater management challenges.

Communities across the country and around the world are increasingly recognizing the value of the environmental services provided by natural features as essential elements of a healthy social, ecological, and economic system. Natural systems have been shown to provide numerous benefits to communities and the environment, including the following:[3]

- Increased property values
- Increased water supply
- Lower ambient temperatures
- More walkable communities
- Reduced water treatment costs
- Cost savings
- Improved air quality
- Increased community resilience
- Increased biodiversity
- Habitat improvement and connectivity
- Healthier communities
- Improved water quality
- Reduced flooding

The value of natural and nature-based features in communities is increasingly represented in the concept of green infrastructure, which simply means designing built systems around existing natural features or incorporating natural features into project designs to further the design goals of a specific system, while often promoting additional co-benefits.

GREEN INFRASTRUCTURE: HOW WE BUILD AND WHERE WE BUILD

Promoting green infrastructure requires policies and practices that affect both how we build and where we build. In this guide, green infrastructure includes both development practices and policies (how we build), and

preservation practices and policies (where we build). Green infrastructure, thus, encompasses policies and practices to reduce stormwater and flooding impacts from the built environment and land development. It also focuses on protecting natural areas and working lands from development in the first place.

In Georgia, one primary resource for incorporating green infrastructure approaches into land development is the Coastal Stormwater Supplement (CSS) to the Georgia Stormwater Management Manual. The CSS is currently the primary resource for local governments in Georgia looking to implement green infrastructure practices.[4] It is designed to help protect coastal Georgia's unique and vital natural resources from the negative impacts of land development and nonpoint source pollution. To reach this goal, the CSS lays out a framework for local governments to implement green infrastructure approaches to stormwater management, site design, and natural resource management.[5] The practices described in the CSS framework are both structural and nonstructural—that is, they can be built features such as a stormwater infiltration basin, or they can be policies such as a tree ordinance limiting the removal of specimen trees. The practices described vary in scale from a few square feet to thousands of acres. The practices discussed in the CSS cover both the "how we build" and the "where we build" aspects of green infrastructure.

This guide goes further than CSS's goal of "reduc[ing] the impacts of land development and nonpoint source pollution" to consider the broader concept of community resilience.

Development Practices and Policies: How We Build

Built green infrastructure elements primarily consist of manmade infrastructure systems that intentionally and strategically utilize natural features. The US Environmental Protection Agency (EPA) describes green infrastructure as "a range of approaches" for managing stormwater, including the following:

- Using the natural processes of soils and vegetation to capture, slow down, and filter runoff, often allowing it to recharge groundwater;
- Using practices that collect and store rainwater for future use; and
- Using techniques that fit into individual development, redevelopment, or retrofit projects, such as permeable pavements, bioswales, rain gardens, vegetated or green roofs, rain barrels, and cisterns.[6]

These practices can be as simple as planting trees to intercept rainfall or as complex as an intricate arrangement of wetlands used to treat urban wastewater in place of physical and chemical treatment processes. In regard to designed and engineered systems, this guide focuses on smaller-scale projects, generally implemented in specific sites, that are designed to reduce the impacts of human development and attempt to make developed sites function more like their pre-development conditions.

Effective green infrastructure approaches are complemented by policies and practices that also protect existing buildings from flood and wind damage. By requiring that buildings be flood and wind resilient, communities can reduce damage from flooding, while also often lowering insurance premiums. In storms, the damage to windows and doors is common, and this can lead to much more extensive damage to the building. Practical measures such as storm shuttering and waterproofing requirements can pay off greatly for property owners and communities.[7] The following are examples of activities that can protect property from flooding and wind:

- Elevating structures
- Elevating electrical, heating, and plumbing equipment
- Dry floodproofing
- Wet floodproofing
- Shuttering

In recent years, regulatory requirements for coastal construction have become more stringent, primarily based on lessons learned from previous storms and because many of the buildings constructed in coastal areas recently are larger and more valuable than structures built in the past.[8] "Siting residential buildings to minimize their vulnerability to coastal hazards should be one of the most important aspects of the development (or redevelopment) process."[9]

Preservation Practices and Policies: Where We Build

Green infrastructure also includes landscape-scale practices that preserve existing natural conditions or restore ecological functions to an area. This kind of green infrastructure can be defined as a "strategically planned and managed network of natural lands, such as forests and wetlands, working landscapes, and other open spaces that conserves or enhances ecosystem values and functions and provides associated benefits to human populations."[10] These practices emphasize protecting, managing, restoring, and enhancing existing environmental systems in such a way that they provide valuable infrastructure services to human communities.

FEMA: Building Successful Disaster-Resilient Structures

FEMA describes successfully designed buildings as being "capable of resisting damage from coastal hazards and processes over a period of decades." Some damage may occur, of course, over a building's lifetime, but the overall goal should be to limit the effects of erosion, wind, or flood above and beyond minimum "design-level" standards generally found in local building codes. For FEMA, a building is considered successful if the following are true after a design-level event:

- The building foundation is intact and functional.
- The envelope (lowest floor, walls, openings, and roof) is structurally sound and capable of minimizing penetration of wind, rain, and debris.
- The lowest floor elevation is high enough to prevent floodwaters from entering the building envelope.
- The utility connections (e.g., electricity, water, sewer, natural gas) remain intact or can be easily restored.
- The building is accessible and habitable.
- Any damage to enclosures below the lowest floor does not result in damage to the foundation, utility connections, or elevated portions of the building or nearby structures.

Source: FEMA, Protection of Openings– Shutters and Glazing, Home Builder's Guide to Coastal Construction, Technical Fact Sheet No. 6.2

PLANNING SCALES FOR RESILIENCE:
LANDSCAPE, WATERSHED, COMMUNITY, AND SITE

Achieving the broader concept of community resilience requires close attention to the impact of community planning decisions. Planning establishes the location of land development activities (the "where we build") as well as the structure of what gets built ("what we build"). Such decisions largely determine how vulnerable a community is to floods and other natural hazards. It is often said that a flood is a natural event but that flood damages are manmade. Policies that consider the green infrastructure functions of undeveloped areas can mitigate the manmade impacts.

Green infrastructure concepts can be applied to a wide range of practices, which can also be overlapping. Again, these techniques might include site-specific and highly engineered practices incorporating living vegetation into building materials such as in a "green roof" or "green wall." They also might include general, landscape-scale government policies that protect sensitive environmental areas such as wetlands or floodplains from development. Both types of practices serve the overall goal of improving community resilience by reducing flood risk and improving water quality. However, they are not applied in the same way, often involve different government departments and code sections, and can at times work at cross purposes. Therefore, it is important to understand the context and purposes for which these different practices are intended.

The bottom line is this: A variety of large- and small-scale policies and practices that occur at different levels of government and in different parts of the community will be crucial for community resilience. True community resilience requires planning that looks at how all the various components of a system interact, and then examines their cumulative impacts on the whole system. This guide, therefore, encourages communities to consider how natural and green infrastructure practices fit within the following "scales."[11]

Scales

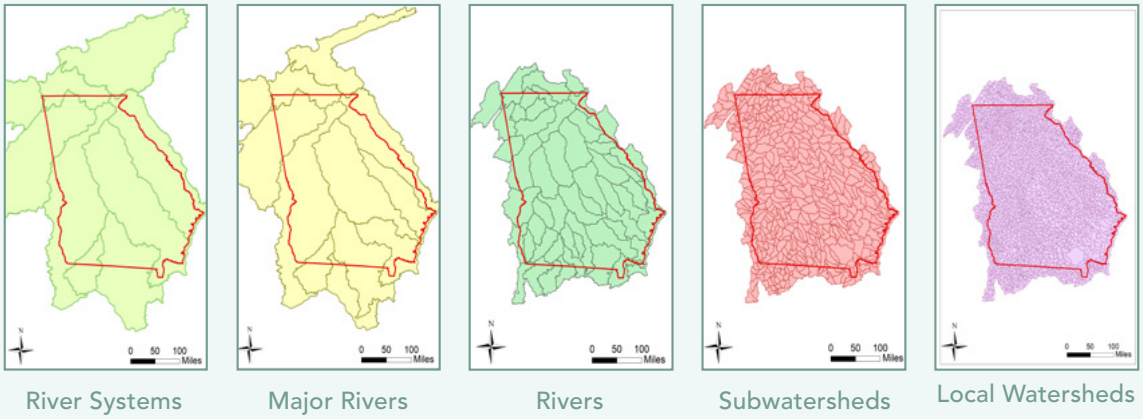
| *Landscape Scale*

A landscape-scale approach generally covers a large geographic area that encompasses more than smaller, parcel-by-parcel land use management practices and may extend across governmental boundaries. Such an approach recognizes that effective environmental management requires the consideration of ecological systems across broad regions to provide connections and resilience such as across Georgia's major ecoregions. A good example of this scale of planning is the efforts to restore longleaf pine habitat across Georgia's coastal plain. This effort includes numerous jurisdictions and watersheds, and it is having profound impacts on floodplain management, habitat conservation, and many other environmental issues. When large areas are considered holistically, it allows for interconnections, the balancing of priorities, and the implementation of practices that further resilience-compatible goals such as the promotion of working farmlands or forests.

| *Watershed Scale*

Planning for stormwater management and flood mitigation should consider the multiple scales of the watershed. This means that development decisions should consider the impacts to local waterbodies as well as the overall impact to the larger watershed — after all, what happens in these small watersheds determines what happens at the larger scale, and thus local decisions can mitigate or exacerbate flooding downstream.

Such planning involves analyzing the impacts that land use and development decisions have on the hydrologic system, as well as how interconnected watersheds interact in the larger environmental and human systems.[12] This type of planning is characterized by looking beyond the immediate and local impacts of a decision and considering the interconnections and overlapping interests at different scales and potentially involving multiple communities and jurisdictions located within a single watershed. By considering the entirety of the watershed, community planners and regulators can better balance goals and priorities. They can then implement diverse policies and practices that promote green and natural infrastructure that together function as a single system at the larger watershed level.[13]



A watershed is generally defined as all the land area from which precipitation drains to a given point. Watersheds are drawn around where streams or rivers flow together or where they flow into a lake or the ocean. Each watershed is made up of smaller watersheds of the creeks and streams that comprise the larger water body, and each watershed can be considered as its own interconnected system. These small watersheds connect to make a larger watershed, and the major river watersheds are comprised of numerous smaller watersheds. The graphic above illustrates how the state of Georgia is composed of numerous watersheds: 8 major river systems can be divided into 12 major rivers, which are in turn made up of 52 smaller rivers that can be further broken down into 458 smaller creeks and 2,537 individual reaches of those creeks.

| *Community Scale*

Community scale refers to a geographic area defined as a city, town, or neighborhood that typically identifies socially and culturally as a community. Often political jurisdictions, such as cities and towns, define what people think of as a community, but the proximity and connections between residential areas, stores, jobs, and recreation opportunities can also help define a community. Planning at the community scale considers the connections between specific parcels for both infrastructure and environmental services within a single jurisdiction. Community-scale planning often includes zoning regulations and building codes. This scale of planning has to balance the need to provide community services, including basic infrastructure such as transportation and sewers, with other factors such as flood protection and overall community resilience. For example, promoting density at the community scale often has benefits for residents within the community as well as those outside of it, as it limits sprawl and keeps surrounding natural or agricultural areas intact.

| *Site Scale*

Site scale generally refers to a parcel. Green infrastructure practices at the site scale often involve landscaping or engineering designed to mimic natural systems in order to control water and improve aesthetics. Site-scale green infrastructure may also include green building practices like green roofs or efforts to develop the urban tree canopy.

In addition to geographic size, these four scales of green infrastructure practices also reflect a progression from more dense urban environments to less dense rural areas. Green infrastructure practices that are most applicable at the site scale, for example, are the most relevant in the more densely developed areas. Meanwhile, the community scale will involve practices that are less space constrained but that are still focused on reducing the impact of development. The landscape scale and watershed scale more generally involve larger areas and thus often correspond to rural areas where development is much less dense.

Communities are built to meet human needs, and the purpose of incorporating community resilience into land development and local government planning and practice is to figure out how to meet those needs as effectively as possible. Thinking about green infrastructure in the context of these scales allows policies and practices to be better coordinated with other community goals such as transportation and recreation.

Merging green infrastructure planning at multiple scales into the broader planning considerations also recognizes that community resilience is a feature of the community as a whole and not simply a set of practices. For example, while preserving open space is generally seen as a benefit to resilience, there are circumstances where more compact and dense development could provide greater environmental benefits than a smaller development next to a small patch of conserved land that is isolated from the larger ecological system.

Indeed, studies have shown that stormwater management goals and pollutant reduction can often be better achieved by increasing urban densities.[14] In fact, when buildings are built more densely together in a watershed, their impact on the ecological health of the watershed as a whole is lower.[15] Outside of the densely developed area, larger and more ecologically functional areas can be preserved, and upstream or downstream areas can be used to manage flows.[16] Density is not only good for the environment, it creates more walkable and

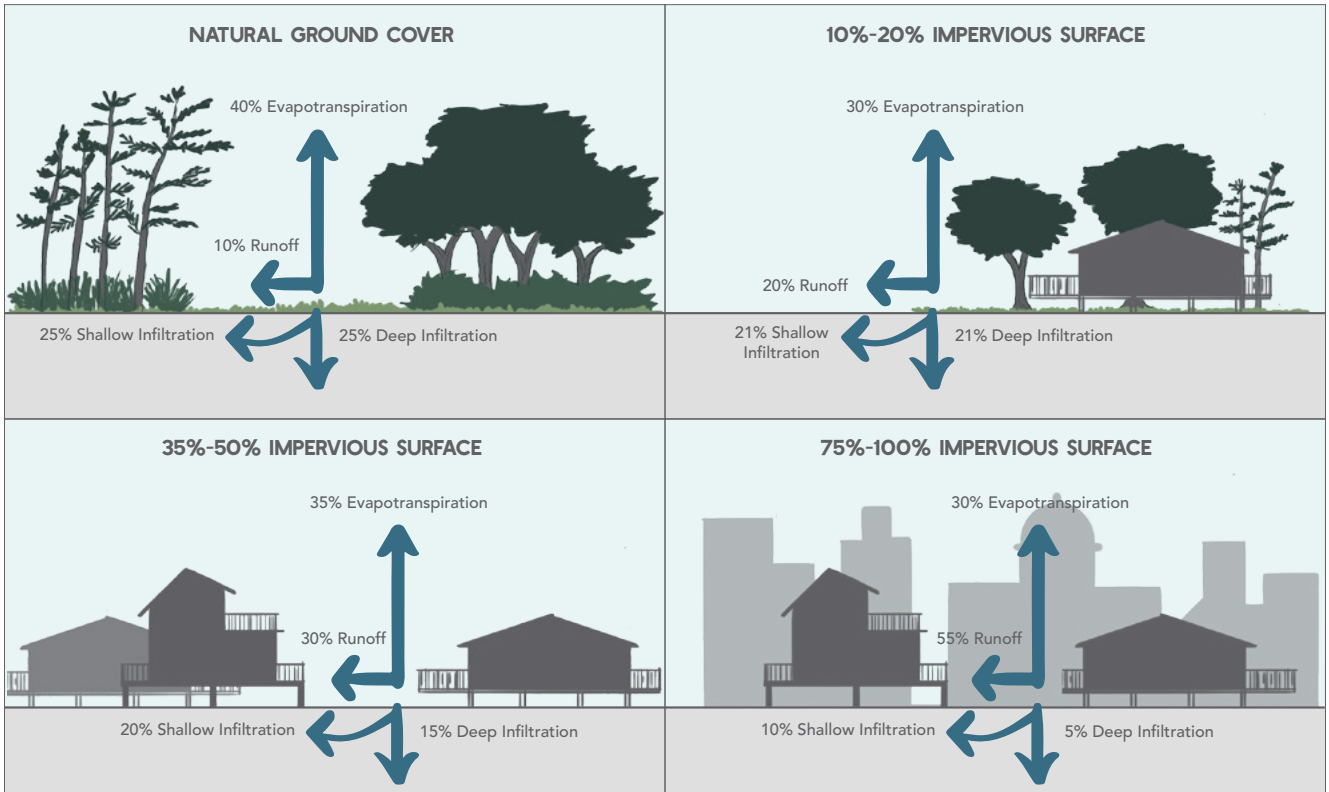
vibrant urban spaces that people truly enjoy, leading to many other social and public health benefits.[17]

Implementing natural and green infrastructure practices across geographic scales will require communities to think and plan across administrative and political boundaries to coordinate a cohesive policy that works in the watershed. Different governing bodies will approach this differently based on their existing development and their jurisdiction. Because municipalities likely contain the more densely developed areas, they may be more site-scale focused. Counties are likely to control the more rural and natural areas; thus, they may focus on more landscape-scale approaches. Broad community resilience will require jurisdictions to consider how their respective activities and responsibilities fit together. Planning for resilience has the potential to facilitate productive discussions about how these types of practices can be used to foster greater community resilience overall.

The Need for Green Infrastructure to Improve Flooding Resilience

The rate of human development has increased rapidly in recent decades. Over the last 70 years, the population of the United States has more than doubled,[18] but during that same period, the urban footprint of human development has increased almost twice as fast.[19] This increase in area devoted to urban and suburban land uses has serious impacts on the resilience and sustainability of communities.

Impervious surfaces — artificial surfaces such as rooftops, concrete, and asphalt — disrupt the natural hydrologic cycle.[20] Without human development, when it rains, most of the water either soaks into the ground as it moves across the land (infiltration) or returns to the atmosphere



Development increases the volume and rate of runoff from a site, and reduces groundwater recharge and evapotranspiration

(evapotranspiration). Impervious surfaces, on the other hand, cause the water to runoff much more quickly, preventing both evapotranspiration and infiltration. Increased volume and velocity of water runoff results, and this leads to more flooding and erosion. Additionally, water quality is degraded as runoff picks up pollutants from parking lots, roadways, and other developed areas and washes it into waterways.

Stormwater infrastructure was originally designed to manage rainfall by routing floodwater out of cities as quickly as possible.[21] This approach exacerbated flooding-created problems downstream, leading to the adoption of requirements such as detention ponds and other built infrastructure to slow the release of stormwater from a site. These strategies focused on changing the timing of the water going downstream. More recent approaches call for a more holistic approach that also considers the volume and quality of the water, and generally seeks to mimic how the water would flow in a natural setting. This involves watershed planning and design based on local hydrology.

This new era of stormwater management is based on the recognition that as stormwater runoff damages local streams and other waterbodies, it impacts the overall environmental health of the area. Generally, water quality and hydrologic systems begin to noticeably degrade when impervious surfaces make up 10% of a watershed's land area, and the system is significantly impacted as the impervious area approaches 20% or more.[22] Local land use plans and policies can minimize the impacts of development on flooding risk, aquatic system health, and community resilience by managing the total impervious cover allowed in target areas.

Green infrastructure can help limit and reduce the impacts of development as well as make communities more resilient to environmental changes and natural disasters. Green infrastructure practices manage impervious cover either by protecting the hydrologic functions of existing natural areas or by engineering systems that mimic those functions. Green infrastructure approaches can also curtail development, limiting its impact and preserving the important parts of the landscape and the ecological services they provide. By protecting or re-creating these environmental services, communities can grow and develop in such a way that human life and property are not exposed to additional risks posed by flooding and environmental degradation. They consequently can develop in more resilient and sustainable ways.

Modeled Damage Reductions in Georgia: Green Infrastructure Saves Money

Changes in precipitation, sea level rise, temperature, and other climatic shifts, along with urban development and land use changes, are altering coastal communities' vulnerability to natural hazards. In particular, the increasing frequency and magnitude of flood events and the growing size and intensity of hurricanes are changing the risk profiles of communities. As a result, communities must consider mitigation actions that can build community resilience for future flood and wind risks in addition to building according to current hazard profiles.

As part of this project, experts at the Polis Center at Indiana University–Purdue University Indianapolis (IUPUI) and the University of Wisconsin-Madison completed hazard development and risk assessments of two Georgia communities. This study utilized HAZUS-MH, a powerful flood and wind damage and loss software developed by FEMA, to provide detailed economic damage and loss estimates for each flood and wind scenario. The researchers modeled a total of 118 wind and flood scenarios in these two communities. The goal of their models was to capture the range of possible current and future conditions, with and without green infrastructure.

In Tybee Island, Georgia, a barrier island community east of Savannah, risks from future wind and coastal flooding were assessed based on hurricanes ranging in intensity from Category 1 through 4. Riverine flood hazards were modeled for the City of Hinesville, Georgia, and the adjacent areas in Liberty County, both with and without additional green infrastructure. Current modeled hazards included potential flooding resulting from five modeled return periods: 10, 25, 50, 100, and 500 years. For future hazards, the researchers used these same return periods while also evaluating a range of possible flood extents for each return period based on different predictions about future rainfall intensity in the study area. Predictions for both riverine and coastal flood hazards also incorporated projections of population and building changes.

Research Partners

Researchers with the Polis Center at Indiana University–Purdue University Indianapolis (IUPUI) and with the University of Wisconsin–Madison conducted hazard development and risk assessments as part of this project. Both organizations are nationally recognized leaders in hazard risk modeling. The Polis Center works with partners to define, measure, and actively improve community health, well-being, and resiliency. As part of the Geoinformatics Program, experts at the Polis Center assess different types of vulnerabilities and needs of local, state, tribal, and federal governments; the private sector; and nonprofits. The Space Science and Engineering Center (SSEC) is an internationally known research and development center at the University of Wisconsin–Madison. With a history of remote-sensing innovation spanning more than 50 years, SSEC develops and utilizes space-, aircraft-, and ground-based instrumentation to collect and analyze observations of the Earth's atmosphere, oceans, and land surface, as well as other planetary atmospheres to improve our understanding of weather, climate, and atmospheric processes.

HAZUS®

EARTHQUAKE • WIND • FLOOD • TSUNAMI

Hazus-MH is a software program that contains models for estimating potential losses from earthquakes, floods, and hurricane winds. It is used in vulnerability assessments. CRS credit is provided under CRS 512a for conducing vulnerability assessments. Specifically, Hazus-MH uses geographic information system (GIS) software to map and display hazard data and the results of damage and economic loss estimates for buildings and infrastructure. It also allows users to estimate the impacts of hurricane winds, floods, and earthquakes on populations.

The implementation of nature-based or green infrastructure was simulated by enhancing the natural dunes and implementing a shuttering ordinance on Tybee Island. Similarly, the researchers mimicked a reduction in impervious surfaces and reduced input to riverine flooding in Hinesville. Flood depths were recalculated for all green infrastructure scenarios. The researchers were then able to compare "business as usual" practices with the use of green infrastructure practices as a mitigation tool.

To demonstrate the efficacy of natural and green infrastructure in coastal Georgia, the researchers created damage assessments using the HAZUS model developed by FEMA. Flood depth grids and wind profiles developed for each hazard scenario were inputted into HAZUS, along with detailed user-defined building inventory information. Researchers were then able to run HAZUS models to capture geographically where and to what extent flooding would impact those identified structures under various conditions. They also calculated the economic loss associated with the damages to each structure. This analysis is compiled in a detailed report that can be found at **www.coastalgadnr.org/ResiliencewithGreenInfrastructure**.

The research team estimated that *future* coastal floods will increase Tybee Island flood damages by as much as 70%. Areas in and around Hinesville and Liberty County may see damages that are three to eight times higher than current estimates of flood losses. However, the models showed that incorporating green infrastructure practices could reduce damages by as much as 16% in Tybee Island and by as much as 27% in Liberty County.

The models also showed that green infrastructure practices protect Tybee Island and the city of Hinesville. In Hinesville, the showed that the costs of damages were reduced 36% when green infrastructure is incorporated as a mitigation strategy for riverine flooding. Damages in Tybee Island, after storm surge flood and wind scenarios were modeled, was estimated to be reduced by $181 million out of a $579 million potential future cost. The study's findings are described in more detail in the graphics that follow.

In addition to assessing the impact of green infrastructure on flooding, researchers used HAZUS-MH to model the presence or absence of hurricane shutters on the buildings in Tybee Island. Because the damages in the hurricane modeling included significant wind impacts, the researchers felt the project should offer some practical measures communities could take to reduce these damages in addition to addressing flooding damages. These were described on pages 15 and 16.

The data from the HAZUS-MH modeling indicate that there is significant monetary value in promoting community resilience by the use of green infrastructure systems. This guide highlights the green infrastructure and nature-based resilience practices shown to reduce damage in the modeling phase of this project.

Green and natural infrastructure practices capture and store rainfall and stormwater runoff, promote infiltration of the water into the ground, and encourage evapotranspiration of the water back into the atmosphere.

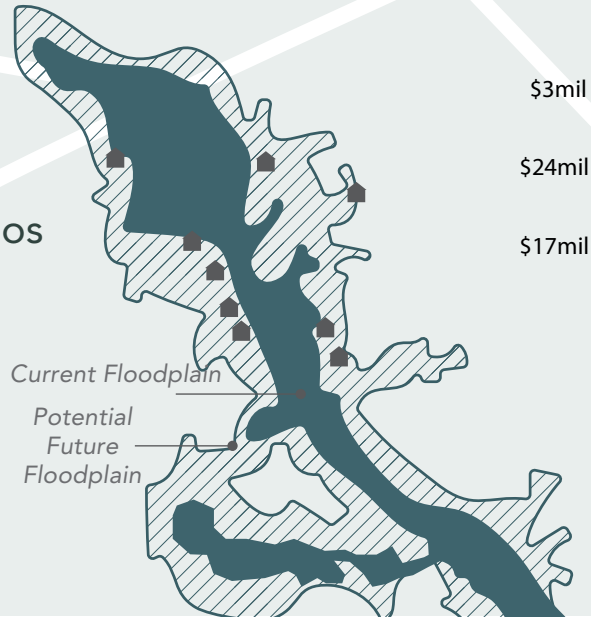
The result is that less water travels downstream, reducing the risk of flooding. The integration of natural features into existing stormwater management and floodplain protection efforts reduces peak flows and flood depths, leading to fewer damaged buildings and less damage to affected structures. Coastal sand dunes act as a natural barrier to storm surge inundation and absorb a significant amount of wave energy, which makes them an essential green infrastructure component when planning for resiliency. Strategically protecting natural features that are environmentally significant and located in flood-prone areas can help ensure that future development and infrastructure is placed in less vulnerable areas. Regulators and community planners can take advantage of the environmental benefits that land conservation and protection provide to promote resilience and minimize risk from hazards, allowing communities to realize significant cost savings from disasters.

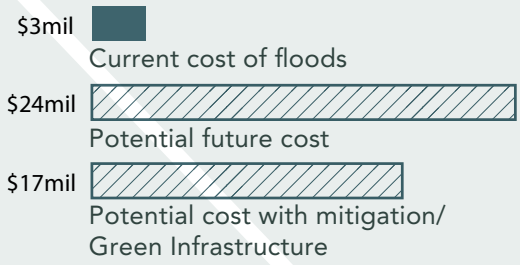
Flood & Wind Damage Significantly Increases in Coming Years

HINESVILLE

Riverine Flood Scenarios

Although there may not be a significant number of home-owners currently living in a flood zone, with a changing climate indicating increasing flood events, property owners should consider adding flood insurance to protect their homes.





36% REDUCTION

in costs with types of Mitigation/Green Infrastructure when compared to the maximum projected cost of a "100 year flood"

TYBEE ISLAND

Storm Surge Flood & Wind Scenarios

WHAT IS A 100 YEAR FLOOD?

"The flood having a 1-percent chance of being equalled or exceeded in any given year; also known as the base flood. If your house is located within a "100 year flood" zone it has a 26% chance of suffering flood damage during the term of a 30-year mortgage."

$256mil
Current cost of floods

$579mil
Potential future cost

$398mil
Potential cost with Mitigation/Green Infrastructure

$181 MILLION

estimated savings with Mitigation & Green Infrastructure & no new development when compared to the maximum projected cost of a "100 year flood."

Mitigation initiatives such as hurricane shuttering could save up to $19 million in wind damage cost.

TYPES OF MITIGATION/GREEN INFRASTRUCTURE

- Building codes and/or zoning that will enhance resiliancy in the floodplain
- Ordinances requiring shuttering or secondary water proofing
- Implement smart growth ordinances requiring land conservation measures, wetland conservation or creation, rainwater harvesting, bioretention, bioswales, permeable pavement or other green infrastructure practices
- Protect, conserve and when needed enhance sand dunes

A recent study by the National Institute of Building Sciences shows that for every **1 dollar spent** on mitigation, on average **6 dollars can be saved** on losses from natural hazards.

Behind the Numbers

STUDY SCOPE

118 different current and future wind and flood scenarios were modeled to evaluate potential damages from hurricane wind and storm surge on Tybee Island and riverine floods in the City of Hinesville, Georgia . We examined current as well as future development with and without green infrastructure mitigation options such as increased dune height for coastal flooding, flood water infiltration and retention for riverine flood, and enhanced building codes for hurricane winds.

STUDY FINDINGS

Future risks such as increased rainfall and sea level rise will present a significant impact to Georgia coastal communities. It is important to foster awareness and understanding of the role of natural resources in protecting communities and citizens from the effects of tropical storms, hurricanes, riverine flooding events and future hazards such as sea-level rise. Green Infrastructure practices and policy changes can help mitigate those risks and strengthen community resilience.

WHAT IS MITIGATION?

Actions that reduce the social and economic impacts of hazards on the community.

WHAT IS GREEN INFRASTRUCTURE?

Natural and nature-based engineered systems that mimic natural processes—can be used to make communities better prepared and more resilient to extreme weather and coastal hazards that are becoming more frequent with climate change.

EFFECTS OF MITIGATION

Current losses from coastal floods are estimated at $256 million for the 100 year flood (12.4' in surge). In the future, changes to hurricane strength, sea level rise and increased building density could increase Tybee Island losses by as much as $322 million.

BUT, IF GREEN INFRASTRUCTURE PROJECTS AND SMART GROWTH POLICIES ARE IMPLEMENTED, FUTURE LOSSES COULD BE REDUCED BY AS MUCH AS $181 MILLION BASED ON THE STUDIED METHODS.

In the Hinesville area the future 1% annual chance flood is expected to have damages as much as 300-800% higher than current estimates of flood losses. This is in part due to many people living on the fringe of the current floodplain. The implementation of Green Infrastructure projects can reduce future losses by 36% based on the studied methods.

GEORGIA
DEPARTMENT OF NATURAL RESOURCES
COASTAL RESOURCES DIVISION

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

For additional information contact Kelly (O'Rourke) Hill, Coastal Resources Specialist, Georgia Department of Natural Resources Coastal Resources Division, Kelly.Hill@dnr.ga.gov or visit:

coastalgadnr.org/ResiliencewithGreenInfrastructure

This infographic and the associated study upon which it is based was prepared by The Polis Center at Indiana University Purdue University Indianapolis and the Space Science and Engineering Center at the University of Wisconsin Madision under grant award #NA17NOS4190164 to the Georgia Department of Natural Resources from the Office for Coastal Management, National Oceanic and Atmospheric Administration.

SECTION 2

Connections: The Coastal Stormwater Supplement and Other Important Plans and Policies

Managing coastal flooding hazards and improving community resilience will require a variety of large and small policies and practices that occur at different scales and in different parts of the community. Importantly, efforts related to planning, stormwater management, emergency management, flood control, and environmental quality already exist, and many of these efforts already inform green infrastructure implementation in Georgia. This section provides an overview of the following important resources for Georgia's coastal communities.

- *The Georgia Stormwater Management Manual*
- *The Coastal Stormwater Supplement* to the Georgia Stormwater Management Manual
- Municipal Separate Storm Sewer System Permits
- Hazard Mitigation Plans
- Disaster Recovery and Redevelopment Plans
- Community Rating System
- *Coastal Nonpoint Source Management Program and Statewide Plan*
- Coastal Georgia Regional Plan
- The Coastal Resource Division's *Green Growth Guidelines*
- The Coastal Regional Commission of *Georgia's Green Infrastructure Planning Guidelines*

In addition, **page 34** provides a list and description of ordinances, policies, and plans at the local level that involve and/or affect the implementation of green infrastructure.

GEORGIA STORMWATER MANAGEMENT MANUAL

The *Georgia Stormwater Management Manual,* often called "the Blue Book," is the principal guide for postconstruction stormwater infrastructure in the state of Georgia. The latest edition, updated in 2016, takes a comprehensive approach to stormwater system design. This approach recognizes the fact that Georgia communities have increasingly complex regulatory, economic, and social drivers that influence their stormwater management practices. The Clean Water Act's National Pollutant Discharge Elimination System (NPDES) permits for government and private infrastructure, the Clean Water Act's total maximum daily loads (TMDLs), watershed assessments, water supply planning, water quality protection or restoration, floodplain management, disaster preparedness, and many other issues are affected by stormwater management decisions. Although the manual has no direct regulatory authority, the standards in it have been incorporated into many local stormwater management ordinances. Adoption of those standards or an equivalent is required for local governments covered by a municipal separate storm sewer system (MS4) permit. MS4s are discussed in more detail on **page 26**.

The *Georgia Stormwater Management Manual* is published in three volumes. Volume 1 provides

background information on why communities need to manage stormwater effectively. It also describes the concept of integrated stormwater management as well as the tools and technologies used to implement it. Volume 2 is the Technical Handbook. It is designed to provide planners, designers, and engineers with the information they need about basic construction and maintenance practices as well as relevant stormwater best management practices to develop site plans, review those plans, and conduct site inspections. Volume 3 is the Pollution Prevention Guidebook, which is a compendium of pollution prevention practices at a variety of scales that can improve the water quality of stormwater runoff.

COASTAL STORMWATER SUPPLEMENT: GEORGIA STORMWATER MANAGEMENT MANUAL

The Coastal Stormwater Supplement (CSS) to the *Georgia Stormwater Management Manual* is an additional guidance document that builds upon the basic stormwater management processes introduced in the manual. While the CSS is widely applicable in many communities, it does incorporate features specifically relevant to coastal plain conditions in its recommendations. The CSS is intended to improve pre- and postconstruction stormwater management practices to prevent environmental degradation caused by land development practices. It does so by laying out an "integrated green infrastructure-based approach to natural resource protection, stormwater management, and site design."[23] The CSS emphasizes site planning and design practices to protect natural resources and maintain predevelopment site hydrology. It also includes practices to improve postconstruction stormwater runoff.

Like the *Georgia Stormwater Management Manual*, the CSS has no direct regulatory authority, but its practices and requirements have been incorporated into many local stormwater management ordinances. In coastal counties, adoption of those standards or an equivalent is required for local governments covered by an MS4 permit.

MUNICIPAL SEPARATE STORM SEWER SYSTEM PERMITS

Recognizing that population growth and urban development are major contributors to water quality problems across the country, the federal Clean Water Act's National Pollutant Discharge Elimination System (NPDES) regulates the discharge for stormwater from MS4s.

In 1990, the US EPA began requiring large and medium-sized cities, and other similarly dense "urbanized areas," to obtain an NPDES permit for their stormwater discharge. These are individual permits with specific conditions related to each permitted entity's discharges. There are approximately 850 communities permitted under this program. Since 1999, EPA has designated small MS4s, which are communities that include anurbanized area as defined by the US Census Bureau. Large institutional stormwater systems for entities like public universities, hospitals, and prisons are also generally considered small MS4s. There are almost 7,000 small MS4s. The vast majority of small MS4s are covered by statewide general permits that include common permit requirements for all of the permittees in that state.

The requirements of the MS4 permits focus primarily on reducing impacts to water quality from nonpoint source pollution. These requirements increasingly promote the use of natural and green infrastructure practices and emphasize removing local barriers to implementing such practices as best practices for reducing pollution. The requirements of the *Georgia Stormwater*

Management Manual—and the CSS for coastal counties—and are made enforceable against MS4 permittees through their inclusion in the individual and general MS4 permits.

HAZARD MITIGATION PLANS

Hazard mitigation is one of the major components of community resilience, and many green infrastructure and nature-based practices and policies further those goals. Flooding is one of the most common—and most expensive—natural hazards that communities face. While flood risk can have many interrelated components such as stormwater, floodplain management, and storm surge, these components are generally connected and sometimes compound. Often, similar management techniques can be applied to mitigate risks from these different flooding sources. Hazard mitigation planning helps communities understand the components of their flood risk, which can help them determine the appropriate siting and scale of green infrastructure solutions. Green infrastructure practices and policies incorporated into local hazard mitigation planning can improve water quality, reduce stormwater runoff, and reduce community vulnerability to flooding hazards.[24] Importantly, aligning hazard mitigation planning with stormwater management has great potential to expand sources of funding for green infrastructure projects.[25]

Prepared and adopted by local communities, hazard mitigation plans identify, assess, and reduce risk to life and property from hazard events. Hazard mitigation planning anticipates future conditions instead of reacting to events after they happen. This type of planning is designed to reduce human suffering, loss of life and property, economic disruption, and postdisaster assistance costs. Since 2000, state and local governments have been required to prepare hazard mitigation plans to receive mitigation project funding from FEMA.[26] These plans must be updated every five years.

HAZARD MITIGATION PLANNING AND DISASTER RECOVERY AND REDEVELOPMENT PLANNING ARE OPPORTUNITIES FOR COMMUNITIES TO INCORPORATE GREEN INFRASTRUCTURE AS PART OF OVERALL RESILIENCE STRATEGIES TO CONTROL FLOODING AND PROTECT PROPERTY.

DISASTER RECOVERY AND REDEVELOPMENT PLANS

Ultimately, local governments are primarily responsible for disaster response, recovery, and redevelopment. Recognizing this fact, FEMA's National Disaster Recovery Framework is designed to assist communities to better manage the recovery and redevelopment process after a disaster through the development of disaster recovery and response plans (DRRPs).

A DRRP is an all-hazard plan to guide action and decision-making after a disaster. The goal is to streamline the recovery process and allow the community to successfully achieve some basic predetermined recovery and redevelopment objectives. The plan includes predisaster activities meant to bolster resilience and address potential obstacles to achieving postdisaster goals. It also includes postdisaster recommendations to coordinate activities in the aftermath of a significant event.

While Georgia, had not been hit by a major hurricane for many years, that recently changed. Hurricanes Irma, Matthew, and Michael, while not direct hits on Georgia, each cause significant damage in the state. These storms prodded the state and local communities to take action and continue to motivate them to become more resilient and to incorporate long-term planning to respond more effectively to natural disasters.

Thanks to funding from the National Oceanographic and Atmospheric Administration (NOAA), the Georgia Coastal Management

AS FLOOD INSURANCE COSTS CONTINUE TO RISE, COMMUNITIES HAVE EVEN GREATER INCENTIVES TO IMPLEMENT GREEN INFRASTRUCTURE POLICIES AND PRACTICES TO IMPROVE THEIR CRS RATINGS.

Program (GCMP) at the Coastal Resources Division (CRD) has led an important effort to help our coastal communities adapt to potential changes from increased flooding and sea level rise as well and reduce vulnerabilities to storms, storm surge, and flooding. The CRD developed ***Post-Disaster Recovery and Redevelopment Planning: A Guide for Local Communities*** to support community redevelopment after a natural disaster. Many of the recommendations in the guide to better protect property and life during a disaster—for example, building setbacks and avoiding shoreline hardening—directly relate to green infrastructure. In addition, the GCMP is leading an effort to complete DRRPs for all Georgia coastal counties, making Georgia the first state in the nation to have DRRPs for every one of its coastal counties. Completed DRRPs are available on GCMP's **website.**

The policies and activities planned as part of the DRRP process to guide postdisaster recovery and redevelopment intersect closely with the same plans, codes, and regulations that promote overall community resilience such as green infrastructure. They should be consulted and incorporated into green infrastructure planning and implementation efforts.

COMMUNITY RATING SYSTEM

Local governments throughout Georgia are protecting their communities from flood risks by participating in FEMA's Community Rating System (CRS). The CRS is a voluntary program that encourages local governments to enact enhanced floodplain management in exchange for reductions in flood insurance premiums across the community. The CRS gives credits that, as they accumulate, create flood insurance discounts for property owners. The CRS provides a tremendous opportunity for communities to help people understand their flood risks and take appropriate actions to mitigate these risks, including through policies and practices that promote green infrastructure and resilient building practices.

The CRS is directly tied to the National Flood Insurance Program (NFIP), which provides federally backed flood insurance to homeowners, renters, and business owners in communities that participate in the program.[27] Among other requirements, communities participating in the NFIP must adopt and enforce ordinances that meet or exceed requirements set forth by FEMA to reduce the risk of flooding in the community.[28] Many of the flood damage prevention ordinances found in local codes across Georgia today were adopted so that the community could join the NFIP. While the minimum NFIP requirements must be included in community floodplain ordinances, they do not restrict local governments from enacting more stringent regulations. The CRS was created to reward communities undertaking activities that exceed NFIP requirements.[29] As flood insurance costs continue to rise, communities have even greater incentives to implement more resilient green infrastructure and development policies and practices to increase their CRS ratings.

Below are some of the major incentives in the CRS that relate to green infrastructure and built resilience goals. The CRS Coordinators Manual describes in detail how CRS ratings and credits are calculated and reported.

CRS CLASS	CRS CREDITS	RATE REDUCTION SPECIAL FLOOD HAZARD AREA	RATE REDUCTION OUTSIDE OF SPECIAL FLOOD HAZARD AREA
10	0–499	0%	0%
9	500–999	5%	5%
8	1,000–1,499	10%	5%
7	1,500–1,999	15%	5%
6	2,000–	20%	10%
5	2,500–	25%	10%
4	3,000–	30%	10%
3	3,500–	35%	10%
2	4,000–	40%	10%
1	4,500+	45%	10%

Appendix A provides several model ordinances. Many of the elements included in these ordinances are designed to help communities achieve CRS credits. These elements are also noted in the tables in Section 6 of this guide, which describes in more detail the CRS credit areas highlighted above. In addition, Section 8 of the **Model Flood Resilient Development and Building Ordinance in Appendix A** includes a provision that improves how the "impact adjustment" applicable to the Special Flood Hazard Area is used. Impact adjustments are used throughout the CRS Manual to determine how many of the structures within the Special Flood Hazard Area are affected by a CRS-credited activity.[30] Finally, note that the CRS Manual is updated periodically and how credits are calculated may change. This guide is based on the 2017 manual.

Whenever possible, communities should consider how to leverage or supplement resilience efforts to achieve both broad impact and multiple CRS credits. In addition, planning, mapping, and modeling efforts also may generate CRS credits. For example, the CRS is designed to incentivize improved mapping of risks at the local level. While many of the FEMA-required flood insurance rate maps (FIRMs) have detailed data, flood problems may nevertheless exist in areas not indicated by those maps, and those maps generally do not incorporate changing climatic conditions or the impacts of new development. Local mapping efforts that go beyond FEMA flood requirements therefore may generate additional CRS credits.

Community Rating System Incentives

PUBLIC INFORMATION ACTIVITIES			
Hazard Disclosure	CRS 322c:	Other Flood Problems Not Shown on the FIRM	20 Credits
	CRS 342a:	Disclosure of Flood Hazard	35 Credits
	CRS 342b:	Other Disclosure Requirements	25 Credits
	CRS 342d:	Disclosure of Other Hazards	8 Credits
MAPPING AND REGULATION			
Floodplain Mapping	CRS 412d:	Higher Study Standards	200 Credits
	CRS 412e:	More Restrictive Floodway Standard	140 Credits
Open Space Preservation	CRS 420a:	Open Space Preservation	1,450 Credits
	CRS 420b:	Deed Restrictions	50 Credits
	CRS 422c:	Natural Functions Open Space	350 Credits
	CRS 422d:	Special Flood-Related Hazards Open Space	50 Credits
	CRS 422e:	Coastal Erosion Open Space	750 Credits
	CRS 422f:	Open Space Incentives	250 Credits
	CRS 422g:	Low-Density Zoning	600 Credits
	CRS 422h:	Natural Shoreline Protection	120 Credits
Higher Regulatory Standards	CRS 432a:	Development Limitations	1,330 Credits
	CRS 432b:	Freeboard	500 Credits
	CRS 432c:	Foundation Protection	80 Credits
	CRS 432d:	Cumulative Substantial Improvements	90 Credits
	CRS 432f:	Protection of Critical Facilities	80 Credits
	CRS 432h:	Building Code	100 Credits
	CRS 432k:	Coastal A Zones	500 Credits
	CRS 432o:	Other Higher Standards	100 Credits
	CRS 432n:	Coastal Erosion Hazard Regulations	370 Credits
	CRS 422f:	Open Space Incentives	250 Credits
Stormwater Management	CRS 452a:	Stormwater Management Regulations	380 Credits
	CRS 452c:	Erosion and Sediment Control Regulations	40 Credits
FLOOD DAMAGE REDUCTION ACTIVITIES			
Floodplain Management Planning	CRS 512b:	Repetitive Loss Area Analysis	140 Credits
Acquisition and Relocation	CRS 520:	Acquisition and Relocation	2,250 Credits

Note: FIRM = Flood Insurance Rate Map

Extra credits are also available if the community produces maps based on models that consider future conditions, including sea level rise.[32] The **Model Sea Level Rise Resilience Ordinance in Appendix A** requires the use of future sea level rise projections in all future plans, maps, regulations, ordinances, policies, public infrastructure and facilities planning and construction, and future land use decisions. It also establishes the minimum projections to be used based upon NOAA projection of global mean sea level. The following CRS activities may produce credit for such efforts:

- CRS Credit 322c: Other Flood Problems Not Shown on the FIRM
- CRS Credit 342d: Disclosure of Other Hazards
- CRS Credit 412d: Higher Study Standards
- CRS Credit 412e: More Restrictive Floodway Standard
- CRS Credit 432.k: Coastal A Zones
- CRS Credit 452.b: Watershed Management Plan[33]
- CRS Credit 512.a: Floodplain Management Planning

To be rated Class 4 or better, a community must show it has programs that minimize increases in future flooding. To become a Class 1 community, the highest rating possible, communities must receive credit for using regulatory flood elevations that reflect future conditions, including sea level rise, in the V and Coastal A Zones.[34]

COASTAL NONPOINT SOURCE MANAGEMENT PLAN AND STATEWIDE PLAN

The Coastal Nonpoint Pollution Control Program, which was established in 1990 by Section 6217 of the Coastal Zone Act Reauthorization Amendments, is jointly administered by NOAA and the EPA. The program is nonregulatory and is designed to provide funding and technical assistance to reduce nonpoint source pollution in coastal waters. The Georgia Coastal Nonpoint Management Program was federally approved in November 2018 and establishes a set of management measures for the state to use in controlling runoff from five main sources: agriculture, forestry, urban areas, marinas, and hydromodification (shoreline and stream channel modification).

The following are examples of practices promoted in Georgia's program:

- Urban development and redevelopment best management practices
- Conservation tillage methods including no-till farming
- Expanded buffers to minimize runoff from the land surface
- Protection of wetlands in order to decrease runoff and maintain natural regimes
- Restoration of wetlands in silviculture/agriculture lands to undo hydromodification
- Logging best management practices to reduce soil disturbance
- Managing dirt roads
- Standard livestock best management practices to minimize fecal runoff from pastures and poultry farms[35]

The approved Coastal Nonpoint Source Management Program has now been incorporated into the Statewide Nonpoint Source Management Plan. The statewide plan is updated every five years. In 2019, the Coastal Resources Division, in partnership with a stakeholder group, provided updates for the coastal sections.

REGIONAL PLAN OF COASTAL GEORGIA, COASTAL REGIONAL COMMISSION OF GEORGIA

Development pressure in Coastal Georgia threatens existing natural areas that provide critical ecosystem services. The Regional Plan of Coastal Georgia

guides local decision-makers on how to balance economic progress and environmental stewardship for sustainable growth along Georgia's coast. Updates to the plan include adding "community resilience" as a new element, as part of a growth leadership strategy that addresses land use, infrastructure, and economic development issues from a regional perspective.

This plan includes a risk and vulnerability assessment of Coastal Georgia that analyzes each community's comprehensive plan, ordinances, and emergency management plans. The assessment also evaluates the communities' assets and then makes conclusions about the community's risk and vulnerability. The regional plan contains the assessment's recommendations and a review of development pressure along Georgia's coast. The Coastal Regional Commission also published green infrastructure planning guidelines that provide economic justification, technical support, and resources to help guide regional decision-makers.

GREEN GROWTH GUIDELINES

The first edition of the *Green Growth Guidelines* was developed in 2006 as part of the Coastal Resource Division's Georgia's Nonpoint Source Management Program.[36] The *Green Growth Guidelines* provide strategies for communities to prevent, reduce, or alleviate the impacts of nonpoint source pollution in coastal Georgia. The second edition of the guidelines was released in 2014, and it includes valuable information about green infrastructure, stormwater management best practices, and streambank and shoreline stabilization.

The *Green Growth Guidelines* demonstrate how low-impact development (LID) strategies can have significant positive impacts on the environment while also providing superior outcomes both socially and economically. The *Green Growth Guidelines* outline the environmental, social, and economic benefits of using LID strategies and compare them to today's conventional development approach.

GREEN INFRASTRUCTURE PLANNING GUIDELINES, COASTAL REGIONAL COMMISSION OF GEORGIA

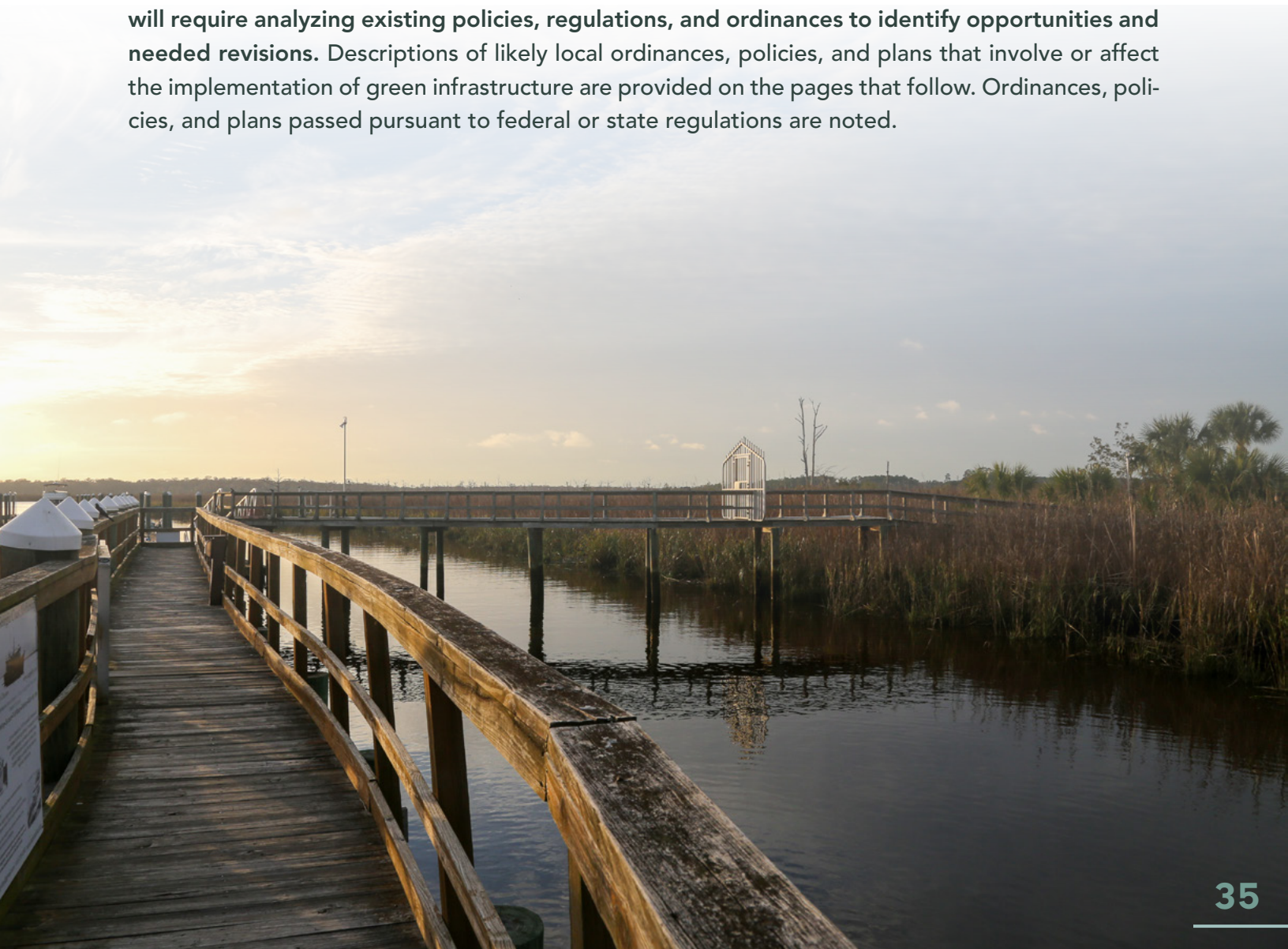
The Coastal Regional Commission of Georgia, in conjunction with the Georgia Forestry Commission, the Coastal Resources Division of the Georgia Department of Natural Resources, and numerous other partners, developed a set of green infrastructure planning guidelines to facilitate coordinated planning for green infrastructure and natural system conservation across Georgia's coastal region. These guidelines promulgate principles to guide both land development and land conservation in a thoughtful and organized way. They seek to maximize the benefits of growth and development in conjunction with natural ecosystem services by helping communities collaborate on larger-scale regional projects that would ultimately be more effective than disconnected and uncoordinated projects.

LOCAL PLANS, POLICIES, AND ORDINANCES

In Georgia, local governments—cities and counties—have the primary authority to regulate land use and manage development decisions. Local government and community laws, plans, and policies are significant determinants of community resilience, and they are critical in the effort to develop more green infrastructure and nature-based solutions to reduce flooding and improve community resilience. Below is a summary of some of the local government

activities to manage land use and development that will influence the use of green infrastructure. It is important to remember, however, that every community is unique. This is a general list based on Georgia communities and the hazard modeling of Liberty County, Georgia, that was conducted as part of this project. Every item listed may not apply to every community, and specific elements may go by other titles or names in some communities.

To improve community resilience, a variety of green infrastructure approaches will be necessary, both large and small scale. Consequently, the policies and practices affecting their implementation will involve or affect different existing ordinances throughout a community's local code. Elements from various local ordinances such as erosion and sedimentation control, stormwater management, floodplain management, and zoning may either promote or inhibit the implementation of green infrastructure. Those that inhibit green infrastructure may not necessarily do so by design but rather because they were drafted to achieve different goals unrelated to green infrastructure, were adopted at different times, have not been revised to incorporate best practices, or were adopted to meet state or federal regulatory requirements. Or the ordinance may just be silent on the matter, leaving it open to interpretation whether such practices are allowed. For this reason, **no single ordinance will result in the kind of nature-based infrastructure implementation necessary to result in broad-based community resilience. Instead, promoting green infrastructure at the local level will require analyzing existing policies, regulations, and ordinances to identify opportunities and needed revisions.** Descriptions of likely local ordinances, policies, and plans that involve or affect the implementation of green infrastructure are provided on the pages that follow. Ordinances, policies, and plans passed pursuant to federal or state regulations are noted.



Examples of Common Ordinances, Policies, and Plans at the Local Level Relevant to Green and Natural Infrastructure

COMPREHENSIVE PLAN

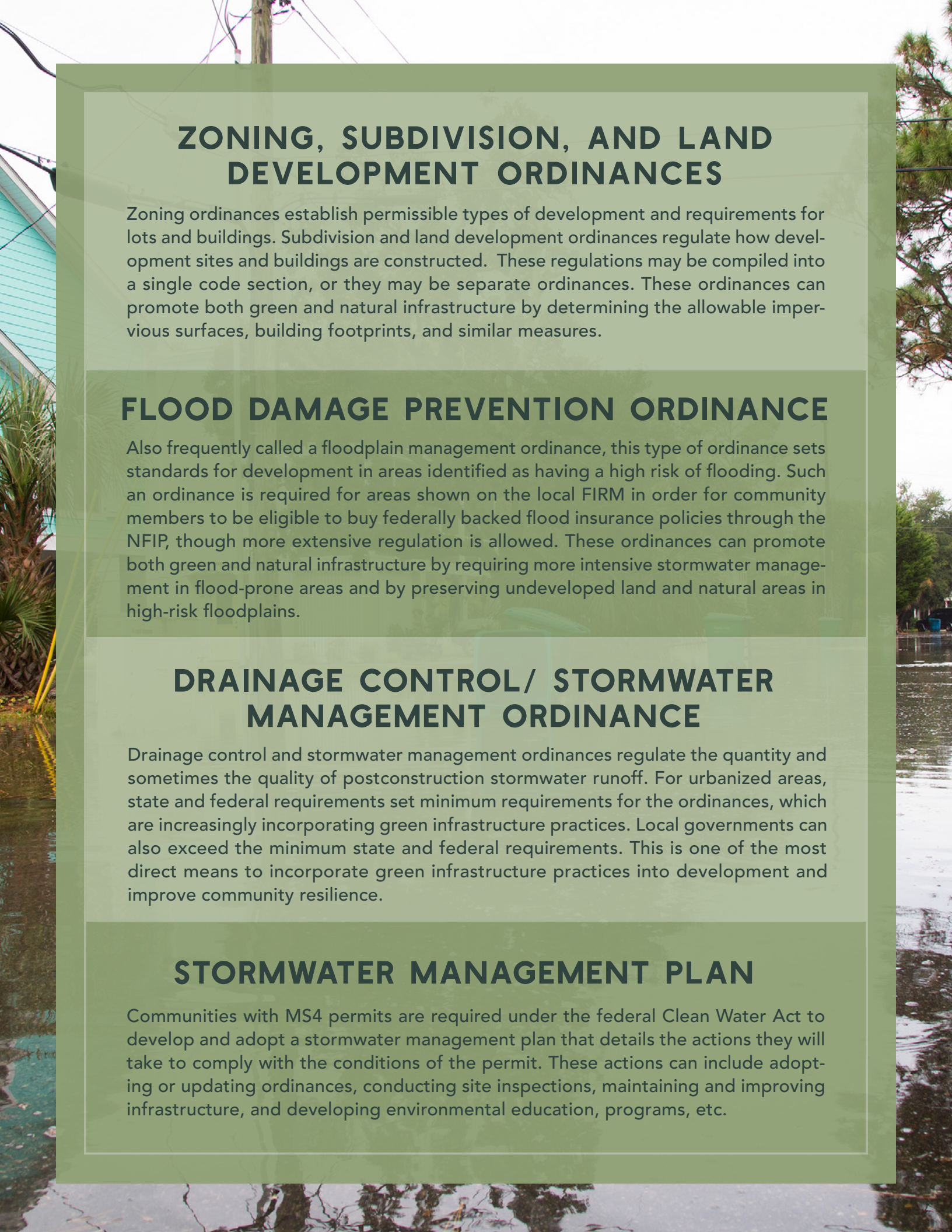
A comprehensive plan is required by the Georgia Planning Act (O.C.G.A. 45-12-200, et seq., and 50-8-1, et seq.) for any local government to be eligible to receive state funding or permits. This plan serves as the basis for the exercise of many local government powers, particularly the power to zone land and regulate land development. Among other things, the plan states a community's vision of the future, identifies local priorities, and includes maps that show areas for future development. Incorporating community resilience ideas into the comprehensive plan is a great way to initiate programs and policies to improve community resilience.

FUTURE LAND USE MAP

Usually developed as part of a comprehensive plan, a community's future land use (FLU) map describes the areas that are envisioned for future growth and development, and it describes the character of that development. The FLU is meant to inform land use decisions such as zoning and granting development permits, as well as driving investment in infrastructure such as roads, water systems, sewer systems, and stormwater infrastructure. Incorporating community resilience into future development patterns and styles of development can avoid substantial future risks.

SERVICE DELIVERY STRATEGY

A service delivery strategy is required in Georgia by the Service Delivery Act, O.C.G.A. 36-70-20, and it describes how the cities and the county government in a single county should work together to provide local services. This minimizes the duplication of services and limits competition between local governments. The strategy also provides a mechanism for resolving disputes over local government service delivery, funding, and land use. The service delivery strategy can significantly impact the way land development occurs, and plans to protect or enhance community resilience should involve all affected local governments. Thus, how government services will be provided under the service delivery strategy needs to be considered.



ZONING, SUBDIVISION, AND LAND DEVELOPMENT ORDINANCES

Zoning ordinances establish permissible types of development and requirements for lots and buildings. Subdivision and land development ordinances regulate how development sites and buildings are constructed. These regulations may be compiled into a single code section, or they may be separate ordinances. These ordinances can promote both green and natural infrastructure by determining the allowable impervious surfaces, building footprints, and similar measures.

FLOOD DAMAGE PREVENTION ORDINANCE

Also frequently called a floodplain management ordinance, this type of ordinance sets standards for development in areas identified as having a high risk of flooding. Such an ordinance is required for areas shown on the local FIRM in order for community members to be eligible to buy federally backed flood insurance policies through the NFIP, though more extensive regulation is allowed. These ordinances can promote both green and natural infrastructure by requiring more intensive stormwater management in flood-prone areas and by preserving undeveloped land and natural areas in high-risk floodplains.

DRAINAGE CONTROL/ STORMWATER MANAGEMENT ORDINANCE

Drainage control and stormwater management ordinances regulate the quantity and sometimes the quality of postconstruction stormwater runoff. For urbanized areas, state and federal requirements set minimum requirements for the ordinances, which are increasingly incorporating green infrastructure practices. Local governments can also exceed the minimum state and federal requirements. This is one of the most direct means to incorporate green infrastructure practices into development and improve community resilience.

STORMWATER MANAGEMENT PLAN

Communities with MS4 permits are required under the federal Clean Water Act to develop and adopt a stormwater management plan that details the actions they will take to comply with the conditions of the permit. These actions can include adopting or updating ordinances, conducting site inspections, maintaining and improving infrastructure, and developing environmental education, programs, etc.

EROSION CONTROL ORDINANCE

Usually adopted to meet minimum requirements in the state Erosion and Sediment Control Act, these ordinances require practices to reduce erosion from construction sites, and they require riparian buffers along state waters. Local governments may exceed the state minimum standards, and many do. These regulations can help control runoff, and the buffer requirements promote the protection of ecologically valuable open space that is also important for resilience.

DUNES/SHORELINE PROTECTION ORDINANCE

These ordinances prohibit activities destructive to sand dunes, which provide a defense against coast flooding. This type of local ordinance is enacted in addition to state law and regulations under Georgia's Shore Protection Act. It can exceed the state requirements, or it can allow local enforcement of the state-level standards.

LAND CLEARING AND TREE PROTECTION ORDINANCE

These ordinances require landscape vegetation controls during land-clearing activities. They also prioritize preserving existing trees and may require minimum replanting standards. Some also promote the conservation of native and/or ecologically important trees or tree species. Maintaining the existing tree canopy and promoting an urban tree canopy can enhance the evapotranspiration of stormwater and reduce the impacts of runoff, while also providing numerous other resilience benefits.

PLANNED USE DEVELOPMENT ORDINANCE

These ordinances allow greater flexibility in development by promoting the use of low-impact development practices such as cluster development, mixing of uses, and alternative, environmentally focused lot designs. These regulations can reduce the overall footprint of a development as well a protect primary conservation areas, preserve open space, allow reduced road widths, and promote other impervious cover reductions.

SECTION 3
Getting Started

Planning and building for community resilience is an extremely local process that must consider local conditions and be driven by local purposes. Promoting resilient development and green infrastructure at the local level will require analyzing a variety of existing policies, regulations, and ordinances to identify opportunities and/or needed revisions. For this reason, this guide recommends the following step-by-step approach to evaluate existing codes and policies so that local leaders can make recommendations that align with community priorities for resilience.

IDENTIFY KNOWLEDGEABLE STAFF AND STAKEHOLDERS. Local governments should identify officials and staff to consider the basic community resilience concepts laid out in the guide, ideally with cooperation from private-sector and nongovernmental partners. Together, these stakeholders can develop actions and programs designed to improve their community's resilience. The first step is identifying the right individuals to participate. Individuals with the following responsibilities should be considered.

- Chief Code Enforcement Officer
- Emergency Manager
- Floodplain Manager
- Planning Director
- Public Works Director
- Georgia Department of Natural Resources Coastal Management Program Technical Assistance
- Stormwater Manager
- Geographic Information Systems Administrator
- Parks and Open Space Manager
- County Attorney
- University Extension Agent (and/or other outreach and communications personnel)

ORGANIZE RESILIENCE PLANNING. Consider whether to assemble a team, advisory committee, or steering committee after key staff and stakeholders are identified. Alternatively, many local governments designate or hire a staff person as a resilience officer to initiate, oversee, organize, and direct resilience efforts across departments as well as to manage consultants and seek grant funds.

DEVELOP COMMUNITY RESILIENCE GOALS AND TARGETS, A TIMELINE FOR ACHIEVING THOSE GOALS AND TARGETS, AND METRICS TO DETERMINE PROGRESS. Setting short-term, mid-term, and long-term goals can enable the resilience team to demonstrate progress toward improving community resilience.

REVIEW AVAILABLE DATA CONCERNING ENVIRONMENTAL QUALITY, FUTURE CLIMATIC CONDITIONS, AND POTENTIAL IMPACTS TO LOCAL COMMUNITY RESILIENCE. Working with outside experts when necessary, it is important to develop a full understanding of the present and future impacts of natural hazards and climate change.

SELECT ONE OR MORE FUTURE CLIMATE SCENARIOS TO USE FOR COMMUNITY RESILIENCE PLANNING. The future scenarios selected may be incorporated from other community planning activities as appropriate, such as the disaster recovery and redevelopment plan or other such plans.

CONDUCT A POLICY AND PRACTICES REVIEW, IDENTIFYING OPPORTUNITIES AND BARRIERS TO ACHIEVING RESILIENCE GOALS AND TARGETS. If a team is established, team members should collaboratively review local laws, policies, and practices to identify barriers to the use of green infrastructure practices in both public and private projects.

MAKE RECOMMENDATIONS THAT ALIGN WITH COMMUNITY PRIORITIES FOR RESILIENCE. Such recommendations should do the following:

- Identify policies and practices to build on existing local laws, policies, and practices that enable the use of green infrastructure;
- Identify policies and practices to address gaps where local laws, policies, and practices inhibit the use of green infrastructure practices;
- Ensure community resilience projects and programs address needs of underserved and socially vulnerable communities;
- Develop standards for future public buildings and infrastructure investments;
- Develop local incentive programs for using green infrastructure; and
- Promote public awareness of community resilience issues.

IDENTIFY OPPORTUNITIES FOR RESILIENCE PROJECTS. Green infrastructure projects should be prioritized. Partners and funding should be identified.

*Appendix A contains a **Model Coastal Resilience Ordinance** that creates a Resilience Innovation Team charged with the above tasks. While communities are not required to create such a team, adopting this type of ordinance formalizes the process and increases accountability.*

SECTION 4

Understanding Your Future Flooding Vulnerability

Accurately assessing flood risks is crucial, and while current tools, such as FEMA's FIRMs, provide important information, they are generally based on historical data about flood conditions and do not take land use changes and future projected risks into account. Communities seeking to become more resilient must build upon these methods and take a more proactive approach. This section discusses how FIRMs are currently being used by local governments for planning and land development. It then highlights some of the ways these assessments do not fully communicate future flooding risks. Finally, this section describes more recent data and modeling related to both sea level rise and high tide flooding developed by a federal interagency partnership and presented by NOAA. The Coastal Zone Management Program at the Georgia Department of Natural Resource's Coastal Resources Division recommends that coastal communities use these projections to enhance their resilience planning, and therefore this guide demonstrates how they can be incorporated into local flood risk management practices and regulations to help communities improve their resilience to future hazards.

FLOOD RISK ASSESSMENT

Since the inception of the NFIP in the 1960s, communities and residents have primarily relied on FEMA to assess flood risks and identify high-hazard areas that are likely to flood. FEMA's risk assessment is based on the creation of a flood insurance rate map (FIRM), which is used to calculate flood insurance rates for residents of communities participating in the NFIP. These FIRMs designate areas at high risk of flooding—defined as having a 1% annual chance of experiencing a flood—as the Special Flood Hazard Area (SFHA). This area is often misleadingly referred to as the "100-year floodplain," which causes people to mistakenly believe that floods only happen in those areas once every 100 years. **In reality, based on these maps, there is 26% chance that a property in this area will flood in any given 30-year period.**[37]

While the designation of SFHAs was developed as a tool for calculating actuarial risks for insurance purposes, it has been widely adopted as a broad assessment of risk and used for general planning and land development in communities across the country. This has occurred in large part because the NFIP requires participating communities to regulate land development in the SFHA; consequently, most communities have adopted some type of floodplain management ordinance based on these maps. The other major reason FIRMs are used in this way is because, until recently, they were generally the only risk assessments available to local governments.

A great deal has been written about the limitations of using FEMA's FIRMs for general flood risk assessments and for other purposes beyond the actuarial use for which they were designed. The most relevant concern with using FIRMs in the context of developing community resilience to future flooding events is that they are entirely based on historical flood data; therefore, they do not include anticipated future

changes to flood risk. A number of factors will affect future flood risk in a given area, including changing precipitation patterns, erosion rates, changes in topography, and human land use practices. The factor most relevant to the focus of this guide is rising sea levels.

SEA LEVEL RISE PROJECTIONS

Rising sea levels is one of the most important concerns for flood resilience in coastal communities. Since 1900, global mean sea level has risen faster than during any comparable period over the last 2,800 years, and that rate of increase has been accelerating in recent decades. In 2014, global sea level was 2.6 inches higher than the 1993 average, and the rate of rise continues at about one-eighth of an inch annually.[38] Much of this sea level rise is a result of climate change and rising average global temperatures. Thus, global mean sea level (GMSL) will continue to rise throughout the 21st century and beyond. Questions remain regarding how much it will rise and when it will happen—much of that uncertainty relates to global trends in greenhouse gas emissions—but there is very little doubt that this is happening. Therefore, to improve community resilience, communities must reduce flooding and storm surge hazards by incorporating sea level rise projections into local planning decisions. To address the need to incorporate sea level rise into flood risk assessments, the federal government created the Federal Interagency Sea Level Rise and Coastal Flood Hazard Scenarios and Tools Task Force. This task force was charged with establishing a baseline for assessing future hazard and flooding scenarios that could inform a nationwide system of sea level rise information and decision support. In 2017, NOAA published a report on one part of the task force's overall goal.[39] This report updates GMSL rise projections, regionalizing the global estimates for different parts of the US coastline, and then uses the regional estimate to define local relative sea level (RSL) rise scenarios. Where specific local data are not available, these local scenarios are appropriate baseline targets to inform community planning.

GMSL projections suggest a rise ranging from 0.1–0.3 meters (4 inches to 1 foot) by 2100 on the lowest end to 2.0–2.5 meters (6.5 feet to 8.2 feet) on the high end. With these estimates as the outer bounds, the NOAA report defines six potential GMSL scenarios: *Low* (0.3m by 2100), *Intermediate-Low* (0.5m), *Intermediate* (1.0m), *Intermediate-High* (1.5m), High (2.0m), and *Extreme* (2.5m). These scenarios are intended to give the public and government planners a range of values to use when considering the potential future impacts of sea level rise. **The Georgia DNR Coastal Resources Division generally recommends using the Intermediate or Intermediate-High scenarios for community planning purposes.**

GLOBAL MEAN SEA LEVEL (GMSL)

is the average elevation of all the Earth's oceans measured from the center of the Earth. It is based on averages from a variety of data sources including satellites and tide stations around the world.

RELATIVE SEA LEVEL RISE (RSL)

reflects changes in local sea level in relation to the adjacent land. This may vary substantially from the global average represented as GMSL due to the influence of local conditions such as land subsidence or rebound, tidal ranges, ocean currents, erosion or accretion, and other factors. RSL is measured by local or regional tide gauges. This is typically the most relevant sea level rise information for coastal planning and community resilience efforts.

HIGH TIDE FLOODING

The effects of rising sea levels will first be seen in increasing incidents of "high tide flooding." A higher GMSL refers to water levels that will be inundated by seawater on an average high tide. However, other areas will also be subject to regular flooding during exceptional high-tide events known as spring tides or sometimes called "king tides." This is particularly true in areas with large tidal ranges, such as in Georgia where tides can regularly reach three feet or more above the average high tide line. These flooding events are also referred to as nuisance flooding, sunny day flooding, and recurrent tidal flooding.[40]

These events are likely to cause significant impacts because their frequency and severity can be greatly increased by relatively small increases in local sea level—the RSL. This is particularly true in regions with relatively flat and low-lying coastal zones, such as the southeastern United States. Along the coasts of almost all of the continental United States, RSL is projected to exceed the rate of GMSL under the Intermediate-High, High, and Extreme scenarios. The tide elevation that can cause this kind of event varies along the coast but is generally about 0.8m (2.6 feet) above the highest average daily tide. Because these events are tied to regular tide cycles, they occur at relatively predictable intervals. On the Southeast Atlantic Coast, high tide flooding generally peaks during September–November, with a secondary peak occurring in June–July.[41] Today, high tide flooding affects low-lying infrastructure such as roads, stormwater systems, and private and public properties. Rising sea levels are increasing the frequency, depth, and extent of high tide flooding events along the Southeast Atlantic coastline.

On average, there is about a 20% chance each year that this will occur. For most coastal communities, NOAA estimates that a 0.35m (14 inches) rise in RSL will result in a 25-fold increase in the frequency of these events. **Put another way, instead of a flooding event that will occur on average once every five years, high tide flooding becomes an event that will occur five times per year, or every two to three months.** Under the Intermediate-High scenario, many communities will experience these impacts by 2030, causing significant disruptions to their communities.

USING SEA LEVEL RISE PROJECTIONS IN PLANNING

To protect lives, infrastructure, and property, decision-makers tasked with planning for both long- and short-term land use and infrastructure investment must look beyond historical flood information and take future conditions into account. NOAA's sea level rise projections

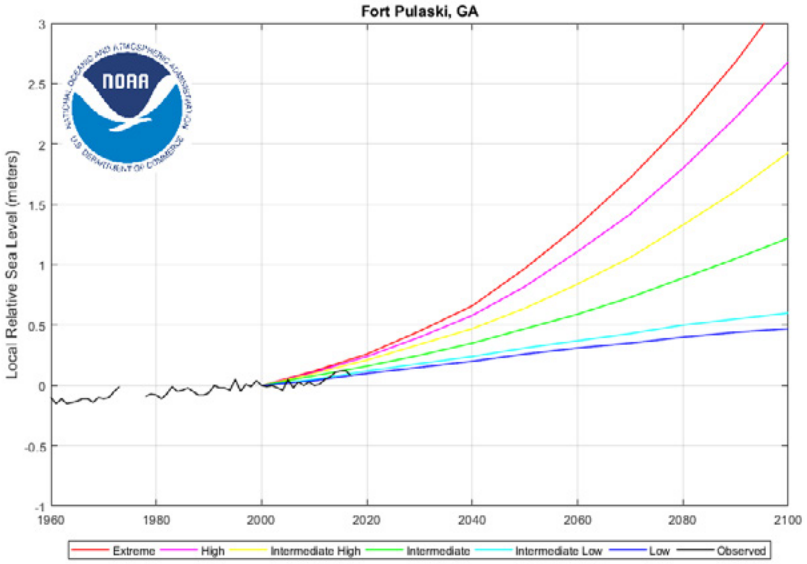


Figure 3. This figure shows annual mean relative sea level based on the Fort Pulaski (Savannah, Georgia) tidal gauge, with six regionalized sea level rise scenarios plotted to 2100, as described in NOAA's 2017 report on **Global and Regional Sea Level Rise Scenarios for the United States.**

Chart available **here.**

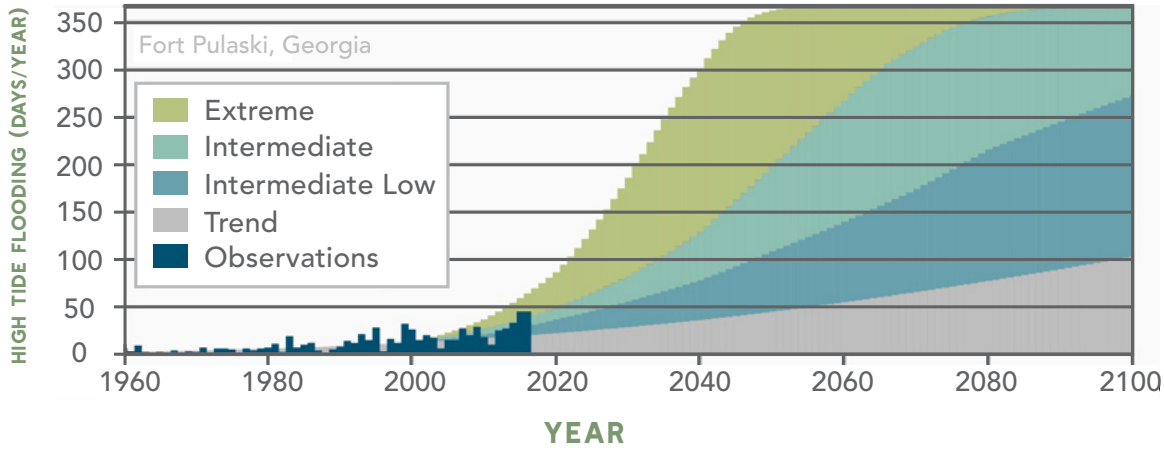
provide useful data points for incorporating this information into local planning documents, government policies, regulations, and decision making. For some decisions, planners need to consider the worst-case scenario to protect critical facilities from potential impacts. For other decisions, it is more important to focus on what is likely to happen. As detailed in the Model Sea Level Rise Ordinance included in Appendix A, this guide recommends the following:

Online Tools for Mapping Projected Rising Sea Levels

Click the links below to view websites.

+ GEORGIA'S COASTAL HAZARDS PORTAL
+ NOAA'S DIGITAL COAST
+ US ARMY CORPS OF ENGINEERS, SEA-LEVEL CHANGE CURVE CALCULATOR

- Adopt a specific planning horizon for specific types of planning and development decisions. For planning and land use decisions, 30 years is generally considered a suitable period for long-term planning. In that context, in the year 2020, utilizing the sea level rise projections for the year 2050 as a standard for future risk assessments is recommended.
- Adopt a specific sea level rise projection scenario in conjunction with the planning horizon. For most purposes, the Intermediate-High range, as defined in the NOAA 2017 report, is advisable. This projection range presents a conservative estimate of likely impacts with the most scientific support of its likelihood. This is also the minimum projection required for FEMA's CRS purposes.[43] However, as additional data become available and the uncertainty regarding the actual rate of sea level rise diminishes, the selection of sea level rise projection ranges should be revisited regularly.
- For critical infrastructure such as hospitals, water treatment plants, or emergency management centers, adopt a planning scenario that considers "risks across a broad range of possible outcomes, including those associated with high-consequence, low-probability situations."[44] These facilities may need to be developed to a higher standard of safety, and thus a more extreme projection may be warranted.
- Adopt an adaptive management approach that allows planning scenarios to be adjusted based on new information produced by NOAA or the Georgia Department of Resources Coastal Resources Division as well as data generated by local studies.



The dark blue bars show the annual number of days that Fort Pulaski, near Savannah, Georgia, experienced high tide floods based on observations over the 1960–2016 period. The figure shows that the number of high tide flooding events has increased over the past 30 years. The figure also shows projected increases in the number of annual high tide flood events based on four future scenarios.[42]

SECTION 5

Implementing Resilience: Policy and Practice Summary Cards

As noted throughout this guide, a variety of approaches will be appropriate when promoting community resilience using nature-based infrastructure. This section identifies specific policies and practices designed to promote green infrastructure at the site, community, watershed, and landscape scales. **Policies** are legislative and regulatory actions that local governments can take to direct the activity of landowners, developers, and other private parties in their community. **Practices** are the actions that local governments or other landowners can take to improve community resilience through site design, development, and operations.

Policies	Practices
BMP CARD 1 **LIMIT IMPERVIOUS COVER**	Introduce Green Streets concepts. Adopt infiltration and evapotranspiration practices. Reduce lengths and widths of roadways, driveways, and sidewalks. Use fewer or alternative cul-de-sacs. Reduce parking lot footprints. Create landscaping areas in parking lots. Reduce building footprints.
BMP CARD 2 **DUNE, SHORELINE, AND REEF PROTECTION**	Protect dunes or beaches. Create or restore dunes or beaches. Protect and restore oyster reefs. Promote living shoreline practices.
BMP CARD 3 **NATURAL AREA PROTECTION**	Protect and restore salt marshes and tidal wetlands. Protect primary and secondary conservation areas. Limit land clearing and grading. Protect trees. Establish site reforestation/revegetation programs. Adopt soil restoration practices. Establish riparian and wetland buffers. Adopt conservation zoning. Adopt transferable development rights.

BMP CARD 4 **PROMOTE INFILTRATION/ EVAPOTRANSPIRATION PRACTICES**	Encourage Green Streets. Increase the urban tree canopy. Encourage bioretention and landscaping with native plants. Establish low-impact development stormwater practices. Institute tree planting/forestry management. Harvest rainwater.
BMP CARD 5 **DENSIFY DEVELOPMENT**	Promote infill development, mixed-use zoning, and other smart growth principles. Redevelop brownfields. Reduce setbacks and frontage requirements. Reduce minimum lot sizes. Establish transferable development rights. Allow regional stormwater management.
BMP CARD 6 **RESILIENT FLOOD RISK MANAGEMENT**	Limit development and redevelopment in wetland and marsh-front areas. Establish riparian and wetland buffers. Limit impervious cover. Prevent adverse impacts to floodplain areas and downstream properties. Implement higher standards for floodplain development. Include areas likely to be impacted by future flood conditions in floodplain development limitations.
BMP CARD 7 **RESILIENT DEVELOPMENT AND BUILDING**	Identify areas in the community most suitable for development over the long term. Utilize planned unit development districts (PUDs) to allow for more resilient designs. Require disclosures of flood risks as part of real estate transactions. Adopt stricter building codes in areas prone to wind and flood impacts (shuttering, secondary waterproofing, floodplain building codes). Adopt the most updated model codes from the International Building Code.
BMP CARD 8 **SEA LEVEL RISE PLANNING AND ADAPTATION**	Adopt a projected level of sea level rise for planning purposes. Identify areas and infrastructure potentially vulnerable to tidal flooding. Adopt zoning and land-use regulations to account for future vulnerabilities. Implement stormwater system upgrades and enhanced maintenance.

These policies and practices are described in a series of "Best Management Policy and Practice" cards that follow. These cards provide an overview of policies and practices that can help promote the use of green and natural infrastructure in public and private projects. They also offer ordinance examples and language that may be used to modify existing laws to promote coastal community resilience. In addition, the policies and practices are grouped based on scale and density of the developed area.

BMP CARD 1

Limit Impervious Cover

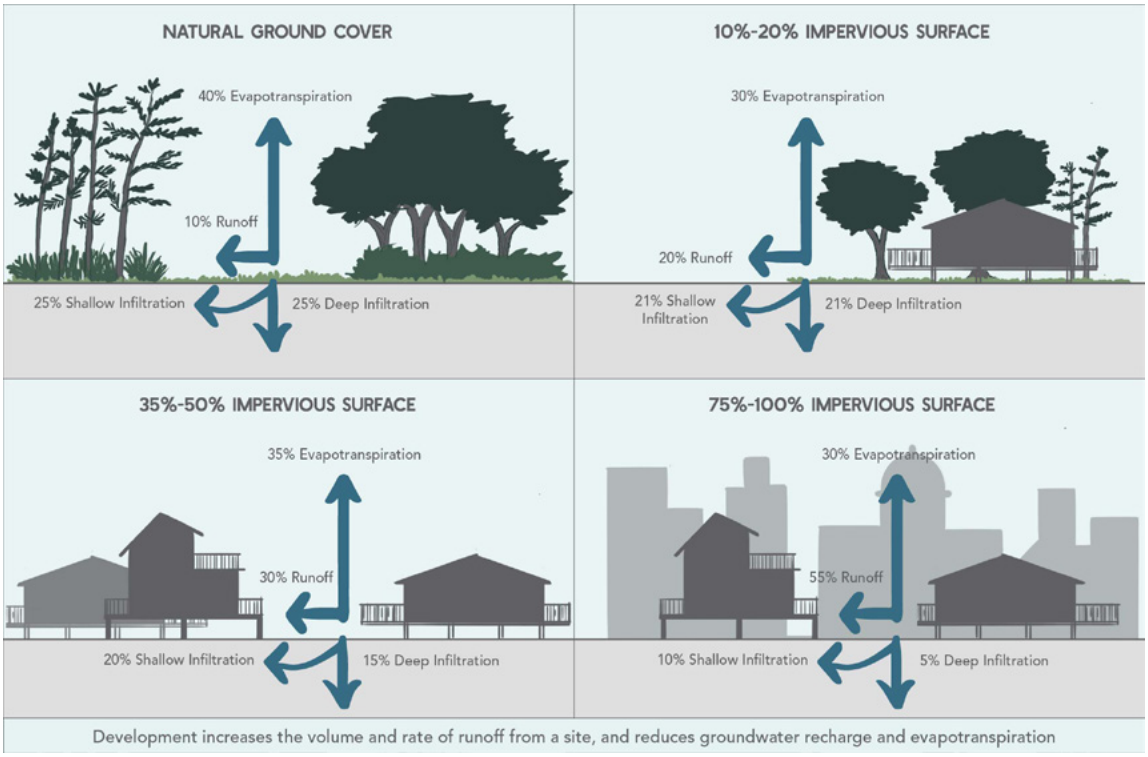
DESCRIPTION: Impervious surfaces such as pavement, asphalt, and rooftops contribute to increasing runoff from rain events, which causes flash flooding and increases the height of other downstream flood events. Limiting the amount of ground in a watershed that is covered by impervious surfaces will reduce potential damages from flooding. In addition, limiting impervious cover has been shown to have positive impacts on downstream water quality.

PREFERRED AREA: Limiting impervious cover is a valuable design policy that should be implemented in suburban and rural settings, and in any area except the urban core where urban density is the overriding consideration.

PLANNING SCALE: Limiting impervious cover is best applied at the watershed scale as the percentage of a watershed that is covered with impervious surfaces directly affects the flood potential within that watershed. Communities can balance areas where impervious cover is needed with preservation and other offsets in other parts of the watershed.

IMPLEMENTATION EXAMPLES

- Mandate or promote Green Streets practices.
- Mandate or promote practices that result in less area covered by impervious surfaces.
- Include pre-application meetings in the community design review process.
- Require green infrastructure practices to offset impervious areas that exceed that maximum.



Development increases the volume and rate of runoff from a site, and reduces groundwater recharge and evapotranspiration

BMP CARD 1

RELEVANT MODEL ORDINANCE PROVISIONS

The Model Enhanced Stormwater Resilience Ordinance in Appendix A includes the following provisions:

- Section 5 limits the amount of impervious cover that can be used onsite based on the existing zoning districts.
- Section 6 requires that building downspouts be disconnected from impervious areas and be directed into infiltrative stormwater infrastructure.

The Model Coastal Resilience Ordinance in Appendix A establishes a process through which a local government can implement an internal review and planning process to incorporate sea level rise and flooding vulnerability into its planning and operations.

To view technical resources, click on each title to visit each site online.

EXAMPLES OF PRACTICES	TECHNICAL RESOURCES
GREEN STREETS	• US EPA: Managing Wet Weather with Green Infrastructure Municipal Hand Book: Green Streets • National Association of City Transportation Officials: Urban Street Stormwater Guide • Environmental Law Institute: Giving Green Streets the Green Light: Improving Water Quality Through Capital Improvement Policies
INFILTRATION AND EVAPOTRANSPIRATION PRACTICES	• Coastal Supplement to the Georgia Stormwater Management Manual • Coastal Resources Division of the Georgia Department of Natural Resources, Green Growth Guidelines
BETTER SITE DESIGN TECHNIQUES	• Coastal Supplement to the Georgia Stormwater Management Manual Reduce lengths and widths of roadways, driveways, and sidewalks Use fewer or alternative cul-de-sacs Reduce parking lot footprints Create landscaped areas in parking lots Reduce building footprints

CRS CREDIT CONNECTIONS

- CRS 452a(1): Stormwater Management Regulations, Size of Development (110 credits)
- CRS 452a(3): Stormwater Management Regulations, Low Impact Development (25 credits)

BMP CARD 2

Dune, Shoreline, & Reef Protection

DESCRIPTION: Sand dunes, natural or "living" shorelines, and offshore reefs are nature-based features that protect communities from flooding by absorbing energy from storm surges and wave action, and by buffering development from rising tides and other coastal flooding events. These green infrastructure elements are naturally occurring, but they can also be designed and constructed to protect vulnerable areas, or where they have been damaged or eroded by storms or other events.

PREFERRED AREA: Dunes, living shorelines, and reefs are generally used where there is sufficient space to accommodate them, and where sea walls and other more heavily engineered structures are not practical or would cause other undesirable impacts. Therefore, these features are most applicable in suburban and rural areas where less dense development allows sufficient space without hindering the density of urban development.

PLANNING SCALE: These features are generally designed at the site scale or across a relatively small number of parcels along a section of the beach or a river. However, they are part of larger environmental systems. Effective implementation should consider the cumulative impacts of their construction and deployment at a landscape scale.

IMPLEMENTATION EXAMPLES

- Implement dune protection ordinances and setbacks.
- Implement passive or active dune construction efforts.
- Enact local ordinances favoring living shorelines over hardened erosion control measures like sea walls or bulkheads.

Tybee Island 4-H Center Living Shoreline (left) Little Saint Simons Island Living Shoreline (right)
Credit: UGA Marine Extension Credit: UGA Marine Extension

BMP CARD 2

RELEVANT MODEL ORDINANCE PROVISIONS

The Model Enhanced Stormwater Resilience Ordinance in Appendix A includes the following provisions:

- Section 5 requires that all planning and regulatory decisions take into account future sea level rise projections.
- Section 6 requires that all new structures or buildings be at least 100 feet from any tidally influenced waters.

To view technical resources, click on each title to visit each site online.

EXAMPLES OF PRACTICES	TECHNICAL RESOURCES
DUNE PROTECTION	• Tybee Island, Georgia, Beach, Dune, or Vegetation Disturbance/ Crossover Maintenance and Construction • Liberty County, Georgia, Dunes and Marshland Zoning District • Isle of Wight, Virginia, Coastal Primary Sand Dune Ordinance
DUNE CREATION OR RESTORATION	• US Army Corps of Engineers, Beach Nourishment • Florida Department of Environmental Protection, Dune Restoration • Broward County, Coastal Dune Grant Program
OYSTER REEF PROTECTION AND RESTORATION	• National Oceanic and Atmospheric Administration maintains resources on the value of oyster reefs • Duke University Nicholas Institute
PROMOTE LIVING SHORELINE PRACTICES	• Coastal Resources Division of the Georgia Department of Natural Resources administers living shoreline permitting

CRS CREDIT CONNECTIONS

- CRS 432n: Coastal Erosion Hazard Regulations (370 Credits)

BMP CARD 3

Natural Area Protection

DESCRIPTION: Protecting undeveloped natural areas ensures that their environmental functions, especially their stormwater detention and infiltrative capacity, is preserved. Of particular importance are high conservation value lands such as aquifer recharge areas, wetlands and marshes, and areas that provide habitat and connectivity between preserved areas.

PREFERRED AREA: Preserving natural areas by limiting the development of impervious cover should be the primary means of decreasing stormwater flows in rural areas. Preserved natural areas can also be integrated into suburban landscapes. However, this strategy is likely to be less desirable in urban centers where development density is highly valued. In urban area, it should be limited to particularly important areas that serve multiple social and environmental functions.

PLANNING SCALE: To maximize the value of protecting natural areas, it is important to assess the areas with the most important conservation values, and it is best if protected areas link large contiguous areas of preserved land through connective corridors. Therefore, preservation planning should take place at a landscape scale and should consider ecologically and geophysically related areas in the region.

IMPLEMENTATION EXAMPLES

- Implement a land acquisition and preservation program.
- Promote the use of conservation easements and other conservation techniques.
- Promote outdoor recreation.
- Develop a greenway trail network.
- Institute conservation zoning.
- Implement a transferable development rights program.

Woodland Trail (left) and Wetland Bog (right) | Credit: UGA Botanical Garden

BMP CARD 3

RELEVANT MODEL ORDINANCE PROVISIONS

The Model Tidal Flooding Resilience Ordinance in Appendix A includes the following provisions:

- Section 6 prohibits new development in areas subject to recurrent tidal flooding.
- Section 6 prohibits privately developed infrastructure built in areas vulnerable to tidal flooding from being accepted into public ownership.
- Section 9 requires the development of a plan to acquire land in the area of coastal tidal vulnerability.

The Model Enhanced Stormwater Resilience Ordinance in Appendix A includes the following provision:

- Section 5 limits the amount of impervious cover that can be used onsite based on the existing zoning districts.

To view technical resources, click on each title to visit each site online.

EXAMPLES OF PRACTICES	TECHNICAL RESOURCES
SALT MARSH AND TIDAL WETLANDS PROTECTION AND RESTORATION	• Coastal Supplement to the Georgia Stormwater Management Manual, Section 7-25
PROTECT PRIMARY AND SECONDARY CONSERVATION AREAS	• Coastal Supplement to the Georgia Stormwater Management Manual, Section 7-26 • Coastal Supplement to the Georgia Stormwater Management Manual, Section 4-5
LIMIT LAND CLEARING AND GRADING	• Coastal Supplement to the Georgia Stormwater Management Manual, Section 7-35
TREE PROTECTION	• Georgia Forestry Commission, Community Forests Program • Georgia Forestry Commission, Tree Ordinance Development Guidebook • US Forest Service, Urban Forestry Resources
SITE REFORESTATION/ REVEGETATION	• Coastal Supplement to the Georgia Stormwater Management Manual, Section 7-3
SOIL RESTORATION	• Coastal Supplement to the Georgia Stormwater Management Manual, Section 7-8

BMP CARD 3

To view technical resources, click on each title to visit each site online.

EXAMPLES OF PRACTICES	TECHNICAL RESOURCES
ESTABLISH RIPARIAN AND WETLAND BUFFERS	• USDA, Conservation Reserve Program • Georgia Department of Community Affairs, "Backyard Buffers" • Athens–Clarke County, Georgia, Rules for Stream Buffer Brochure • Athens–Clarke County, Georgia, Stream Buffer Ordinance
CONSERVATION ZONING	• Coastal Regional Commission, Model Subdivisions Regulations Including Conservation Subdivisions • Liberty County, Georgia, Conservation Subdivision Ordinance • Liberty County, Georgia Land Clearing and Tree Protection Ordinance
PURCHASE OR TRANSFER OF DEVELOPMENT RIGHTS	• City of Milton, Georgia, TDR Ordinance • City of Madison, Georgia, TDR Ordinance • Sustainable Development Code, Purchase of Development Rights • Rick Pruetz and Noah Standridge, 2008, December 30, "What Makes Transfer of Development Rights Work?" Success Factors from Research and Practice," *Journal of the American Planning Association.*

CRS CREDIT CONNECTIONS

- CRS 420: Open Space Preservation
- CRS 422e: Coastal Erosion Open Space
- CRS 422f: Open Space Incentives
- CRS 422g: Low-Density Zoning

BMP CARD 4

Promote Infiltration/ Evapotranspiration Practices

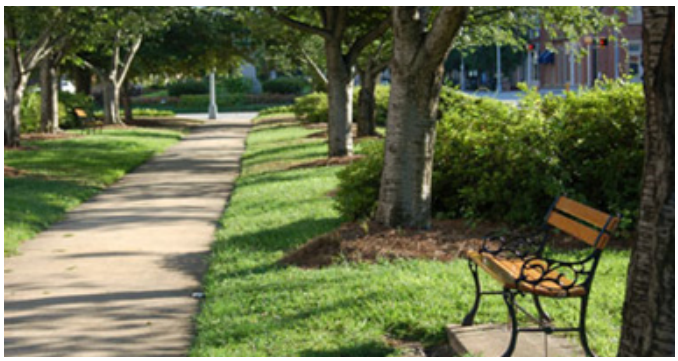
DESCRIPTION: Infiltration and evapotranspiration practices reduce stormwater volumes by capturing runoff and infiltrating it into the ground or promoting its evaporation or transpiration back into the atmosphere. Such practices can also reduce pollutant loads that are carried to nearby surface waters. Infiltration and evapotranspiration can be bolstered by incorporating additional trees and other vegetation into the built environment, using engineered bioretention and infiltration structures, and preserving existing natural vegetated areas.

PREFERRED AREA: Promoting infiltration and evapotranspiration through the use of landscaping and vegetation is appropriate in all development settings, whether urban, suburban, or rural. However, the use of bioretention areas and the preservation of natural areas are more appropriate in suburban areas, and preservation of natural areas should be the primary means of promoting this practice in rural areas.

PLANNING SCALE: Infiltration and evapotranspiration practices decrease flooding by reducing peak downstream flows within their watershed. Therefore, these practices would optimally be considered as an integrated network of practices designed and implemented at the watershed scale.

IMPLEMENTATION EXAMPLES

- Mandate or promote Green Streets practices.
- Mandate or promote practices resulting in less area covered by impervious surfaces.
- Include pre-application meetings in the community design review process.
- Require green infrastructure practices to offset impervious cover that exceeds that maximum.



Rain Garden (left) Credit: Coastal GA LID Inventory | Urban Trees (right) Credit: Georgia Forestry Commission

RELEVANT MODEL ORDINANCE PROVISIONS

The **Model Enhanced Stormwater Resilience Ordinance in Appendix A** includes the following provisions:

- Section 5 limits the amount of impervious cover that can be used onsite based on the existing zoning districts.

BMP CARD 4

- Section 6 requires that building downspouts be disconnected from impervious areas and be directed into infiltrative stormwater infrastructure.

The **Model Tidal Flooding Resilience Ordinance in Appendix A** includes the following provision:

- Section 6 prohibits new development in areas subject to recurrent tidal flooding.
- Section 6 prohibits privately developed infrastructure built in areas vulnerable to tidal flooding from being accepted into public ownership.
- Section 9 requires the development of a plan to acquire land in the area of coastal tidal vulnerability.

To view technical resources, click on each title to visit the site online.

EXAMPLES OF PRACTICES	TECHNICAL RESOURCES
GREEN STREETS	• US EPA Green Streets • National Association of City Transportation Officials, Urban Street Stormwater Guide
URBAN TREE CANOPY	• Georgia Forestry Commission, Community Forests Program • US Forest Service, Urban Forestry Resources • Center for Watershed Protection, Urban Tree Canopy
BIORETENTION AND LANDSCAPING WITH NATIVE PLANTS	• Coastal Supplement to the Georgia Stormwater Management Manual • Coastal Resources Division of the Georgia Department of Natural Resources, Green Growth Guidelines
LOW-IMPACT DEVELOPMENT PRACTICES	• Coastal Supplement to the Georgia Stormwater Management Manual • Coastal Resources Division of the Georgia Department of Natural Resources, Green Growth Guidelines
TREE PLANTING/ FORESTRY MANAGEMENT	• Georgia Forestry Commission, Community Forests Program • Georgia Forestry Commission, Tree Ordinance Development Guidebook • US Forest Service, Urban Forestry Resources
RAINWATER HARVESTING	University of Georgia Extension, Rainwater Harvesting for System Designers and Contractors Georgia Department of Community Affairs, Georgia Rainwater Harvesting Guidelines

CRS CREDIT CONNECTIONS

- CRS 420: Open Space Preservation
- CRS 422e: Coastal Erosion Open Space
- CRS 422f: Open Space Incentives
- CRS 422g: Low Density Zoning

BMP CARD 5

Densify Development

DESCRIPTION: Human development generally leads to increased impervious cover. However, dense urban development can lead to less per capita impervious cover, which means that for a given population, more dense development will lead to less impervious cover. Less impervious cover means reduced stormwater flows, decreased flooding, and fewer impacts to the natural environment. Therefore, concentrating urban development in specific areas can have positive impacts on community resilience, especially if the developed area has been selected and designed to be resilient to natural hazards.

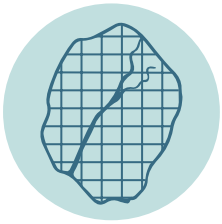
PREFERRED AREA: These practices are meant to create more dense urban areas, potentially using offsite or regional stormwater management to maximize the land available for development at the site level. These practices are less applicable in suburban areas where onsite stormwater management practices will be used, or rural areas where the preservation of existing features should be emphasized.

PLANNING SCALE: To maximize density, much of the stormwater management in these urban areas will be handled offsite, likely in regional stormwater facilities. Therefore, stormwater management facilities will need to be developed to address the potential stormwater needs of a number of sites.

IMPLEMENTATION EXAMPLES

- Implement "smart growth" and low-impact development principles of community planning and urban design.
- Encourage mixed-use development.
- Promote walkable communities and transit alternatives.
- Incentivize infill development, particularly through brownfield and greyfield redevelopment.

SCENARIO A



10,000 houses built on 10,000 acres produce:
10,000 acres x 1 house x 18,700 ft^3/yr of runoff =
187 million ft^3/yr of stormwater runoff
Site: 20% impervious cover
Watershed: 20% impervious cover

SCENARIO B

10,000 houses built on 2,500 acres produce:
2,500 acres x 4 houses x 6,200 ft^3/yr of runoff =
62 million ft^3/yr of stormwater runoff
Site: 38% impervious cover
Watershed: 9.5% impervious cover

SCENARIO C

10,000 houses built on 1,250 acres produce:
1,250 acres x 8 houses x 4,950 ft^3/yr of runoff =
49.5 million ft^3/yr of stormwater runoff
Site: 65% impervious cover
Watershed: 8.1% impervious cover

US EPA, "Protecting Water Resources with Higher Density Development," EPA 231-R-001, 2006.

BMP CARD 5

RELEVANT MODEL ORDINANCE PROVISIONS

The Model Tidal Flooding Resilience Ordinance in Appendix A includes the following provisions:

- Section 9 requires the development of a plan to acquire land in the area of coastal tidal vulnerability.

The Model Enhanced Stormwater Resilience Ordinance in Appendix A includes the following provision:

- Section 5 limits the amount of impervious cover that can be used onsite based on the existing zoning districts.

The Model Coastal Resilience Ordinance in Appendix A establishes a process through which a local government can implement an internal review and planning process to incorporate sea level rise and flooding vulnerability into its planning and operations.

To view technical resources, click on each title to visit the site online.

EXAMPLES OF PRACTICES	TECHNICAL RESOURCES
PROMOTE INFILL DEVELOPMENT, MIXED-USE ZONING, AND OTHER SMART GROWTH PRINCIPLES	• US EPA, "Smart Growth Fixes for Urban and Suburban Zoning Codes" • Smart Growth Network • Smart Growth Network, "This is Smart Growth" • Sustainable Building Code "Encourage Infill Development"
BROWNFIELD REDEVELOPMENT	• US EPA Brownfield Program • Georgia Environment Protection Division Brownfield Program
REDUCE SETBACKS, FRONTAGE, AND MINIMUM LOT SIZE REQUIREMENTS	• Coastal Supplement to the Georgia Stormwater Management Manual, Section 7-59
TRANSFER OF DEVELOPMENT RIGHTS	• City of Milton, Georgia, TDR Ordinance • City of Madison, Georgia, TDR Ordinance • Sustainable Development Code, Purchase of Development Rights • Rick Pruetz and Noah Standridge, 2008, December 30, "What Makes Transfer of Development Rights Work? Success Factors from Research and Practice," *Journal of the American Planning Association.*

CRS CREDIT CONNECTIONS

- CRS 452a(1): Stormwater Management Regulations, Size of Development
- CRS 452a(3): Stormwater Management Regulations, Low Impact Development

BMP CARD 6

Resilient Flood Risk Management

DESCRIPTION: Flooding vulnerability is increasing as climate change alters precipitation patterns, increases sea levels, and alters other natural processes. In addition, human land-use patterns are intensifying stormwater runoff issues. These changes are creating a condition with unpredictable flood patterns that do not conform to past expectations and that are likely to become much more intense and severe. In particular, development along the edges of the current regulatory floodplain will be at increasing risks. Preparing for these greater risks will require more dynamic and adaptive planning and adjusting current practices and regulations to account for future changes.

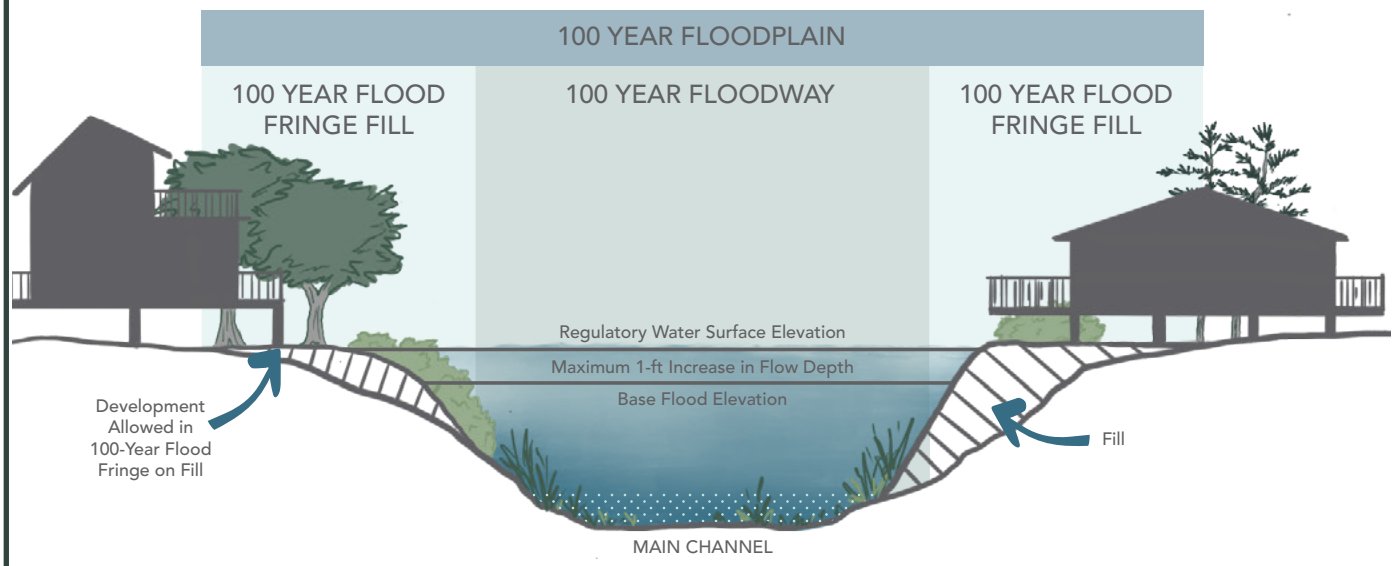
PREFERRED AREA: Resilient flood-risk management will require a variety of practices in different parts of the community. In rural areas, practices should focus on protecting floodplains and limiting the impervious cover that is added to the landscape. In suburban areas, resilient flood management practices should center on implementing site design elements, such as bioswales and rain gardens, designed to mimic the runoff characteristics of undeveloped areas. In urban areas, it should emphasize the development of offsite features to offset the impacts of the urban development while providing recreational opportunities and other social amenities to the community.

PLANNING SCALE: Resilient flood-risk management requires a hydrologic assessment of the watershed to identify present and future risks. However, planning and development decisions will be made within that context at the community scale, which may encompass only a portion of the watershed or span multiple watersheds, to develop a coherent strategic vision for addressing the identified risks and challenges. In particular, development along the edges of the current regulatory floodplain will be at increasing risk.

IMPLEMENTATION EXAMPLES

- Adopt more stringent floodplain regulations than those required to participate in the NFIP.
- Acquire or protect land in the floodplain.
- Limit impervious cover in suburban and rural areas both in the floodplain and in upland areas.
- Use projections of future flood levels and precipitation for planning, regulations, and design standards.

BMP CARD 6



RELEVANT MODEL ORDINANCE PROVISIONS

The **Model Tidal Flooding Resilience Ordinance in Appendix A** includes the following provisions:

- Section 6 prohibits new development in areas subject to recurrent tidal flooding.
- Section 6 prohibits privately developed infrastructure built in areas vulnerable to tidal flooding from being accepted into public ownership.
- Section 9 requires the development of a plan to acquire land in the area of coastal tidal vulnerability.

The **Model Flood Resilient Development and Building Ordinance in Appendix A** includes the following provision:

- Section 6 requires that construction in the Coastal A Zone shown on the FIRM meet the standards of the V Zone.
- Section 6 requires that all critical facilities be constructed outside of the 0.2% annual recurrence floodplain (i.e., the 500-year floodplain).
- Section 7 sets a freeboard requirement of 2 feet measured from the bottom of the lowest horizontal structural member above the 0.2% annual recurrence floodplain.
- Section 8 extends regulations applications in the 1% annual recurrence floodplain (i.e., the 100-year floodplain) applicable to all areas in the 0.2% annual recurrence floodplain.
- Section 9 requires that realtors disclose flood risk of a property as defined on the FIRM.

The **Model Enhanced Stormwater Resilience Ordinance in Appendix A** establishes a process through which a local government can implement an internal review and planning process to incorporate sea level rise and flooding vulnerability into its planning and operations.

BMP CARD 6

To view technical resources, click on each title to visit the site online.

EXAMPLES OF PRACTICES	TECHNICAL RESOURCES
LIMIT DEVELOPMENT IN WETLAND AND MARSH-FRONT AREAS	• ASFPM, NAI How-To Guide for Regulations and Development Standards • US EPA, Smart Growth Fixes for Climate Change and Resilience
ESTABLISH RIPARIAN AND WETLAND BUFFERS	• US Department of Agriculture, Conservation Reserve Program • Georgia Department of Community Affairs, "Backyard Buffers" • Athens–Clarke County, Georgia, Rules for Stream Buffer Brochure • Athens–Clarke County, Georgia, Stream Buffer Ordinance
LIMIT IMPERVIOUS COVER	• ASFPM, NAI How-To Guide for Regulations and Development Standards
PREVENT ADVERSE IMPACTS TO FLOODPLAIN AREAS AND DOWNSTREAM PROPERTIES	• ASFPM, NAI How-To Guide for Regulations and Development Standards
IMPLEMENT HIGHER STANDARDS FOR FLOODPLAIN DEVELOPMENT	• Coastal Supplement to the Georgia Stormwater Management Manual • ASFPM, NAI How-To Guide for Regulations and Development Standards
INCLUDE AREAS LIKELY TO BE IMPACTED BY FUTURE FLOOD CONDITIONS IN FLOODPLAIN DEVELOPMENT LIMITATIONS	• NOAA Office of Coastal Management, Sea Level Rise Viewer

CRS CREDIT CONNECTIONS

- CRS 452a(1): Stormwater Management Regulations, Size of Development
- CRS 452a(3): Stormwater Management Regulations, Low Impact Development

BMP CARD 7

Resilient Development and Building

DESCRIPTION: The location and design of buildings and infrastructure are primary determinants of overall community vulnerability to flood damages. Policies and regulations directing such development to areas where they are less likely to be impacted by floods presently and in the future can greatly improve community resilience. Where buildings and infrastructure must be located in vulnerable areas, some of the risk can be mitigated by requiring design elements that make these structures less susceptible to damages from floods.

PREFERRED AREA: Avoiding development in the most vulnerable areas is critical to community resilience in all parts of the community—urban, suburban, and rural. However, in more densely developed areas, particularly urban areas, the value of the development better justifies the cost of including design elements and deploying infrastructure to protect structures from flooding impacts.

PLANNING SCALE: Vulnerability to flooding varies across a landscape; therefore, siting and design decisions are primarily made at the site scale, though longer term decisions about land use planning and zoning should be made at the community level.

IMPLEMENTATION ACTIVITIES:

- Map areas vulnerable to future flooding due to sea level rise and changes in development patterns.
- Adopt improved building siting requirements and higher building code standards where appropriate.
- Implement homeowner and homebuyer education efforts concerning present and future flood risks in different parts of the community.

RELEVANT MODEL ORDINANCE PROVISIONS

The Model Sea Level Rise Resilience Ordinance in Appendix A includes the following provisions:

- Section 5 requires that all planning and regulatory decisions account for future sea level rise projections.
- Section 6 requires that all new structures or buildings be at least 100 feet from any tidally influenced waters.

The Model Tidal Flooding Resilience Ordinance in Appendix A includes the following provisions:

- Section 6 prohibits new development in areas subject to recurrent tidal flooding.
- Section 6 prohibits privately developed infrastructure built in areas vulnerable to tidal flooding from being accepted into public ownership.
- Section 9 requires the development of a plan to acquire land in the area of coastal tidal vulnerability.

BMP CARD 7

The **Model Flood Resilient Development and Building Ordinance in Appendix A** includes the following provisions:

- Section 6 requires that construction in the Coastal A Zone shown on the FIRM meet the standards of the V Zone.
- Section 6 requires that all critical facilities be constructed outside of the 0.2% annual recurrence floodplain (i.e., the 500-year floodplain).
- Section 7 sets a freeboard requirement of 2 feet measured from the bottom of the lowest horizontal structural member above the 0.2% annual recurrence floodplain.
- Section 8 extends regulations application in the 1% annual recurrence floodplain (i.e., the 100-year floodplain) applicable to all areas in the 0.2% annual recurrence floodplain.
- Section 9 requires that realtors disclose the flood risk of a property as defined on the FIRM.

The **Model Enhanced Stormwater Resilience Ordinance in Appendix A** includes the following provisions:

- Section 5 limits the amount of impervious cover that can be used onsite based on the existing zoning districts.
- Section 6 requires that building downspouts be disconnected from impervious areas and be directed into infiltrative stormwater infrastructure.

To view technical resources, click on each title to visit the site online.

EXAMPLES OF PRACTICES	TECHNICAL RESOURCES
IDENTIFY AREAS IN THE COMMUNITY MOST SUITABLE FOR DEVELOPMENT IN THE LONG TERM	• ASFPM, NAI How-To Guide for Regulations and Development Standards
UTILIZE PLANNED UNIT DEVELOPMENT DISTRICTS (PUDS) TO ALLOW FOR MORE RESILIENT DESIGNS	• Coastal Georgia Regional Commission, Model Ordinance for Planned Unit Developments
REQUIRE DISCLOSURES OF FLOOD RISKS AS PART OF REAL ESTATE TRANSACTIONS	• Texas Flood Disclosure Requirement • Texas Real Estate Commission Seller's Disclosure Form

BMP CARD 7

To view technical resources, click on each title to visit the site online.

EXAMPLES OF PRACTICES	TECHNICAL RESOURCES
EXCEED THE MINIMUM BUILDING CODE STANDARDS IN AREAS PRONE TO WIND AND FLOOD IMPACTS (SHUTTERING, SECONDARY WATERPROOFING, FLOODPLAIN BUILDING CODES).	• Georgia Department of Community Affair's **Disaster Resilient Building Code Appendices** for the International Building Code and the International Residential Code provide for optional regulations that local jurisdictions may adopt, in whole or in part, through local ordinance. • American Society of Civil Engineers, Minimum Design Loads and Associated Criteria for Buildings and Other Structures (ASCE/SEI 7-16) recommending shutters or impact-resistant glazing • **Florida Building Code referencing ACSE/SEI 7-16** • **FEMA, *Protection of Openings – Shutters and Glazing*, Homebuilder's Guide to Coastal Construction**
ADOPT THE MOST UPDATED MODEL CODES FROM THE INTERNATIONAL BUILDING CODE	• **International Code Council** • **National Institute of Building Sciences, "Benefits and Challenges of Timely Building Code Adoption Cycle"**

CRS CREDIT CONNECTION

- CRS 422f: Open Space Incentives – TDRs, Planned Unit Developments, and Cluster Developments
- CRS 432b: Freeboard

BMP CARD 8

Sea Level Rise Planning and Adaptation

DESCRIPTION: Flooding vulnerability is increasing as sea levels around the world rise. These risks will manifest in more frequent impacts from tidal flooding, higher storm surges, and more frequent flash floods. Preparing for the greater risks will require more dynamic and adaptive planning and activity to adjust current practices and regulations to account for future changes.

PREFERRED AREA: Sea level rise planning and adaptation will affect all areas of a community, requiring assessments of vulnerable transportation infrastructure in rural areas and decreased capacity of stormwater infrastructure in urban areas.

PLANNING SCALE: Planning and adaptation decisions should be made at the community scale.

IMPLEMENTATION ACTIVITIES:

- Assess vulnerability to future flooding.
- Adopt zoning and land-use regulations to account for future flooding vulnerability.
- Update building regulations to make vulnerable properties safer.
- Update flood damage reduction regulations to account for future conditions.
- Digitize spatial and technical data for stormwater infrastructure.

RELEVANT MODEL ORDINANCE PROVISIONS

The **Model Sea Level Rise Resilience Ordinance in Appendix A** includes the following provisions:

- Section 5 requires that all planning and regulatory decisions account for future sea level rise projections.

The **Model Tidal Flooding Resilience Ordinance in Appendix A** includes the following provisions:

- Section 6 prohibits new development in areas subject to recurrent tidal flooding.
- Section 6 prohibits privately developed infrastructure built in areas vulnerable to tidal flooding from being accepted into public ownership.
- Section 9 requires the development of a plan to acquire land in the area of coastal tidal vulnerability.

The **Model Flood Resilient Development and Building Ordinance in Appendix A** includes the following provisions:

- Section 6 requires that construction in the Coastal A Zone shown on the FIRM meet the standards of the V Zone.
- Section 6 requires that all critical facilities be constructed outside of the 0.2% annual recurrence floodplain (i.e., the 500-year floodplain).

BMP CARD 8

- Section 7 sets a freeboard requirement of 2 feet measured from the bottom of the lowest horizontal structural member above the 0.2% annual recurrence floodplain.
- Section 8 extends regulations applicable in the 1% annual recurrence floodplain (i.e., the 100-year floodplain) to all areas in the 0.2% annual recurrence floodplain.
- Section 9 requires that realtors disclose the flood risk of a property as defined on the FIRM.

The **Model Coastal Resilience Ordinance in Appendix A** establishes a process through which a local government can implement an internal review and planning process to incorporate sea level rise and flooding vulnerability into its planning and operations.

To view technical resources, click on each title to visit the site online.

EXAMPLES OF PRACTICES	TECHNICAL RESOURCES
ADOPT A PROJECTED LEVEL OF SEA LEVEL RISE FOR PLANNING PURPOSES	• NOAA Global and Regional Sea Level Rise Scenarios for the United States
IDENTIFY AREAS AND INFRA-STRUCTURE POTENTIALLY VULNERABLE TO TIDAL FLOODING	• NOAA Office of Coastal Management, Sea Level Rise Viewer
ADOPT ZONING AND LAND-USE REGULATIONS TO ACCOUNT FOR FUTURE VULNERABILITY	• US EPA, Smart Growth Fixes for Climate Change and Resilience • Wetlands Watch, Resilient Zoning
IMPLEMENT STORMWATER SYSTEM UPGRADES AND ENHANCED MAINTENANCE	• NOAA, Adapting Stormwater Management for Coastal Floods

SECTION 6

Implementing Resilience: Connections to the Community Rating System

FEMA created the CRS to reward communities undertaking activities that exceed minimum NFIP requirements. As flood insurance costs continue to rise, the CRS increasingly incentivizes communities to implement more resilient green infrastructure and development policies and practices to increase their CRS ratings. This section outlines some of the major incentives in the CRS that relate to green infrastructure and built resilience, connecting them more directly to potential policy and ordinance changes.

CRS CREDIT
Hazard Disclosure

CRS 322c: Other Flood Problems Not Shown on the FIRM – 20 Credits
CRS 342a: Disclosure of Flood Hazard – 35 Credits
CRS 342b: Other Disclosure Requirements – 25 Credits
CRS 342d: Disclosure of Other Hazards – 8 Credits

These activities are designed to inform community members and prospective buyers about their need for flood insurance when they consider purchasing a property. Under CRS 322c, communities earn credit when they provide information about areas not mapped on their FEMA Flood Insurance Rate Map (FIRM) that are predicted to be susceptible to flooding because of sea level rise.[45] Under CRS 342, communities earn credit when real estate agents advise prospective buyers of properties in the floodplain about flood risk hazards as well as the flood insurance purchase requirement when the buyer is purchasing the property with a federally backed loan.[46] Credit is provided under CRS 342d when prospective property buyers are advised about the potential for flooding due to sea level rise.[47] Ordinances requiring such disclosures earn additional credit under CRS 342b.

DISCLOSURE OF FLOOD HAZARD ACTIVITIES

Both the Model Tidal Flooding Resilience Ordinance and the Model Flood Resilient Development and Building Ordinance in Appendix A include, in Section 9, a disclosure requirement for buyers purchasing properties in the "[Special Flood Hazard Area], the elevation of the 0.2% annual chance floodplain, erosion, subsidence, or other documented risk." In addition, the Model Sea Level Rise Resilience Ordinance in Appendix A establishes a standard requiring that projections of future sea level rise be incorporated into the community's planning and development guidelines, maps, and regulations. The Model Coastal Resilience Ordinance in Appendix A establishes a process through which a local government can implement an internal review and planning process to incorporate sea level rise and flooding vulnerability into its planning and operations.

CRS CREDIT

Floodplain Mapping

CRS 412d: Higher Study Standards – 200 Credits
CRS 412e: More Restrictive Floodway Standard –140 Credits

The CRS provides incentives to communities that improve the quality of how they map flood risks beyond the minimum standards that FEMA sets for FIRMs.[48] Under CRS 412d, credit is provided when the community's regulatory map is based on future-conditions hydrology, including sea level rise.[49]

CRS 412e awards credit for mapping and adopting more restrictive standards for the floodway.[50] Under the NFIP, communities must adopt and enforce a minimum standard of floodplain management regulations and an NFIP map known as a FIRM. Typically, new development cannot be permitted if, along with all other existing and anticipated development, it will increase the base flood elevation one foot or more anywhere in the community. Communities may exceed this standard by lowering the threshold to less than a one-foot rise, effectively expanding the area of the floodway.[51] Enacting a more stringent floodway rise that reduces floodplain development would further green infrastructure practices such as preserving conservation areas and maintaining undisturbed pervious areas.[52]

FLOODWAY STANDARD ACTIVITIES

Georgia communities can adopt a more stringent floodway rise standard by reducing the allowable cumulative rise to less than one foot and adopting it in their **flood damage prevention ordinance** or similar regulation. In addition, the Model Sea Level Rise Resilience Ordinance in Appendix A requires that projections of future sea level rise be incorporated into the community's planning and development guidelines, maps, and regulations.

CRS CREDIT
Open Space Preservation

CRS 420a: Open Space Preservation – 1,450 Credits
CRS 420b: Deed Restrictions – 50 Credits
CRS 422c: Natural Functions Open Space – 350 Credits
CRS 422d: Special Flood-Related Hazards Open Space – 50 Credits
CRS 422e: Coastal Erosion Open Space – 750 Credits
CRS 422f: Open Space Incentives – 250 Credits
CRS 422g: Low-Density Zoning – 600 Credits
CRS 422h: Natural Shoreline Protection – 120 Credits
CRS 432i: Local Drainage Protection – 120 Credits

Preserving open space in the floodplain is a great way for communities to reduce flood damage risks by protecting their floodplain from further development. A community may receive up to **2,870 credits** for activities promoting open space preservation. The average Georgia community earns 130 credits.[53] A community can either acquire property for preservation, acquire easements limiting development, or require or incentivize private protection of open space and other floodplain areas. The credit received depends on the enforceability of the preservation measures, the longevity of the protections, and the extent to which natural functions of the area are preserved. Communities should be aware that a public park with a recreational trail system and playground is considered an acceptable development that could be placed on land that is preserved as open space.

OPEN SPACE PRESERVATION ACTIVITIES

422b: Deed Restrictions Up to 50 credits[54]	The open space land must contain a restriction in the deed that prohibits new buildings on the land. The deed restriction must transfer to future owners (run with the land) and can only be amended by a court for just cause.
422c: Natural Functions Open Space Up to 350 credits[55]	The open space land must either be in an undeveloped state—not developed, graded, or farmed—or have been returned to a state approximating the predevelopment condition.[56] A groomed beach or dune and beach nourishment projects that involve filling, snow fences, or other artificial constraints on natural dune migration or beach erosion usually would NOT receive credit, unless additional information was supplied that showed that other criteria are met. Such dunes and beaches may generate coastal erosion open space credit, described in more detail below.
422d: Special Flood-Related Hazards Open Space Up to 50 points[57]	Credits are available for special flood-related hazards open space (SFHOS), which is open space directly related to coastal erosion, tsunamis, inland flood hazards from uncertain flow paths (alluvial fans, channel migration, etc.), closed basin lakes, ice jams, land subsidence, and mudflows.
422e: Coastal Erosion Open Space Up to 750 points[58]	Credits are available for open space preservation of areas subject to coastal erosion. The CRS defines "coastal erosion hazard area" as "the area between the current location of the community's erosion reference feature and the projected location of that erosion reference feature 30 to 100 years into the future."[59] The open space must be included within a community's mapped coastal erosion hazard area. Qualifying areas must be landward of a coastline eroding at a rate greater than or equal to 1.5 feet per year and qualify for open space preservation credit. Designated open space may include areas protected by coastal construction setbacks, but creditable setbacks must prohibit all buildings or other encroachments. Regulations merely requiring permits for construction in certain areas are not sufficient for coastal erosion open space credit. Dune and beach areas preserved in their natural undeveloped state may also qualify for natural functions open space and natural shoreline protection credit.[60]

CRS 422f: Open Space Incentives

Up to 250 credits

Communities can receive credit for protecting undeveloped open space. In addition, many tools can be used to incentivize developers and property owners to preserve environmentally sensitive areas such as floodplains as open space even when a site is developed. In addition to protecting floodplains, communities have adopted policies and ordinances for farmland preservation, protection of sensitive areas, and even for economic reasons. Examples include the following:

- **Transfer of Development Rights (TDRs):** TDRs are a market-based zoning tool that redirects development from areas suitable for conservation to receiving areas suitable for denser development. Property owners in "sending" areas can be compensated for their redirected development rights.
- **Planned Unit Developments (PUDs):** PUDs allow unique, flexible, creative, and imaginative mixes of land uses and patterns of development by allowing developers to propose designs that would otherwise not be allowed under conventional land use requirements but that satisfy the general purposes of the regulations.[63]
- **Cluster Development:** This planning approach groups residential developments on smaller lots, leaving remaining open space for recreational or conservation purposes.

ACTIVITIES

Communities can promote cluster development through a **zoning ordinance or planned developments ordinance** that, instead of requiring a minimum lot size, assigns a fixed density to the parcel, allowing the developer more flexibly to divide the parcel in various shapes and sizes while avoiding floodplains. The Coastal Regional Commission created a model ordinance for planned unit developments that provides a framework for local governments seeking to utilize a PUD or planned development district as a specialty zoning designation within their land development codes. Communities can also incentivize open space through **riparian/marsh protection ordinances** and **zoning ordinances** that limit the floodplain for conservation, agriculture, forestry, or other low-density uses; **subdivision ordinances** that limit building in the floodplain or require open space; and TDR programs that provide incentives for developers.

OPEN SPACE PRESERVATION ACTIVITIES

420.h: Natural Shoreline Protection

Up to 120 credits[61]

Credit is available for allowing natural stream channels and shorelines to follow the courses dictated by natural processes and for encouraging natural shorelines that provide water quality benefits for runoff. The program must prohibit filling, dredging, and armoring existing channels and shorelines, including beach nourishment projects. The program may allow alterations that improve natural floodplain functioning such as removal of a levee, habitat restoration, and plantings. Two types of programs are credited:

1. Programs that protect channels. This includes programs that govern construction activities and written policies followed on public lands such as city parks. Credit is only available to channels or shorelines approximately in their natural state without substantial human intervention.[62]

2. Programs that restore impaired channels. This covers programs that actively restore floodplain functions; regulations that require restoration activities by developers are credited under CRS 422e.

Protection credit is only available for channels or shorelines that are currently in their approximate natural state, i.e., no concrete, rip rap, levees, armoring, beach nourishment, dams, or other human intervention is present that constrains the natural processes of the shoreline of the river, stream, lake, or ocean.

ACTIVITIES

Communities can preserve open space in the floodplain through regulatory measures such as a **zoning ordinance** and/or **riparian buffer or marsh protection ordinances.** Conservation easements, transferable development rights (TDR) programs, and land acquisition programs are also ways communities can preserve open space.

Communities can preserve open space in the coastal erosion hazard area through regulatory measures such as a **zoning ordinance** and/or **shore and dune protection ordinances**. Conservation easements, rolling easements, TDR programs, and land acquisition programs are also ways communities can preserve open space.

Section 8 of the **Model Tidal Flooding Resilience Ordinance in Appendix A** includes a provision requiring the development of a plan to acquire land in the area of coastal tidal vulnerability and for the removal of repetitively flooded structures, setting the stage for communities to earn open space credits for both fee-simple acquisitions and easement protections.

The **Model Sea Level Rise Ordinance in Appendix A** implements a regulatory buffer that limits new structures within 100 feet of a tidally influenced water body or coastal marsh. The areas protected by this buffer would earn community CRS credits under this section.

CRS 422g: Low-Density Zoning Up to 600 credits	Another way to preserve the floodplain's flood mitigating functions is through low-density zoning. This element rewards communities that keep areas of the regulatory floodplain relatively open. "Low density" means that that size of the lots is at least five acres.[64] For this element, it does not matter why an area is zoned for low density; what counts is the minimum lot size and lot coverage allowed in the zoning district. Sparsely populated counties or counties that have a substantial proportion of their area dedicated to agricultural or forestry production are well-positioned to receive credit under CRS 422.f because they are already zoned at low densities.

LOW-DENSITY ZONING ACTIVITIES

Low-density zoning is achieved through a **zoning ordinance** and the traditional zoning approach of setting minimum lot sizes for different zoning districts. The bigger the lot size, the less dense the floodplain development will be and the more the credit that will be provided.

CRS 432i: Local Drainage Protection Up to 120 credits	Approximately 20% of flood insurance claims under the NFIP occur for properties located outside of the Special Flood Hazard Area. Local drainage problems can cause some of these claims. Ensuring that new buildings are above street level or protected from shallow drainage flooding is rewarded with CRS credit.

LOCAL DRAINAGE PROTECTION ACTIVITIES

Regulatory language relevant to drainage protection is usually found in **building ordinances** or **land development ordinances**. Some communities have a drainage ordinance that may also be relevant. According to the CRS Manual, Sections 1803.3 and 1805 of the International Building Code, for example, have a positive-drainage requirement that would receive some credit.

CRS CREDIT
Higher Regulatory Standards

CRS 432a: Higher Regulatory Standards: Development Limitations
1,330 Credits

The CRS incentivizes regulations that provide more protection to new development, redevelopment, and existing development.[65] Limiting development in the floodplain is a valuable protection measure against flood damage. Reducing the number of structures in this area reduces overall risk of property damage, while undeveloped floodplains mitigate flooding hazards to inland areas.

DEVELOPMENT LIMITATIONS ACTIVITIES	
Prohibition of Fill [66] Up to 280 credits	The open space land must contain a restriction in the deed that prohibits new buildings on the land. The deed restriction must transfer to future owners (run with the land) and can only be amended by a court for just cause.
Prohibition of Buildings [67] Up to 1,000 credits	One way to protect property is to keep development out of flood-prone areas. Prohibiting buildings in the regulatory floodplain is more likely to be successful if the regulation is related to protecting public health, safety, and natural floodplain functions and if the property owner retains some economic benefit from the property.
Prohibition of Outdoor Storage of Materials[68] Up to 50 credits	Another way to protect property is to prohibit people from storing materials outdoors, including hazardous materials.

Communities may prohibit or limit fill through their **flood damage prevention ordinance.**[69] They can prohibit buildings on fill and require construction on piers, pilings, or crawlspaces; prohibit all fill; or require the removal of fill. Liberty County, for example, limits placing fill in coastal high-hazard areas designated under the NFIP as "V Zones" and requires all new construction and substantial improvements of buildings to be elevated.[70] Communities can limit or prohibit buildings by enacting setback and buffer zones through **riparian/marsh protection ordinances**; by enacting zoning ordinances that limit the floodplain for conservation, agriculture, forestry, or other low-density uses; through **subdivision ordinances** that limit building in the floodplain or require open space; and by providing incentives for developers through **TDR programs.**

Section 7 of the Model Tidal Flooding Resilience Ordinance in Appendix A restricts new development and prohibits privately developed infrastructure in areas of coastal tidal vulnerability from being accepted into public ownership.

CRS 432b: Freeboard

Up to 500 credits

As a minimum standard, the NFIP requires that the lowest floor in residential structures be elevated to or above the base flood elevation, and nonresidential structures must be elevated or floodproofed to or above the base flood elevation. A freeboard requirement adds height above the base flood elevation, creating an extra margin of protection. To earn credit, communities must meet a series of requirements related to measuring criteria and fill as well as to all utilities, ductwork, and attached garages. Credits increase as the freeboard height increases.[72]

ACTIVITIES

In 2018, Chatham County revised its flood damage prevention ordinance to require new homes to be built three feet above base flood levels. Sections 24-118(1) and 24-120(2) of that ordinance provide the following:

- Where base flood elevation data are available, new construction and/or substantial improvement of any residential structure or manufactured home shall have the lowest floor, including basement, elevated no lower than three feet above the base flood elevation.[73]
- New construction or substantial improvements of buildings shall be elevated or flood-proofed to elevations established in accordance with Section 24-118. All heating and air conditioning equipment and components including ductwork, all electrical fixtures and devices, ventilation, plumbing fixtures, and other service facilities shall be elevated no lower than *three feet* above the base flood elevation.

Section 7 of the Model Flood Resilient Development and Building Ordinance in Appendix A includes a two-foot freeboard from the 500-year floodplain, which provides communities with credit for the additional foot. In addition, this requirement applies to the lowest horizontal structural member, essentially creating a more protective standard because the structural elements of the floor are higher. This also earns additional CRS credit.

CRS 432c: Foundation Protection Up to 500 credits	This requirement credits actions that require foundations to be designed by a registered design professional, meet International Building Code requirements, and, when constructed on fill, are constructed on designed and compacted fill that meets International Building Code requirements.[74]

ACTIVITIES

Section 6 of the **Model Flood Resilient Development and Building Ordinance in Appendix A** extends foundation requirements to additional areas in the community.

CRS 432d: Cumulative Substantial Improvements Up to 90 credits	This requirement ensures that owners do not evade flood protection measures by making many small improvements that eventually add up to a major or substantial improvement. If, over time, a series of permits are issued for different repairs or improvements to the same structure, this can increase the overall flood damage potential to the structure as well as FEMA's insurance liability. To earn credit, communities must ensure that the total value of all improvements or repairs permitted over time does not exceed 50% of the structure's value. When that occurs, the original building must meet ordinance requirements for new buildings.[75] Additional CRS credit is awarded to adopt a standard that is below 50% of the structure's value.

ACTIVITIES

The **Model Flood Resilient Development and Building Ordinance in Appendix A,** in Section 6, proposes a 40% standard of improvement to increase the amount credited.

CRS 432f: Protection of Critical Facilities Up to 80 credits	Critical facilities vital to health and safety such as hospitals, electric substations, police stations, fire stations, nursing homes, schools, vehicle and equipment storage facilities, and shelters should be located outside of the floodplain or protected from flooding. This requirement promotes efforts to keep critical facilities out of the 500-year floodplain and to protect such facilities from flood damage. Credit is only provided if there is regulatory language protecting critical facilities. To receive full credit, the regulations must be enforced in the 500-year floodplain.[76]

ACTIVITIES

The **Model Flood Resilient Development and Building Ordinance in Appendix A,** in Section 6, includes language that critical facilities shall not be developed in the 500-year floodplain.

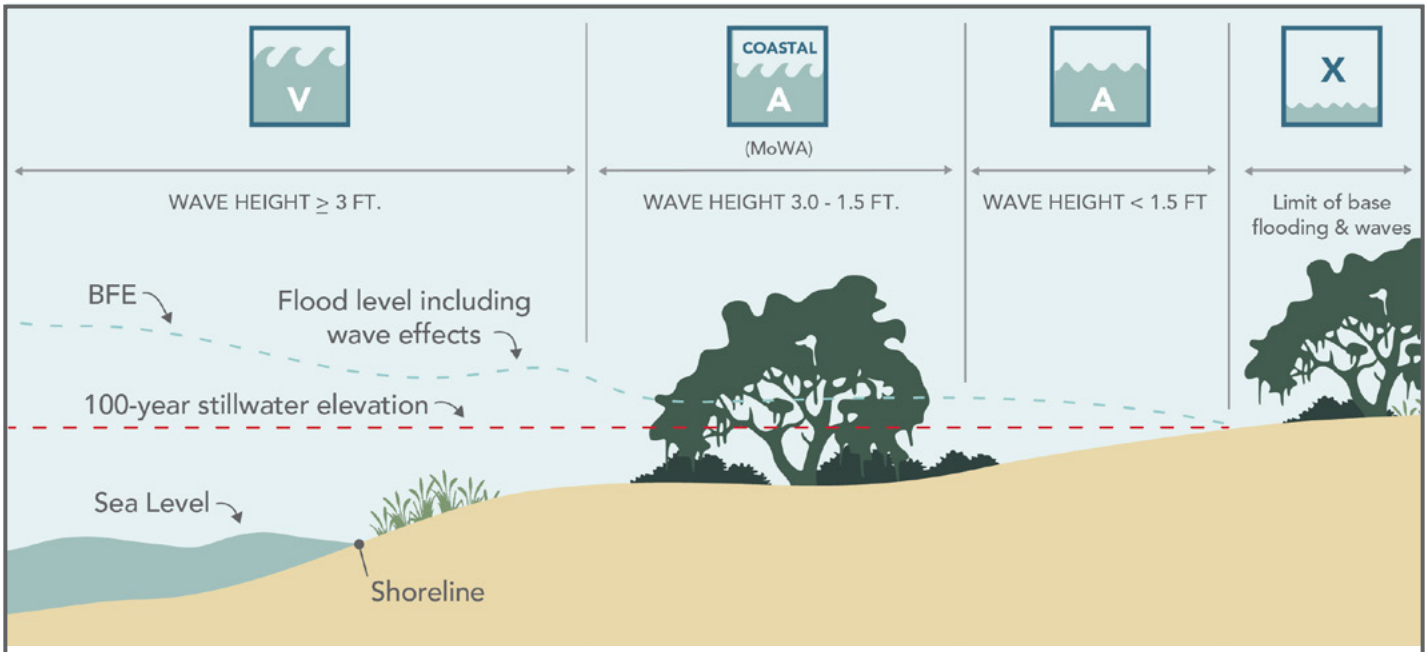
CRS 432h: Building Code Up to 100 credits	Building codes help reduce losses from natural hazards. The CRS provides credit for communities that adopt the most recent editions of the model codes in the International Code Series, as well as for how communities are classified for enforcing their building codes under the Building Code Effectiveness Grading Schedule, which was initiated by the insurance industry and is administrated by Insurance Services Offices, Inc. (ISO).[77]

ACTIVITIES

In 2013, the Georgia Department of Community Affairs developed **Disaster Resilient Building Code Appendices** for the International Building Code and the International Residential Code.[78] These appendices are optional regulations that local jurisdictions may adopt, in whole or in part, through local ordinance. The standards relate to mitigating hazards to property from natural weather-related disasters, high-wind damages, or flooding and establish construction standards for storm shelters. For example, the model code includes specifications for buildings to be designed for impact resistance in accordance with International Building Code and/or ASTM standards.

The American Society of Civil Engineers, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures* (ASCE/SEI 7-16) recommends that buildings within coastal areas in the Southeast be equipped with shutters or impact-resistant glazing and designed as enclosed structures. The Florida Building Code uses this ASCE standard as its basis for requiring either the installation of impact-resistant glass or covering openings with hurricane shutters.[79]

CRS 432k: Coastal A Zones Up to 500 credits	Under the NFIP, the V Zone is the land area subject to damage from waves 3.0 feet and higher. This zone is subject to heightened construction standards. Coastal A Zones are landward of the V Zone and often include significant areas of coastal flooding during storms as well, where the potential base flood wave height ranges between 1.5 and 3.0 feet.[80] Because FEMA has concluded that its minimum criteria for construction in A Zones does not provide adequate protection, the CRS offers additional credit for coastal communities that enforce V-Zone regulations in their Coastal A Zones, thus extending the area protected. Credit also is provided in Section 432k when a community accounts for sea level rise in managing its Coastal A Zones.



Coastal Flood Zones (source: CRS Manual 430-33).

ACTIVITIES

Section 6 of the **Model Flood Resilient Development and Building Ordinance in Appendix A** extends the requirements of the V Zone to the Coastal A Zone. In addition, the **Model Sea Level Rise Resilience Ordinance in Appendix A** establishes a standard requiring that projections of future sea level rise be incorporated into the community's planning and development guidelines and regulations.

CRS 432o: Other Higher Standards
Up to 100 credits

The CRS provides credit for regulatory approaches and standards that are not addressed in specific CRS-credited activities.[81] Examples of areas receiving credits in the past include the following: prohibiting floodproofing for new buildings and requiring buildings to be elevated above the base flood elevation instead; prohibiting new septic systems from being installed in the floodplain; requiring new streets in the floodplain to be at or above base flood elevation; requiring all new multifamily and commercial buildings to provide access to dry land; and requiring an evacuation plan for new residential subdivisions that exceed a certain number of units.

To earn credit, communities submit the higher standard for review, with final determination made by FEMA.

ACTIVITIES

The **Model Tidal Flooding Resilience Ordinance in Appendix A** includes at least one higher regulatory standard that could be considered an "other higher standard." Sec6(2) provides that "no privately developed infrastructure, such as road, water lines, or sewer lines, will be accepted into public ownership." In addition, the **Model Sea Level Rise Resilience Ordinance in Appendix A** establishes that projections of future sea level rise must be incorporated into the community's planning and development guidelines and regulations.

CRS 432n: Coastal Erosion Hazard Regulations
Up to 370 credits

The CRS defines the "coastal erosion hazard area" as "the area between the current location of the community's erosion reference feature and the projected location of that erosion reference feature 30 to 100 years into the future."[82] Protecting areas vulnerable to coastal erosion and sea level rise can prevent future flood damages. Under this credit, communities are rewarded for protecting their coastal erosion hazard area through higher regulatory standards. Up to 370 credits are available for coastal erosion management regulations and for dune and beach regulations that prohibit construction within mapped erosion, dune, and beach areas.

To earn credit, the regulations must prohibit all new buildings from the area expected to erode over the next 30 years, and the regulations must be enforced by either local or state agencies. Additional credit is provided where regulations require substantially improved and/or substantially damaged structures to be set back at least 30 times the average annual erosion rate at the building site. Communities can earn additional credit if they require all new and substantially improved large buildings (i.e., over 5,000 square feet) to be set back beyond the 60-year erosion protection line. Communities that require the removal of "erosion-threatened structures" from the shoreline may also receive points.

ACTIVITIES

The statewide Shore Protection Act may provide Georgia communities with some credit under CRS 432n, given that it prohibits construction within dune and beach areas. Some credit may be dependent, however, on whether coastal erosion rates are taken into account as part of the regulatory standard. **Shore/dune protection ordinances** requiring setbacks or a **zoning district** such as Liberty County's Dunes and Marshlands District are tools that can protect coastal areas.[83]

Section 7 of the **Model Tidal Flooding Resilience Ordinance in Appendix A** restricts new development and prohibits privately developed infrastructure in areas of coastal tidal vulnerability from being accepted into public ownership. In addition, the **Model Sea Level Rise Resilience Ordinance in Appendix A** establishes a setback standard that also could result in credit.

CRS CREDIT
Stormwater Management

CRS 452a: Stormwater Management Regulations – 380 Credits
425b: Watershed Master Plan – 315 credits
CRS 452c: Erosion and Sedimentation Control Regulations – 40 credits

CRS 452a: Stormwater Management Regulations
Up to 380 Credits

A challenge for floodplain management in urbanizing areas is the increase in peak flow caused by development within a watershed. As forests, fields, and farms are covered by impermeable surfaces such as streets, rooftops, and parking lots, more rain runs off at a faster rate, making flooding more frequent and more severe. Significant credit is provided to communities for managing stormwater, focusing on the following four areas:

- Size of the development – if all development is subject to stormwater regulations (110 credits)
- Design storm used – if the stormwater regulation clearly states that all discharges up to and including that from a 100-year storm must be released at rates not exceeding the predevelopment peak discharge, with bonus credit for controlling runoff volume (225 credits)
- Low-impact development regulations – credits regulatory language that requires the implementation of LID techniques when new development occurs (25 credits)
- Requirements for public inspection and maintenance of all facilities constructed to comply with the ordinance (20 credits)

The **Model Enhanced Stormwater Resilience Ordinance in Appendix A,** in Section 5, limits the area of impervious surfaces that can be installed as a result of new development and redevelopment.

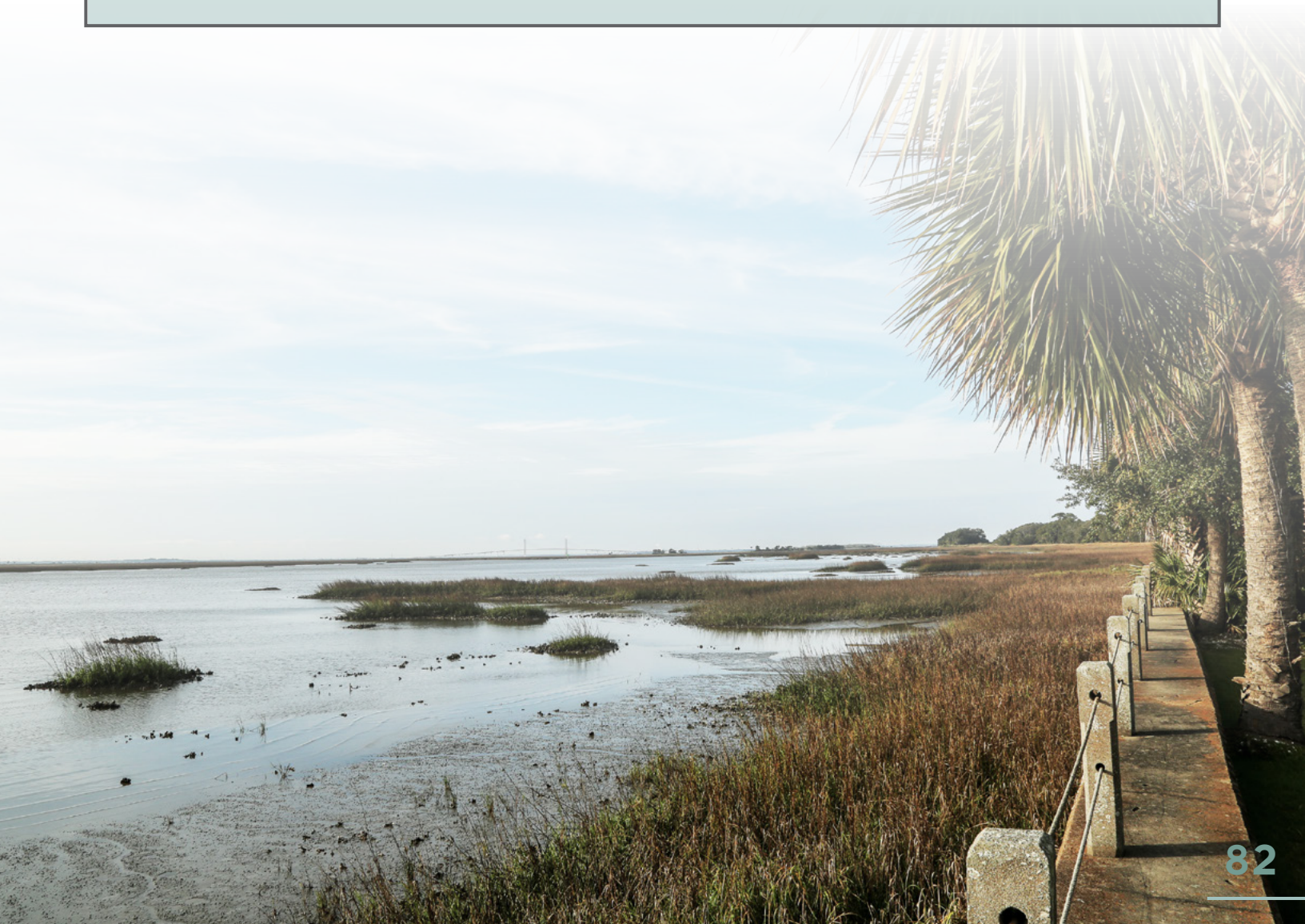
Section 6 requires the disconnection of rooftop downspouts and requires that they be directed into open space or an infiltrative infrastructure element. This basic low-impact development practice is relatively easy to implement and is potentially creditable under this activity.

CRS 452b: Watershed Master Plan Up to 315 Credits	A watershed master plan can help communities identify opportunities to reduce flooding risk, evaluate future risk based on climate change and sea level rise scenarios, and plan necessary funding to implement solutions. At a minimum, a watershed management plan must do the following (90 points): • Evaluate the impact of future conditions for at least one watershed that drains into the community for multiple storm events, including the 100-year storm. • Where applicable, evaluate future conditions, including the impacts of sea level rise using NOAA's Intermediate-High scenario in the year 2100. • The community must have adopted regulatory standards that require onsite management of runoff from all storms up to and including the 25-year event. • Revisit any plan that is more than five years old.
Additional credits are available if the plan: • Provides for onsite management of peak flows (55 points) • Manages the runoff from all storms including the five-day event (35 points) • Identifies existing wetlands or open spaces to be preserved (30 points) • Recommends channel improvements that use natural or green infrastructure approaches (25 points) • References a funding source the community has dedicated to implementing its recommendations (25 points). In addition, to achieve a CRS Class 4 rating or better, a community must receive credits under this section.	
CRS 452c: Erosion and Sedimentation Control Regulations Up to 40 Credits	Erosion and sedimentation control (ESC) credit is provided if the community requires that ESC measures be taken on land that is disturbed during development. The credit awarded is based on the size of the areas subject to the regulation. To receive ESC credit, the community's regulations must apply to all construction sites within the community. An ESC regulation that is part of a floodplain ordinance or a building code and does not affect ALL construction sites in the community does not receive credit under this element. "All construction sites" includes all sites in the community subject to construction of buildings, roads, etc.; regrading; or other non-agricultural land-disturbing activity.

(continued) **CRS 452c: Erosion and Sedimentation Control Regulations** Up to 40 Credits	Credits are earned as follows if regulations control erosion and soil loss from any disturbed land greater than: • 1,000 square feet – 40 points • 0.5 acre – 30 points • 1 acre – 10 points

EROSION AND SEDIMENTATION CONTROL ACTIVITIES

Generally, communities with MS4 stormwater permits must adopt regulations that require erosion control practices to be implemented on construction sites when one acre or more of land is disturbed. All MS4 communities should be eligible for some CRS credit under this element, although not the entire 40 points because of the one-acre exemption. Reducing the threshold size of the disturbed area would increase a community's credits. Most communities manage their erosion control practices as part of their **soil erosion, sedimentation, and pollution control ordinance.**



CRS CREDIT
Floodplain Management Planning

CRS 512b: Repetitive Loss Area Analysis (RLAA) – 140 Credits

CRS 512b: Repetitive Loss Area Analysis (RLAA) Up to 140 Credits	A repetitive loss area analysis is a detailed mitigation plan for a repetitive loss area that provides specific guidance on how repetitive loss damage will be reduced. To receive credit in this area, communities must delineate a repetitive loss area, map and analyze the area, and follow a five-step process.[85]

RLAA ACTIVITIES

The **Model Tidal Flooding Resilience Ordinance in Appendix A** includes, in Section 8, a provision requiring the development of a plan to acquire land in the area of coastal tidal vulnerability, setting the stage for communities to earn open space credits for both fee-simple acquisitions and easement protections. Communities adopting such plans should do so with the RLAA credit in mind.

CRS CREDIT
Acquisition and Relocation

CRS 520: Acquisition and Relocation – 2,250 Credits

CRS 520: Acquisition and Relocation
Up to 2,250 Credits

This is one of the largest credit-generating categories, providing a maximum credit of 2,250 points. The objective of CRS Activity 520 is to "encourage communities to acquire, relocate, or otherwise clear existing buildings out of the flood hazard area."[86] The substantial number of credits available under CRS 520 makes this an attractive option for communities seeking to improve their CRS ratings. In addition, this activity relates directly to one of the key values of this guide: that green infrastructure practices that create and preserve open space enhance community resilience. The CRS Manual further explains:

> *Acquisition and relocation projects remove people and property from harm's way and reduce the community's costs for disaster response, recovery, and repair. [FEMA] recognizes that the acquisition of buildings in the floodplain is especially effective at reducing flood losses because it is a permanent form of mitigation. Other government agencies have also found acquisition projects to be more cost effective than major flood control projects.*
>
> *Acquisition and relocation (or demolition) of buildings also creates additional open space in the floodplain and allows those lands to return to their natural functions. Acquisition is the most effective mitigation alternative for addressing repetitive loss properties.*[87]

To receive these credits, a local government must purchase property (or acquire funds from FEMA to purchase property) and place it in perpetual protection, an expensive activity in terms of both the immediate cost for acquisition and in long-term costs.

ACQUISITION ACTIVITIES

The **Model Tidal Flooding Resilience Ordinance in Appendix A** includes, in Section 8, a provision requiring the development of a plan to acquire land in the area of coastal tidal vulnerability, setting the stage for communities to earn open space credits for both fee-simple acquisitions and easement protections. Communities adopting such plans should do so with CRS 520 credit in mind.

Appendix A

MODEL ORDINANCES

Model Flood Resilient Development and Building Ordinance

The Flood Resilient Development and Building Ordinance augments the provisions of existing floodplain management regulations to enhance specific elements of residential building design in flood-prone areas and to ensure that residents and homeowners in these areas are better prepared for flood hazards. Specifically, it requires that structures built in Coastal A Zones meet the construction standards of Coastal V Zones. It also expands the regulations that are applicable in the 1% annual chance floodplain to the 0.2% annual chance floodplain. New structures associated with critical facilities shall not be located in the 0.2% floodplain. All new development must be built to an elevation that is 2 feet above the 0.2% flood elevation, and that elevation shall be measured from the bottom of the lowest horizontal structural member. Finally, it requires that real estate agents inform prospective buyers of the documented flood risk of the property.

MODEL FLOOD RESILIENT DEVELOPMENT AND BUILDING ORDINANCE

ARTICLE I. - GENERAL PROVISIONS

Sec. 1. - Title.

This chapter, as the same shall be amended from time to time, shall be known as the "County Flood Resilient Development and Building Ordinance."

Sec. 2. – Local Government Authority.

The Constitution of the State of Georgia grants local governmental units the general authority and responsibility to adopt appropriate ordinances, resolutions, or regulations designed to promote the public health, safety, and general welfare.

Sec. 3. – Findings of Fact.

1. Environmental changes are expected to increase global sea levels.
2. The National Oceanic and Atmospheric Administration (NOAA) published a report on the latest science on sea level rise entitled Global and Regional Sea Level Rise Scenarios for the United States (2017), NOAA Technical Report NOS CO-OPS 083, hereinafter referred to as the "NOAA Sea Level Rise Report."
3. Global Mean Sea Level rise estimates support an expected rise of 0.1 meter to 0.3 meter (4 inches to 1 foot) by 2100 on the lowest end or 2.0 meter to 2.5 meters (6.5 feet to 8.2 feet) by 2100 on the highest end.
4. Rising sea levels threaten coastal communities across the nation and worldwide, including this county. These threats will come in multiple forms including, but not limited to: flooding from regular tidal actions, saltwater and groundwater intrusion into drainage systems that reduce system capacity, higher storm surges, increased coastal erosion, increased groundwater tables that result in surface inundation and the loss of infiltration capacity, and the degradation of underground infrastructure.
5. Increased flooding frequency and flood heights necessitates the adoption of additional building requirements to ensure this community develops in a resilient manner that maximizes public safety and the protection of private property.

Sec. 4. – Statement of Purpose.

To increase long-term community resilience, preserve public safety, and minimize public and private property losses due to flooding and storm damage, this ordinance augments the provisions of the existing floodplain management regulations to enhance specific elements of residential building design in flood-prone areas and ensure that residents and homeowners in these areas are better prepared for flood hazards.

Sec. 5. – Definitions.

0.2% Annual Chance Flood Elevation – area that has a 0.2% chance of being flooded in any given year according to the county's most recently adopted FEMA

Base Flood Elevations – the level or height of the flood that has a 1% chance of occurring in any given year according to the county's most recently adopted FEMA FIRM.

FIRM. Also known as the X Zone or the 500-year floodplain.

Coastal A Zone – the area landward of a V Zone, or landward of an open coast without mapped V Zones according to the county's most recently adopted FEMA Flood

Insurance Rate Map (FIRM) - In a Coastal A Zone, the principal source of flooding will be astronomical tides, storm surges, or tsunamis, not riverine flooding, and there is the potential for breaking wave heights between 1.5 feet and 3.0 feet.

Critical Facilities – facilities that are vital to emergency response and public health and safety including hospitals, emergency operations centers, pumping stations, cell towers, electrical substations, police stations, fire stations, schools, and nursing homes.

FIRM – a flood map created by the Federal Emergency Management Agency (FEMA) used by the National Flood Insurance Program (NFIP) for floodplain management, mitigation, and insurance purposes. Digital versions of these maps are called DFIRMs.

CRS CREDIT
432e – Lower Substantial Improvement Threshold (LSI) | Up to 20 points.

Significant Reconstruction – any construction, addition, repair, redevelopment, or similar project that exceeds 40% of the value of the structure, or that exceeds 50% of the value of the structure through multiple projects over a 5-year period.

CRS CREDIT
432d – Cumulative Substantial Improvement (CSI) | Up to 90 points

V Zone – coastal areas with a 1% chance of flooding in a given year and that are vulnerable to damage from storm waves over 3.0 feet during a storm event.

Sec. 6. – Construction Standards.

432d – Cumulative Substantial Improvement (CSI) | Up to 90 points

1. All new construction of residential structures, *including any additions to an existing structure* or the significant redevelopment of existing structures, in the Coastal A Zone according to the most recently adopted FEMA FIRM designation, shall comply with the same design requirements applied in the V Zone.

CRS CREDIT
432.c – Foundation Protection (FRD) | Up to 80 points – requiring V-Zone foundation standards outside of V-Zone

2. Critical facilities shall not be developed in the 0.2% annual chance floodplain.

Sec. 7. – Freeboard Requirement.

CRS CREDIT
432f – Protection of Critical Facilities | Up to 80 points

1. All new construction of residential structures, including the significant redevelopment of existing structures, including manufactured homes, shall have the lowest floor, including basement, elevated 2 feet above the 0.2% annual chance flood elevation. Where base flood elevation data are not available, the structure shall have the lowest floor, including basement, elevated at least 3 feet above the highest adjacent natural grade.

CRS CREDIT
432.b – Freeboard (FRB) up to 500 points; est 375
2 ft
+1ft for horizontal member
+1ft for 500 yr floodplain

2. The elevation requirement shall apply to the lowest horizontal structural member of the lowest floor.

3. All electrical, heating, ventilation, air conditioning, plumbing, and other such equipment shall be elevated to the required freeboard elevation or made flood resistant according to applicable FEMA standards.

Sec. 8. – Regulation of the 0.2% Floodplain.

All regulations and requirements in the county's code of ordinances applicable in the FEMA-defined Special Flood Hazard Area (SFHA), also referred to as the 100-year floodplain, according to the most recently adopted FIRM, shall be applicable in all areas described as being within the 500-year floodplain, which have a 0.2% of flooding in any given year, according to the most recently adopted FIRM.

CRS CREDIT
Improves the impact adjustment for credit applicable to the SFHA

Sec. 9. – Disclosure Requirement.

In all real estate transactions involving property that has one or more structures in an area that has been identified by the county or FEMA as being vulnerable to flooding, any party serving as a real estate agent shall inform prospective buyers of all identified flood risks such as the boundary of the FEMA-defined Special Flood Hazard Area (SFHA), the elevation of the 0.2% annual chance floodplain, erosion, subsidence, or other documented risk. If a property is located in the SFHA, the notice must also include information about the federal requirement to purchase flood insurance if the buyer is seeking a federally backed mortgage.

CRS CREDIT
342a – Disclosure of Flood Hazard
Up to 35 points

342d – Disclosure of Other Hazards
Up to 8 points

Sec. 10. – Administration and Enforcement.

[General Administration and Enforcement, including variances, of this chapter should resemble the enforcement procedures in place for the floodplain management or flood loss prevention ordinance.]

Sec. 11. – Severability.

If any section of this code section is declared unconstitutional or otherwise invalidated by any court of competent jurisdiction, then it is expressly provided that the remaining portions of this section that are not so invalidated are severable and shall remain in full force and effect.

Model Enhanced Stormwater Resilience Ordinance

The Model Enhanced Stormwater Resilience Ordinance focuses on two elements that are generally not addressed in stormwater management regulations but that can enhance those regulations by reducing stormwater runoff, thereby reducing the likelihood of flooding caused by peak flows that overwhelm the downstream infrastructure. The ordinance does this by limiting the amount of impervious cover that can be used in new development and development projects, based on the zoning classification of the project. In suburban and rural areas, it also mandates that stormwater from rooftop runoff be directed through an infiltrative area or structure before it is discharged into a conveyance system or a surface water body.

MODEL ENHANCED STORMWATER RESILIENCE ORDINANCE

ARTICLE I. - GENERAL PROVISIONS

Sec. 1. - Title.

This chapter, as the same shall be amended from time to time, shall be known as the "County Enhanced Stormwater Resilience Ordinance."

Sec. 2. – Local Government Authority.

The Constitution of the State of Georgia grants local governmental units the general authority and responsibility to adopt appropriate ordinances, resolutions, or regulations designed to promote the public health, safety, and general welfare.

Sec. 3. – Findings of Fact.

1. Postconstruction stormwater management practices significantly impact surface waters. Stormwater runoff negatively impacts water quality, species habitat, and general environment quality. It also dramatically affects downstream peak flows, which increases incidents of flooding and increases the severity of floods, thereby endangering public safety, public infrastructure, and private property.
2. The percentage of a watershed that is covered by man-made impervious surfaces significantly affects the health and water quality of the receiving surface waters as well as the peak flows and thus the likelihood of a flood event.
3. Eliminating the direct connections between impervious surfaces and surface waters is the simplest and most direct development practice that can mitigate some of the impacts of expanding impervious cover in a watershed.
4. Changing climatic conditions are expected to alter precipitation patterns, resulting in more intense rain events.
5. Rising sea levels will also impact flooding by reducing the capacity of coastal stormwater systems, causing higher groundwater levels, which will decrease the soil's natural infiltrative capacity, increasing the frequency of tidal flooding and leading to more extensive flooding from storm surges.
6. Recognizing the growing threat of flooding in our community, both through increased development and a changing climate, necessitates limitations on the increase in impervious cover and the implementation of measures to reduce the impact of impervious cover.

Sec. 4. – Statement of Purpose.

To increase long-term community resilience, preserve public safety, and minimize public and private property losses due to flooding as well as improve water quality and protect environmental health, this ordinance shall create standards to limit the amount impervious surfaces associated with future development will negatively impact the future health and safety of the citizens of this community.

Sec. 5. – Limitation on Impervious Cover.

The area in which this is implemented may be limited to certain priority watersheds or other areas such as impaired water bodies, pristine water bodies, drinking water supplies, those within close proximity to coastal marshes, or other sensitive areas.

1. For the purposes of limiting impervious coverage within the county, the existing zoning classifications shall be divided into three classifications:

    a. Urban – [consists of the zoning classifications for central downtown development, primarily commercial, mixed-use, and high-density residential designations that are pedestrian oriented and where development will be the most dense.]

    b. Suburban – [consists of general commercial and residential designations typical of suburban development where development is less dense than the urban areas and transportation is more car oriented.]

    c. Rural – [consists of low-density residential uses as well as agricultural or small-scale commercial uses where development is the least dense and open space easier to preserve.]

2. In order to ultimately limit the total impervious cover in the various watersheds located in the county to 10% of the total area, impervious cover associated with new development shall be regulated as follows.

    a. In Urban zoning classifications, impervious cover shall not be limited. However, a mitigation plan approved by the county shall be implemented that removes impervious surfaces or installs mitigation measures elsewhere in the watershed so that the impact of the development does not increase the impacts of impervious cover in the watershed by more than 20%.

    b. In Suburban zoning classifications, impervious cover shall not exceed 20% of total development area for commercial, mixed-use, or multifamily developments, 10% for single family residential development.

    c. In Rural zoning classifications, impervious cover shall not exceed 5% of the total development areas, though the minimum impervious area allowed on a parcel shall be 5,000 square feet.

If a community or a particular area has a stormwater utility, the minimum impervious cover and the percentage allowed could be defined by the standard units employed by the utility.

3. Impervious surface area calculations may exclude any existing or proposed impervious surface where the property owner can show that runoff from the impervious surface is treated by existing or proposed devices such as constructed wetlands, infiltration systems, rain gardens, bioswales, or other engineered systems, or that the runoff discharges to an internally drained pervious area that retains the runoff on or off the parcel to allow evapotranspiration of the water.

    a. The county engineer shall promulgate technical standards for the treatment of stormwater runoff to be used in the calculation of impervious surface area for watersheds that need protection due to existing water quality impairments, potential impairments, ecological value, importance to the community, or other values.

    b. Where the county engineer has not promulgated such standards, the treatment measures shall be designed such that:

i. The first two inches of runoff from the area of impervious surface is treated by a storm water BMP, or

ii. The first two inches of runoff from the surface is discharged to an internally drained pervious area that retains the runoff on or off the parcel to allow evapotranspiration of the water.

c. If a developer or subsequent property owner fails to maintain the treatment system, treatment device, or internally drained area, the impervious surface is no longer exempt under this ordinance, and it must be brought into compliance by restoring the functionality of the stormwater system or the removal of impervious surface area.

4. Developments in Urban zoning classifications shall submit an impervious cover mitigation plan, and developments in Suburban or Rural zoning classifications shall submit an impervious cover mitigation plan if the development exceeds the maximum percentage of allowed impervious cover. An impervious cover mitigation plan shall consist of the following:

a. A site plan that describes the proposed mitigation measures to be implemented to mitigate the negative impacts on the community and the natural environment and restore natural functions lost through the increase in impervious surface area.

b. The mitigation plan shall include an implementation schedule and enforceable obligations on the property owner to establish and maintain the mitigation measures.

c. The obligations of the property owner under the mitigation plan shall be evidenced by an instrument recorded in the county Office of the Clerk of the Superior Court.

5. Existing impervious surfaces that were legally constructed but that do not comply with the impervious surface standards are permitted to do the following (without mitigation) as long as the percentage of impervious surface that existed lawfully on the effective date of the ordinance is not increased:

a. Maintain and repair all impervious surfaces.

b. Replace existing impervious surfaces with similar surfaces within the existing footprint.

c. Relocate or modify legally existing impervious surfaces with similar or different impervious surfaces, provided that the relocation or modification does not result in an increase in the percentage of impervious surface that existed on the date this ordinance was enacted but shall meet the applicable setback requirements.

6. Any expansion of the area of a pre-existing impervious surface that exceeds the limits of this ordinance shall require mitigation activities that reduce impervious cover elsewhere and/or mitigate the impacts of the increased impervious cover for an area equivalent to 200% of the amount of the increased area.

Sec. 6. – Limit Direct Connections of Impervious Surfaces to Surface Waters.

1. In rural and suburban areas, as defined in Sec. 5 above, downspouts receiving stormwater runoff from the roof of any structure shall not be allowed to discharge that flow onto impervious surfaces, into other stormwater collection infrastructure, or directly into any water body without first directing it through some green infrastructure designed to infiltrate it into the ground.

a. Simple downspout disconnections may be used to separate downspouts and direct flow onto lawns and other pervious areas designed to receive such flow. Any simple downspout disconnection should be designed and constructed according to the criteria and considerations discussed in section 7.8.8 – “Simple Downspout Disconnection” in the Georgia Coastal Stormwater Supplement to the Georgia Stormwater Management Manual.

b. Other green infrastructure practices described in the Georgia Coastal Stormwater Supplement to the Georgia Stormwater Management Manual may also be used to disconnect rooftop stormwater runoff and infiltrate it into the ground, including vegetative filter strips (Section 7.86), rain gardens (Section 7.8.9), dry wells (Section 7.8.11), and rainwater harvesting (Section 7.8.12), and others as appropriate.

c. Green infrastructure practices not described in the Georgia Coastal Stormwater Supplement to the Georgia Stormwater Management Manual may be used if such practice is approved by the county engineer, who certifies that its use in the project will be at least as effective at reducing runoff and protecting water quality as the proper use of the simple downspout disconnection.

2. To the maximum extent practical, all landscaped areas inside or adjacent to parking lots shall be designed to capture and infiltrate stormwater runoff before such runoff is discharged into the site's stormwater system.

Sec. 7. – Administration and Enforcement.

[General Administration and Enforcement, including variances, of this chapter should resemble the enforcement procedures in place for the floodplain management or flood loss prevention ordinance]

Sec. 8. – Severability.

If any section of this code section is declared unconstitutional or otherwise invalidated by any court of competent jurisdiction, then it is expressly provided that the remaining portions of this section that are not so invalidated are severable and shall remain in full force and effect.

Model Sea Level Rise Ordinance

The Model Sea Level Rise Ordinance is intended to be the most basic of the model ordinances presented in this guide. It implements two distinct actions focused on the use of future sea level rise projections and establishes a minimum protective buffer to protect new development for rising tide levels. First, it requires the use of future sea level rise projections in all future plans, regulations, ordinances, policies, public infrastructure and facilities planning and construction, and future land use decisions, and it establishes the minimum projections to be used. Second, it creates a protective buffer around tidally influence waters to ensure a sufficient setback is maintained as water levels rise.

MODEL SEA LEVEL RISE RESILIENCE ORDINANCE

ARTICLE I. - GENERAL PROVISIONS

Sec. 1. - Title.

This chapter, as the same shall be amended from time to time, shall be known as the "County Sea Level Rise Resilience Ordinance."

Sec. 2. – Local Government Authority.

The Constitution of the State of Georgia grants local governmental units the general authority and responsibility to adopt appropriate ordinances, resolutions, or regulations designed to promote the public health, safety, and general welfare.

Sec. 3. - Findings of Fact.

1. Environmental changes are expected to increase global sea levels. Global Mean Sea Level rise estimates support an expected rise of 0.1 meter to 0.3 meter (4 inches to 1 foot) by the 2100 on the lowest end or 2.0 meter to 2.5 meters (6.5 feet to 8.2 feet) by 2100 to the highest end.
2. Rising sea levels threaten coastal communities across the nation and worldwide, including this county. These threats will come in multiple forms including, but not limited to: flooding from regular tidal actions, saltwater and groundwater intrusion into drainage systems that reduces system capacity, higher storm surges, increased coastal erosion, increased groundwater tables and resulting surface inundation and the loss of infiltration capacity, and the degradation of underground infrastructure.
3. To secure the future safety and prosperity of this county, it is necessary to incorporate projections of future sea level rise into the planning and development guidelines and regulations of this community, ensuring that future public infrastructure and building projects incorporate projections of sea level rise.
4. There exists a strong scientific consensus that global climatic changes will result in sea level rise throughout the rest of the century and for centuries to come, but some uncertainty exists as to the rate of this increase in the coming years and timing of specific impacts associated with the increasing tidal heights.
5. The National Oceanic and Atmospheric Administration (NOAA) published a report on the latest science on sea level rise entitled Global and Regional Sea Level Rise Scenarios for the United States (2017), NOAA Technical Report NOS CO-OPS 083, hereinafter referred to as the "NOAA Global and Regional Sea Level Rise Report" or the "NOAA Report."
6. The NOAA Global and Regional Sea Level Rise Report defines six sea level rise scenarios that encapsulate the most likely sea level rise scenarios, described as follows: Low Scenario (0.3 meters by 2100), Intermediate-Low

Scenario (0.5 meters by 2100), Intermediate Scenario (1.0 meters by 2100), Intermediate-High Scenario (1.5 meters by 2100), High Scenario (2.0 meters by 2100), and Extreme Scenario (2.5 meters).

7. For long-term planning, infrastructure development, land development purposes, and other general purposes, the Intermediate-High Scenario for increases of GMSL represents a scientifically sound estimate of future sea level rise for which there is a very low probability that it will be exceeded, and that accounts for estimated variability that will be caused by regional variation, and therefore that will allow this county to plan for and build a safer and more resilient future.
8. Implementing buffers around tidally influenced areas provides a simple mechanism for increasing the resilience of new buildings and infrastructure.

Sec. 4. - Statement of Purpose.

To increase long-term community resilience, preserve public safety, and minimize public and private property losses due to flooding and storm damage, and to minimize other negative impacts associated with rising sea levels, this ordinance shall require the use of future sea level rise projections in future plans, regulations, ordinances, policies, public infrastructure and facilities planning and construction, and other public decisions. Specific decisions may require the use of other projections or estimates, particularly for critical infrastructure and facilities that need a higher standard of protection or where the project's design life warrants the use of a different standard.

In addition, this ordinance creates a buffer around all tidally influenced waters to create a minimum level of safety for new buildings as well as public and private infrastructure that would be damaged by future inundation from future tides or flooding events.

Sec. 5. – Using Sea Level Rise Projection Data.

The following sea level rise projections shall be used for all planning, design, and regulatory purposes that require the county government or its staff to consider tide levels. The appropriate sea level rise increment shall be added to the current Mean-Higher-High-Water level (MHHW), as defined by NOAA, which shall establish the relevant tide line for the relevant plan, permit, ordinance, or other purpose. Where appropriate, additional tidal data should also be considered, such as the height of spring tide events in the area. The appropriate increments shall be identified by determining the relevant planning horizon or the design life of the potentially affected project, and selecting the relevant decade in which that end-date occurs.

Intermediate-High GMSL Scenario	2030	2040	2050	2060	2070	2080	2090	2100
Meters	0.19	0.30	0.44	0.60	0.79	1.0	1.2	1.5
Feet	0.62	0.98	1.44	1.97	2.59	3.28	3.94	4.92

Sec. 6. – Enhanced Buffer Requirements.

1. To limit the exposure of future buildings and infrastructure, all new construction of building and related infrastructure shall take place at least 100 feet landward of the mean higher-high water mark along all tidally influenced waters, or, where coastal marshlands exist as described in the State of Georgia's Coastal Marshland Protection Act, all new construction shall take place at least 100 feet from the edge of the marsh.
2. If a proposed construction project in rendered infeasible by the establishment of this buffer, the County Board of Commissioners may grant a variance from the requirements of this ordinance if the applicant for the variance can establish the following:

a. The project cannot be constructed unless a variance is granted, and that a reasonable reduction in the scale of the project will not avoid the need for a variance.
b. The portions of the project to be built in the buffer areas will be designed and constructed to limit the potential impacts of future flooding.

3. This buffer shall not apply to the following:

a. The maintenance or repair of existing buildings or infrastructure
b. Agricultural activities, land clearing, and other non-construction-related activities
c. The construction of parks, trails, and other structures related to outdoor recreation, environmental education, or similar pursuit

4. Applications for a buffer variance shall be submitted on forms prepared by the planning department and reviewed through the process used to approve variances to the existing zoning code, with review and consultation with the county engineer.

Sec. 7. – Severability.

If any section of this code section is declared unconstitutional or otherwise invalidated by any court of competent jurisdiction, then it is expressly provided that the remaining portions of this section that are not so invalidated are severable and shall remain in full force and effect.

Model Tidal Flooding Resilience Ordinance

The Model Tidal Flooding Resilience Ordinance recognizes that the most at-risk coastal properties are those that are vulnerable to damage from regular tidal flooding events. Therefore, it creates a regulatory designation called the Area of Coastal Tidal Vulnerability (ACTV) in which there are additional land use regulations, oversight over infrastructure investments, and investments in land conservation. The boundary of the ACTV is meant to be "rolling" in that it moves upland as sea levels rise. Thus, in every new decade, an additional area is added to the ACTV based on the anticipated rate of sea level rise.

MODEL TIDAL FLOODING RESILIENCE ORDINANCE

ARTICLE I. - GENERAL PROVISIONS

Sec. 1. - Title.

This chapter, as the same shall be amended from time to time, shall be known as the "County Tidal Flooding Resilience Ordinance."

Sec. 2. – Local Government Authority.

The Constitution of the State of Georgia grants local governmental units the general authority and responsibility to adopt appropriate ordinances, resolutions, or regulations designed to promote the public health, safety, and general welfare.

Sec. 3. – Findings of Fact.

1. Environmental changes are expected to increase global sea levels.
2. The National Oceanic and Atmospheric Administration (NOAA) published a report on the latest science on sea level rise entitled Global and Regional Sea Level Rise Scenarios for the United States (2017), NOAA Technical Report NOS CO-OPS 083, hereinafter referred to as the "NOAA Sea Level Rise Report."
3. Global Mean Sea Level rise estimates support an expected rise of 0.1 meter to 0.3 meter (4 inches to 1 foot) by the 2100 on the lowest end or 2.0 meter to 2.5 meters (6.5 feet to 8.2 feet) by 2100 to the highest end.
4. Rising sea levels will be most notably experienced through increasing frequency, depth, and extent of regular recurrent tidal flooding.
5. Recurrent flooding from regular tidal action, that is flooding that happens due to the regular action of the tides without the presence of storm surge or precipitation, regularly damages coastal property and infrastructure and threatens public health and safety by creating dangerous conditions and limiting access to critical facilities.
6. NOAA published a report concerning recurrent tidal flooding entitled Patterns and Projections of High Tide Flooding Along the U.S. Coastline Using a Common Impact Threshold (2018), NOAA Technical Report NOS CO-OPS 086, hereinafter referred to as the "NOAA Tidal Flooding Report."
7. From the year 2000 to 2015, recurrent tidal flooding events have increased 125% from an average of 1.3 days per year to 3.0 days per year, and this rapid increase is expected to continue for many years.
8. The NOAA Tidal Flooding Report states that in the South Atlantic region, generally areas within 0.8 meters (2.6 feet) of the highest average tide (mean-higher-high-water line) have a 20% annual chance to be flooded by regularly recurring tidal events. This is classified as the threshold for "moderate flooding," which is defined

as flooding that is likely to inundate some structures, causing minor to moderate damage, and making various infrastructure systems inoperable.

9. Along the South Atlantic coast, lands within 0.35 meters of the current mean higher high-water line are expected to see the frequency of tidal flooding events increase by 25 times by the year 2030. This means a flooding event that is expected to happen once every 5 years today will then be expected to happen 5 times every year.
10. In order to ensure public health and safety, protect private property, and promote general community resilience, it is necessary to prepare for these changes by developing regulations that ensure private development and public infrastructure investments are protected from future vulnerabilities.
11. The areas within the County that are vulnerable to the regularly recurring tidal events, both at the present and into the future as rates of sea level rise accelerate, warrant particular attention and protection to ensure that future development, by both public and private developers does not make the community more vulnerable to damages from the impacts of inevitable recurring tidal flooding.

Sec. 4. – Statement of Purpose.

To increase long-term community resilience, preserve public safety, and minimize public and private property losses due to flooding and storm damage, this ordinance shall create standards to limit future development in areas that are vulnerable to recurring tidal flooding currently and into the future based on conservative future sea level rise scenarios. To achieve this goal, this ordinance creates an area with additional land use regulations and increased county responsibility to review infrastructure investments and invest in land conservation. The boundary of this area is meant to be "rolling" in that it moves upland as sea levels rise. Thus, in every new decade an additional area is added to the ACTV based on the anticipated rate of sea level rise.

Sec. 5. – Establishment of the Area of Coastal Tidal Vulnerability (ACTV).
Sec. 6. – Land Use Regulations in the ACTV

1. There is hereby established an Area of Coastal Tidal Vulnerability (ACTV).
2. The ACTV consists of all land in the county that may be subject to recurrent tidal flooding presently or in the foreseeable future. The ACTV shall include all lands adjacent to or in the vicinity of tidally influenced waters where the elevation is within 1.24 meters (4.1 feet) of the mean-higher-high-water mark, as determined by the National Oceanic and Atmospheric Administration using the NAVD88 vertical datum.
3. The area of the ACTV shall be adjusted every decade beginning in the year 2030. The area of the ACTV is determined by adding the expected sea level rise projections under the Intermediate-High Global Mean Sea Level Scenario described in the NOAA Sea Level Rise Report for 30 years in the future to the current average elevation associated with moderate flooding (0.8 meters). Starting in 2020, the applicable increment is based on the projection for the year 2050 (0.44 meters).

In subsequent decades, beginning in 2030, this area shall be adjusted by adding the appropriate increment from the chart below to the base elevation of 0.8 meters above mean-higher-high-water.

The sea level rise increments are shown in the following table:

Intermediate-High GMSL Scenario	2050–2059	2060–2069	2070–2079	2080–2089	2090–2099	2100–2110
Meters	0.44	0.60	0.79	1.0	1.2	1.5
Feet	1.44	1.97	2.59	3.28	3.94	4.92

The elevations of the ACTV boundary arae shown in the following table:

ACTV Boundary Elevation	2050–2059	2060–2069	2070–2079	2080–2089	2090–2099	2100–2110
Meters	1.24	1.40	1.59	1.8	2.0	2.3
Feet	4.1	4.59	5.21	5.9	6.5	7.55

Within the ACTV, the following land use regulations shall apply in addition to all other regulations and restrictions that may apply. Where the requirements of this section conflict with requirements elsewhere, the more restrictive regulation shall apply.

Sec. 7. – Public Infrastructure in the ACTV.

1. No new buildings or other structures shall be allowed.
2. No privately developed infrastructure, such as road, water lines, or sewer lines, will be accepted into public ownership.
3. All plans and plats prepared for submission or review by the county or recording by the Clerk of the Superior Court shall show the boundaries of the ACTV and include a notation that buildings or other fixtures on the land may be vulnerable to tidal flooding.

Where public infrastructure is located in the ACTV, when such infrastructure is damaged by flooding, the county shall consider the long-term costs of continuing to maintain that infrastructure and the public interest of doing so. The county shall the determine whether maintaining or abandoning the infrastructure is of sufficient public interest to justify continued maintenance or whether it should be abandoned as allowed by state law.

Sec. 8. – Land Acquisition and Conservation in the ACTV.

The county shall develop a plan to acquire land in the ACTV for conservation and preservation. This should include the acquisition of existing structures and the permanent preservation of those areas as greenspace. This plan should focus on the acquisition of repetitive loss structures as determined by the Federal Emergency Management Agency and other highly flood-prone properties. It may include the fee simple acquisition of properties or protection by easement by the county or other land conservation agency, whether public or private.

CRS CREDIT
420 – Open Space Preservation
Up to 2,020 points

512b – Repetitive Loss Area Analysis (RLAA) | Up to 140 points

520 – Acquisition and Relocation
Up to 2,250 points

Sec. 9. – Disclosure Requirement.

In all real estate transactions involving property that has one or more structures in the ACTV, or in an another area that has been identified by the county or FEMA as being vulnerable to flooding, any party serving as a real estate agent shall inform prospective buyers of all identified flood risks such as the boundary of the Special Flood Hazard Area (SFHA), the elevation of the 0.2% annual chance floodplain, erosion, subsidence, or other documented risk. If a property is located in the SFHA, the notice must also include information about the federal requirement to purchase flood insurance if the buyer is seeking a federally backed mortgage.

CRS CREDIT

342a – Disclosure of Flood Hazard (DFH)
Up to 35 points

342d – Disclosure of Other Hazards
Up to 8 points

Sec. 10. – Administration and Enforcement.

1. *[General Administration and Enforcement, including variances, of this chapter should resemble the enforcement procedures in place for the floodplain management or flood loss prevention ordinance.]*
2. Existing structures located in the ACTV prior to the enactment of this ordinance or that are brought into the ACTV by an expansion of its boundaries shall be allowed to continue in their present use. However, if any of these structures are significantly damaged by flooding, reconstruction shall not be allowed. Significant damage shall mean damage exceeding 50% of the value of the structure in a single flood event or cumulative damage exceeding 50% of the value of the structure in multiple flood events over a 10-year period. In addition, if the structure is damaged to the extent that it is not fit for human habitation, and repairs have not commenced within 30 days of the flooding event, reconstruction shall not be allowed even if the cost of he damage is less that 50% of the structure's value.

Sec. 11. – Severability.

If any section of this code section is declared unconstitutional or otherwise invalidated by any court of competent jurisdiction, then it is expressly provided that the remaining portions of this section that are not so invalidated are severable and shall remain in full force and effect.

Model Coastal Resilience Ordinance

Introduction

This model ordinance is one of several ordinances drafted as a companion to the guidance document Enhancing Coastal Resilience with Green Infrastructure. The other ordinances provide specific measures designed to improve community resilience. However, this ordinance serves to give local governments a model framework to begin implementing the resilience practices discussed in the other ordinances as well others in the guide. As the guide discusses, conceptualizing and measuring community resilience in a specific community is a multifaceted and scale-dependent exercise. Planning for community resilience and identifying the specific practices to use is an inherently local exercise—one that incorporates community goals, vulnerabilities, and needs. This ordinance complements the guide by providing a ready framework for local governments to consider their unique circumstances and their related goals and needs. Specifically, this ordinance directs the community to do the following:

- Establish a Resilience Innovation Team that draws from a cross-section of planning, floodplain management, emergency response, and environmental expertise
- Develop a local understanding of community resilience
- Acquire critical data to identify local vulnerabilities and opportunities to improve community resilience
- Define goals for community resilience
- Identify projects to achieve those goals.

The guide provides a method for improving community resilience based on incorporating community resilience considerations into structural infrastructure elements, local planning and development practices, and local government operations. It also directs local governments to identify officials and staff to consider the basic community resilience concepts laid out in the guide, ideally with cooperation from private-sector and nongovernmental partners, and then develop actions and programs to implement them and improve their community's resilience.

This model ordinance is structured to apply to diverse communities located along the coast in Georgia. Community resilience is an intensely local topic based on the characteristics of a community as well as its governmental structure and size. From erosion control to zoning, a comprehensive approach to resilience touches many different parts of a community's existing code of ordinances and, indeed, could essentially involve a rewriting of large parts of it.[1] This ordinance therefore directs communities to enact a framework to choose actions and practices that work across their existing code of ordinances and that are based on the most current best practices in the community resilience literature.

[1] For example, the City of Norfolk, Virginia, recently enacted a resilient zoning code that took years to develop and runs to over 800 pages as it completely changes the way the city reviews development proposals – and that just address zoning practices. A copy of the City of Norfolk's ordinance is available at www.adaptationclearinghouse.org/resources/building-a-better-norfolk-a-zoning-ordinance-of-the-21st-century.html.

Title & Preamble

ORDINANCE NO. _____ ……..

AN ORDINANCE ADOPTING COMMUNITY RESILIENCE AS A LOCAL PRIORITY; AND IMPLEMENTING PROCESSES TO IMPROVE COMMUNITY RESILIENCE

The following is quoted directly from the "Handbook for Georgia Mayors and Councilmembers." Refer to this handbook for additional details about ordinances.

"Although state law does not dictate a required format for a municipal ordinance, it is important to review a city's charter and previously adopted ordinances for provisions that may include requirements for inclusion in a municipal ordinance or resolution. However, there are some basic elements to a well-drafted ordinance that may allow a municipality to avoid challenges to the validity and meaning of its enactments."

WHEREAS, the governing authority of _____ has determined that the public health, safety, and welfare of its residents will be significantly improved by a greater emphasis on increasing community resilience to natural hazards and environmental changes;

WHEREAS, the use of nature-based and green infrastructure practices and policies, both in the built environment and in the preservation of existing natural infrastructure systems, has been demonstrated to improve community resilience by reducing risks to lives and property from flooding and other natural hazards;

WHEREAS, green infrastructure practices and the preservation of natural infrastructure are identified as priorities in the Coastal Stormwater Supplement of the Georgia Stormwater Manual, [INSERT OR DELETE REFERENCES TO PLANS AS APPROPRIATE], Disaster Recovery and Redevelopment Plan, Comprehensive Plan,…

WHEREAS, the use of nature-based infrastructure provides opportunities to further other community priorities including, but not limited to, [ADD OR DELETE COMMUNITY GOALS AS APPROPRITATE] expanding access to protected greenspace, reducing water treatment costs, lowering capital expenditures on stormwater infrastructure, creating more walkable communities, increasing property values, and others;

WHEREAS, in addition to promoting local community planning goals, the use of nature-based and green infrastructure has additional environmental benefits including, but not limited to, reducing ambient air temperatures, protecting water quality, increasing stream flows, increasing biodiversity and species habitat, and others;

WHEREAS, using nature-based infrastructure is generally less expensive than providing the same level of service using "hard" or "gray infrastructure" practices;

WHEREAS, implementing many nature-based infrastructure practices can lead to financial savings for many residents in the community who purchase flood insurance through the federal National Flood Insurance Program by making the community eligible for additional point through FEMA's Community Rating System (CRS);

WHEREAS, the practices the Coastal Resources Division (CRD) of the Georgia Department of Natural Resources, with support of the National Oceanographic and Atmospheric Administration, commissioned a guidance document entitled "Enhancing Coastal Resilience with Green Infrastructure," hereinafter the CRD Community Resilience Guide, that describes the core concepts of community resilience and describes practices for local governments to improve community resilience;

WHEREAS, adopting this ordinance establishes a process for implementing the practices described in the CRD Community Resilience Guide;

WHEREAS, improving community resilience requires the integration of different aspects of local government operations; and

WHEREAS, the provisions of this ordinance provide a framework to integrate the various parts of the local government's operations to facilitate the implementation of the community resilience practices described in the CRD Community Resilience Guide,

NOW THEREFORE, the governing authority of _____ hereby enacts the following on this ___ day of _____, 20___.

This ordinance is written as if it would be adopted by a fictional county. It any event, local governments, city or county, will have to adapt the language to their particular situation including the governance and management structure, job title, planning opportunities and responsibilities, and other factors. Nothing in this model ordinance is meant to imply that it is not applicable to a city or county even if that government does not carry out some of the functions or have some of the capacities discussed herein. The language should be tailored to individual community contexts.

Section 1 – Policy Statement

To promote the present and future public interest, health, safety, and welfare of the people of Coastal County, the Board of Commissioners of Coastal County declare that it shall be the policy of this County to plan for future environmental changes including, but not limited to, higher temperatures, increasing precipitation, and rising sea levels; as well as natural hazards including, but not limited to, coastal and riverine flooding, nuisance flooding, flash floods, storm surges, hurricanes and other intense wind storms, and coastal erosion. The goal of this policy shall be to promote community resilience and reduce vulnerabilities to these threats to the maximum extent practical by mandating or promoting structural improvements, incorporating community resilience considerations into planning and development practices and processes, and including community resilience considerations in governmental operations where possible.

Ideally, where feasible, a Resilience Innovation Team should be created in partnership between a county and the major city or cities therein. This could take the form of a Joint Resilience Innovation Team where members from each entity all meet together, or separate Resilience Innovation Teams that operate in parallel and coordinate and collaborate as necessary.

Section 2 – Coastal County Resilience Innovation Team

Section 2.1 – Creation.

To further the goals stated in this ordinance, the Board of Commissioners of Coastal County hereby creates the Coastal County Community Resilience Innovation Team, which shall hereinafter be referred to as the Resilience Innovation Team. The purpose of the Resilience Innovation Team will be to integrate community resilience concepts and considerations into the planning, regulations, and operations of the Coastal County government.

Section 2.2 – Membership and Organization.

Section 2.2.1 – Members.

The Resilience Innovation Team shall be composed of the following representatives of County departments and members of the community:

1. Chief Code Enforcement Officer
2. Community Resilience Officer
3. Emergency Manager
4. Floodplain Manager
5. Planning Director

The job titles listed here are illustrative only. They are only meant to indicate the roles and responsibilities that are important to have in the discussion. If these jobs are titled differently, consolidated, or nonexistent in the community, that should not preclude a community from adopting this ordinance and adapting this section to its needs.

Consider creating a position that focuses on resilience issues if such a position does not currently exist.

6. Public Works Director
7. Stormwater Manager
8. Geographic Information Systems Administrator
9. Parks and Open Space Manager
10. County Attorney
11. University Extension Agent (and/or other outreach and communication personnel)
12. [ADD ADDITIONAL MEMBERS AS DESIRED]

These roles and responsibilities (8–11) are potentially useful to the functioning of the team, and they should be included if it is deemed useful by the community.

The local government's legal representative would be a valuable addition, though this probably makes more sense for communities with an attorney on staff rather than a contract position due to coordination and expense issues.

Section 2.2.3 – Additional Members.
Additional members may be added to the Resilience Innovation Team as needed and the Resilience Innovation Team's discretion on either a permanent or temporary basis.

Section 2.2.3 – Coordinator.
The membership of the Resilience Innovation Team shall select a Coordinator. The Coordinator shall be responsible for the scheduling and organization of all Innovation Team meetings.

Section 2.2.4 – Meetings.
The Coordinator shall schedule regular meetings for the Resilience Innovation Team. Meetings shall be held at regular intervals as determined by the Innovation Team members, but it shall meet no less frequently than once every three months.

Section 3 – Functions.

The Resilience Innovation Team shall perform the following tasks:

Section 3.1 – Develop community resilience targets and goals.

Section 3.1.1 – Develop community resilience goals and targets.

The Resilience Innovation Team shall develop interim and long-term goals and targets for the County to meet as it works to improve community resilience.

Resilience goals should reflect the long-term vision and general goals for the community and examine how community resilience supports the existing goals and how those goals affect the resilience of the community.

More specific numeric targets should be developed based on the data review and assessment conducted as part of Sec. 3.3 below. These targets should be specific and quantifiable, and they may be independent resilience metrics or reflect the numeric or quantifiable aspects of the general goals set by the Resilience Innovation Team.
The Resilience Innovation Team shall also develop a timeline for achieving the goals and targets it develops.

These goals and targets shall define the metrics the County will use to determine its progress toward meeting those specific goals as well as metrics for improving community resilience, and therefore they shall be based on the community priorities described in existing plans and on input from community elected officials and the community at large.

The Resilience Innovation Team shall use the best available science and data to set the goals and targets, and it may consult with subject matter experts as necessary to inform these goals and targets.

Members should include key county staff positions that have decision-making authority in county departments and concerning the relevant issues needed to comprehensively consider the resilience concepts laid out on the Resilience Guide. Supervisors and department heads may delegate responsibilities of this group, but the delegates should either have decision-making authority on their own and/or have regular consultations with the supervisor who does.

It should also include representatives of cities in the county or that have a significant impact on the vulnerabilities of the county – IF they have an interest in promoting community resilience on a larger scale.

Similarly, community members representing important constituencies such as the environmental community, engineering, or the building industry should be included if they are supportive of the mission of the group. However, it is important that the Resilience Innovation Team activities focus on county decisions and operations and do not get conflated with the missions of other groups.

Section 3.1.2 – Submit goals and targets to the Board of Commissioners of Coastal County.

The goals and targets developed by the Resilience Innovation Teams shall be submitted to the Board of Commissioners of Coastal County for adoption. If the Board does not adopt the goals and targets as presented, the Resiliency Innovation Team shall make such changes as necessary and present the modified goals to the Board for adoption.

Section 3.2 – Identify opportunities for resilience projects.

The Resilience Innovation Team shall develop an initial list of projects and activities to improve community resilience. These projects should prioritize the development of green and natural infrastructure as described in the CRD Community Resilience Guide or improvements to community practices, policies, or operations that will advance the county's progress toward achieving the goals and targets adopted by the Board of Commissioners or otherwise enhance community resilience. For each item, this list of projects will:

A. Identify a group member to oversee project implementation,
B. Identify other partners necessary to complete the project, including other Resilience Innovation Team members and others not in the group including parties that are not part of the local government,
C. Include a general timeline for implementation,
D. Estimate funding needed, when possible, and
E. Identify potential sources of outside funding or strategies to developing funding, when applicable.

Progress on implementing these projects shall be included in the Resilience Innovation Team's annual progress report to the Board of Commissioners, discussed in Section 3.10.

Section 3.3 –Policy andpractices review.

Where members of the Resilience Innovation Team do not have requisite authority to make the necessary changes to remove the identified barriers, the Resilience Innovation Team shall submit the proposed changes to the Coastal County Board of Commissioners.

Section 3.3.1 – Audit policies and practices to identify barriers to achieving resilience goals and targets.
Members of the Resilience Innovation Team shall collaboratively review local laws, policies, and practices to identify barriers to the use of green and natural infrastructure practices in both public and private projects.

Section 3.3.2 – Make changes to policies and practices.
When in the best interests of the county, members of the Resilience Innovation Team will make such changes as are necessary to help the county achieve the goals and targets adopted by the Board of Commissioners.

Section 3.3.3 – Develop local incentive programs for use of green and natural infrastructure.
When the Resilience Innovation Team identifies opportunities to better promote local implementation of nature-based or green infrastructure that will improve community resilience or otherwise promote community resilience through private action or on private property, the Team should consider how the county could better incentivize those actions through the County's policies and practices. The Resilience Innovation Team should develop and implement such incentive programs as appropriate or submit such programs to the Coastal County Board of Commissioners where appropriate.

Section 3.4 – Incorporate data about future environmental and climate scenarios into current decision-making, planning, and operations.

If the changes are something that can be approved at the staff level, but the relevant staff member is not a regular member of the Resilience Innovation Team, the relevant staff member can be considered part of the group to take the necessary actions – i.e., any staff-level decision should be able to be handled in this way.

Section 3.4.1 – Data Review.
The Resilience Innovation Team shall review available data concerning environmental quality, future climatic conditions, and potential impacts to local community resilience. The Resilience Innovation Team may consult with university experts and state and federal authorities as appropriate to collect, analyze, and utilize the available data and ensure that the data are being interpreted correctly.

Section 3.4.2 – Future planning scenario selection.
The Resilience Innovation Team shall select one or more future climate scenarios to utilize for community resilience planning. The future scenarios selected shall be used wherever appropriate in community planning activities, such as the local Comprehensive Plan, the Disaster Recovery and Redevelopment Plan, the Hazard Mitigation Plan, and other such plans. As additional data become available, the Team may change the operative future scenario it uses for planning purposes as it deems appropriate.

Section 3.4.3 – Future construction scenarios.
The future scenarios selected by the Resilience Innovation Team shall also be used to develop standards for future public buildings and infrastructure investments. Buildings and other investments shall be designed and built to ensure the appropriate level of safety for the duration of the expected useful life of the building or the infrastructure. The level of safety provided should reflect the significance of the building or other infrastructure to the overall resilience of the community.

For example, a fire station should be built to a higher standard of safety than a park.

Section 3.4.5 – Data development plan.
To the extent locally relevant data about future climate impacts or present or future community resilience are not available, the Resilience Innovation Team shall develop a plan to acquire that data. This includes physical data about local infrastructure, environmental conditions, as well as social, economic, demographic, or other such data.

Recognizing the important role social and demographic considerations play in determining a community's resilience and vulnerability, the data development plan shall address the appropriate scale and metrics by incorporating considerations of "social vulnerability" into its activities under this code section and other community resilience efforts.

The data development plan may include the use of county personnel and resources, outside partnerships with universities, nongovernmental groups, or federal agencies; or the use of private-sector partnerships or contractors as appropriate.

The data development plan shall include goals and milestones that shall be included in the Resilience Innovation Team's annual progress report to the Board of Commissioners, discussed in Section 3.10.

Section 3.5 – Ensure community resilience projects and programs address needs of underserved and socially vulnerable communities.

In all of its activities under this ordinance and in other efforts to plan for community resilience, the Resilience Innovation Team and its members in their individual professional capacities shall consider the particular social and economic vulnerabilities of the residents of Coastal County to ensure that particularly vulnerable communities and traditionally underserved communities are included in the efforts to improve community resilience.

Section 3.6 – Promote public awareness of community resilience issues.

Because public involvement and public understanding of community resilience is critical to successfully developing a more resilient community, the Resilience Innovation Team shall consider how to promote its activities to the residents of Coastal County and engage them as appropriate in the formulation of new policies and practices or

changes to existing policies and practices to ensure that these actions are addressing the immediate and long-term needs of the community.

Messaging and communication efforts that promote better hazard preparation designed and promulgated by state and federal partners such as the Georgia Emergency Management and Homeland Security Agency, the Coastal Resources Division of the Georgia Department of Natural Resources, and the Federal Emergency Management Agency, and those from similar partners should be incorporated into local communication and public education efforts.

Section 3.10 – Provide annual progress reports to the Board of Commissioners.

At least once per calendar year, the Resilience Innovation Team shall present an update to the Coastal County Board of Commissioners concerning its efforts to improve community resilience. This update shall include a progress report on goals and targets, the implementation of resilience projects, data development, potential matters that may be submitted to the Board in the coming year, as well as such other information as requested by the Board or which is necessary for the Board to assess the progress of the Resilience Innovation Team.

Sec. 11 – Severability.

If any section of this code section is declared unconstitutional or otherwise invalidated by any court of competent jurisdiction, then it is expressly provided that the remaining portions of this section that are not so invalidated are severable and shall remain in full force and effect.

Additional Resources

Anderson, Linda M., and Harold K. Cordell. 1988. Influence of trees on residential property values in Athens, Georgia (U.S.A.): A survey based on actual sales prices. *Landscape & Urban Planning* 15(1/2), 153.

Branas, Charles C., Rose A. Cheney, John M. MacDonald, Vicky W. Tam, Tara D. Jackson, and Thomas R. Ten Have. 2011. A difference-in-differences analysis of health, safety, and greening vacant urban space. *American Journal of Epidemiology* 174(11), 1296–1306. doi.org/10.1093/aje/kwr273

Cao, Xin, Akio Onishi, Jin Chen, and Hidefumi Imura. 2010. Quantifying the cool island intensity of urban parks using ASTER and IKONOS data. *Landscape and Urban Planning* 96, 224–231. doi.org/10.1016/j.landurbplan.2010.03.008

Environmental Protection Agency. (2014). *Green infrastructure and climate resiliency*. EPA Pub No. 832F14007. Retrieved from www.epa.gov/sites/production/files/2015-10/documents/climate_res_fs.pdf

Environmental Protection Agency. (March 2018). *Storm smart cities: Integrating green infrastructure into local hazard mitigation plans.* EPA Pub. No. 903-K-18001. Retrieved from epa.gov/sites/production/files/2018-04/documents/storm_smart_cities_508_final_document_3_26_18.pdf

Espey, Molly, and Kwame Owusu-Edusei. 2001. Neighborhood parks and residential property values in Greenville, South Carolina. *Journal of Applied and Agricultural Economics* 3, 487.

Firehock, Karen. 2015, February. *Evaluating and conserving green infrastructure across the landscape: A practitioner's guide.* Charlottesville, VA: Green Infrastructure Center.

Heckert, Megan, and Jeremy Mennis. 2012. The economic impact of greening urban vacant land: A spatial difference-in-differences analysis. *Environment and Planning A: Economy and Space* 44(12), 3010–3027.

Jacob, John S., and Ricardo Lopez. 2009. Is denser greener? An evaluation of higher density development as an urban stormwater-quality best management practice. *Journal of the American Water Resources Association* 45(3), 687–701. doi.org/10.1111/j.1752-1688.2009.00316.x

Kim, Jinki. 2018. Exploring green infrastructure benefits at house and neighborhood scale: Case study of Illinois, USA. *Landscape & Ecological Engineering,* 14(1), 165–174. doi.org/10.1007/s11355-017-0331-0

Liberty Consolidated Planning Commission. 2016, October. Using our past to build our future: 2040 Joint Comprehensive Plan Liberty County, Allenhurst, Flemington, Gum Branch, Hinesville, Midway, Riceboro, Walthourville. Retrieved from thelcpc.org/wp-content/uploads/2013/08/1.11.17-CP-optimized.pdf

Loperfido, J. V., Gregory B. Noe, S. Taylor Jarnagin, and Dianna M. Hogan. 2014. Effects of distributed and centralized stormwater best management practices and land cover on urban stream hydrology at the catchment scale. *Journal of Hydrology* 519(Part C), 2584–2595. doi.org/10.1016/j.jhydrol.2014.07.007

McPherson, E. Gregory, James R. Simpson, Qingfu Xiao, and Chunxia Wu. 2011. Million trees Los Angeles canopy cover and benefit assessment. *Landscape and Urban Planning,* 99, 40–50. doi.org/10.1016/j.landurbplan.2010.08.011

Onishi, Akio, Xin Cao, Takanori Ito, Feng Shi, and Hidefumi Imura. 2010. Evaluating the potential for urban heat-island mitigation by greening parking lots. *Urban Forestry & Urban Greening* 9, 323–332. doi.org/10.1016/j.ufug.2010.06.002

Shaver, Earl, Richard Horner, Joseph Skupien, Chris May, and Graeme Ridley. 2007. *Fundamentals of urban runoff management: Technical and institutional issues.* 2nd Edition. Madison, WI: North American Lake Management Society.

Wisconsin Sea Grant. n.d.. *Tackling barriers to green infrastructure.* Retrieved from seagrant.wisc.edu/Home/Topics/CoastalCommunities/Details.aspx?PostID=2462

ENDNOTES

[1] Susan L. Cutter, Kevin Ash, and Christopher Emrich. 2014. The Geographies of Community Disaster Resilience. *Global Environmental Change* 29, 65–77. In the original ecological context, resilience referred to returning to a pre-impact state, but in the community context, an element of adaptation and improvement has been added—"bouncing forward, not merely bouncing back."

[2] Cutter et al., 2014.

[3] US Environmental Protection Agency. 2018, March. *Storm Smart Cities: Integrating Green Infrastructure in Local Hazard Mitigation Plans.* EPA 903-K-18-001.

[4] Coastal Stormwater Supplement to the Georgia Stormwater Management Manual, First Edition, 2009, pp. 1–2.

[5] CSS, pp. 1–2.

[6] US Environmental Protection Agency. 2014, October. *Enhancing Sustainable Communities with Green Infrastructure.* EPA 100-R-14-006.

[7] FEMA. Protection of Openings; Shutters and Glazing, *Home Builder's Guide to Coastal Construction,* Technical Fact Sheet No. 6.2. Retrieved from www.fema.gov/media-library-data/20130726-1537-20490-6588/fema499_6_2.pdf.

[8] FEMA. 2011, August. *Coastal Construction Manual, Principles and Practices of Planning, Siting, Designing, Constructing, and Maintaining Residential Buildings in Coastal Areas. 4th Edition.* FEMA P-55, Volume I. Retrieved from www.fema.gov/media-library-data/20130726-1510-20490-2899/fema55_voli_combined.pdf.

[9] FEMA*, 2011, Coastal Construction Manual*, Section 4-1.

[10] Mark Benedict and Edward McMahon. 2006. *Green Infrastructure: Linking Landscapes and Communities.* 2nd edition. Washington, DC: Island Press.

[11] This idea of aligning stormwater planning across different community development types is derived from a concept taken from the urban planning literature and practice known as the "urban transect model." This model recognizes that instead of just considering what different properties are used for, the spatial arrangement and physical form of the different areas that make up a community have to be considered in planning for the future of that community. Bruce K. Ferguson. 2016. Toward an Alignment of Stormwater Flow and Urban Space. *Journal of the American Water Resources Association*, 52(5), 1238–1250. Retrieved from doi.org/10.1111/1752-1688.12449; John Jacob. 2011, January 1. Watersheds, Walkability, and Stormwater: The Role of Density. *Forest Network.* Retrieved from forestnetwork.com/daily/water/watersheds-walkability-and-stormwater/email/; Adres Duany and Emily Talen. 2002. Transect Planning. *Journal of the American Planning Association* 68(3), 245–266. For information about its adaptation into a "green infrastructure transect framework" developed to talk about the use of green infrastructure in planning for climate change adaptation, see the following: Yaser Abunnasr and Elisabeth M. Hamin. 2012. The Green Infrastructure Transect: An Organization Framework for Mainstreaming Adaptation Planning Policies. In K. Otto-Zimmermann (ed.). *Resilient Cities 2.* Springer Science+Business Media B.V..

[12] US Environmental Protection Agency. 2018, March. *Storm Smart Cities: Integrating Green Infrastructure in Local Hazard Mitigation Plans.* EPA 903-K-18-001.

[13] Ferguson, 2016.

[14] John S. Jacob and Ricardo Lopez. 2009, June. Is Denser Greener? An Evaluation of Higher Density Development as and Urban Stormwater-Quality Management Practices. *Journal of the American Water Works Association*, 45(3).

[15] Jacob and Lopez, 2009.

[16] Ferguson, 2016.

[17] Jacobs, 2011.

[18] The US Census reports that the US population in 1949 was little over 149 million people. In 2019, it was estimated to be over 328 million, which is an increase of 220%.

[19] The USDA estimates that urban land use increased from approximately 18 million acres in 1949 to almost 70 million acres in 2012, the last year estimates are available, which is an increase of 388%.

[20] Scott Beck, Melissa McHale, and George Hess. 2016. Beyond Impervious: Urban Land-Cover Pattern Variation and Implications for Watershed Management. *Environmental Management* 58; 15–30.

[21] Ferguson, 2016. 9

[22] Beck et al., 2016.

[23] CSS Sec. 1.1

[24] Environmental Protection Agency. 2018. *A Guide to Integrate Green Stormwater Infrastructure into Local Hazard Mitigation Planning*. Retrieved from www.epa.gov/sites/production/files/2018-04/documents/storm_smart_cities_508_final_document_3_26_18.pdf.

[25] EPA, 2018, *A Guide to Integrate*, p. 9.

[26] Section 322 of the Stafford Act; 44 CFR §201.6 Local Mitigation Plans.

[27] The National Flood Insurance Program, *About the National Flood Insurance Program: Overview*, www.floodsmart.gov/floodsmart/pages/about/nfip_overview.jsp. The NFIP requirements are in the Code of Regulations, 44 CFR Parts 59 and 60.

[28] NFIP.

[29] Federal Emergency Management Agency, National Flood Insurance Program, *Community Rating System Coordinator's Manual*, 110-1 (FIA-15/2013). [Hereinafter "CRS Manual"].

[30] CRSResources.org, Impact Adjustment Maps, https://crsresources.org/files/guides/crs-impact-adjustment-maps.pdf.

[31] CRS Manual 410-1.

[32] CRS Manual 430-33.

[33] Including sea level rise in WMP is required for coastal communities to meet the Class 4 prerequisite, and HSS credit for future-conditions hydrology is a Class 1 prerequisite.

[34] CRS Manual 110-15.

[35]Georgia's Statewide Nonpoint Source Management Plan 2019 Update, Georgia Department of Natural Resources Environmental Protection Division, available at: https://epd.georgia.gov/watershed-protection-branch/nonpoint-source-program

[36] See coastalgadnr.org/GGG

[37] USGS. 2010, April. *100-Year Flood—It's All About Chance,* General Information Product. Retrieved from pubs.usgs.gov/gip/106/pdf/100-year-flood-handout-042610.pdf.

[38] National Oceanic and Atmospheric Administration. 2019. *Is Sea Level Rising?* Retrieved from oceanservice.noaa.gov/facts/sealevel.html.

[39] National Oceanic and Atmospheric Administration. 2017. *Global and Regional Sea Level Rise Scenarios for the United States*. NOAA Technical Report NOS CO-OPS 083. Retrieved from tidesandcurrents.noaa.gov/publications/techrpt83_Global_and_Regional_SLR_Scenarios_for_the_US_final.pdf.

[40] National Oceanic and Atmospheric Administration. 2018, February. *Patterns and Projections of High Tide Flooding along the U.S. Coastline Using A Common Impact Threshold.* NOAA Technical Report NOS CO-OPS 086 noaa. Retrieved from tidesandcurrents.noaa.gov/publications/techrpt86_PaP_of_HTFlooding.pdf.

[41] NOAA, 2018.

[42] Carter, L., A. Terando, K. Dow, K. Hiers, K.E. Kunkel, A. Lascurain, D. Marcy, M. Osland, and P. Schramm. 2018: Southeast. In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 743–808. doi: 10.7930/NCA4.2018.CH19, https://nca2018.globalchange.gov/chapter/southeast.

[43] CRS Manual 400-14, *Sea Level Rise Projections and the CRS.*

[44] NOAA, 2017.

[45] CRS Manual 110-15, 320-11.

[46] CRS Manual 340-2.

[47] CRS Manual 340-10.

[48] CRS Manual 410-2.

[49] CRS Manual 410-18.

[50] CRS Manual 410-21.

[51] Development is prohibited in the floodway unless it can be demonstrated that such development causes no rise in base flood elevations. For more information, see Association of State Floodplain Managers, *CRS for Community Resilience*, 412.e. More Restrictive Floodway Standard, www.floodsciencecenter.org/products/crs-community-resilience/element-profiles/412-e-restrictive-floodway-standard.

[52] See note 53.

[53] FEMA, State CRS Summary: Georgia (2012).

[54] CRS Manual 420-12.

[55] CRS Manual 420-20.

[56] Additional credit is provided if the parcel is included in a plan to protect natural functions eligible for credit under Activity 510 (Floodplain Management Planning); if the parcels are part of a designated corridor or connected network plan; and/or if educational materials describing the site's natural functions are provided.

[57] CRS Manual 420-19.

[58] CRS Manual 420-20.

[59] CRS Manual 410-24 ("erosion reference features are generally set by states' coastal management programs, and commonly include first lines of vegetation, crests or toes of dunes, edges of bluffs, or mean high water lines").

[60] Specifically, Coastal Erosion Open Space Credit Criteria require the following: (1) The area must be seaward of an area that is eroding at a rate greater than or equal to 1.5 feet per year. (2) The area must qualify for OSP credit. (3) The community must earn at least 25 points for mapping coastal erosion hazard areas in Section 412f. (4) The community must receive at least 10 points for keeping maps updated in Section 442d. (5) The community must receive at least 20 points for its coastal erosion regulations in Section 432n. CRS Manual 420-20 (2017).

[61] Credit is calculated based on the length of the shoreline protected or restored divided by the length of shoreline in the community as shown on the Natural Shoreline Protection Impact Adjustment Map. Channel shoreline is measured on each side of the channels, and protection or restoration may be counted on only one side or on both sides. Credit is counted in developed and undeveloped areas as well as in open space preservation credited areas. If less than 10% of the community's channels or shoreline are affected, a factor of 0.1 can be used. CRS Manual 420-20.

[62] Setback or buffer requirements can also receive credit under 422a.

[63] Coastal Regional Commission. 2010. Model Ordinance for Planned Unit Developments.

[64] CRS Manual 420-26.

[65] CRS Manual 430-2.

[66] CRS Manual 430-6.

[67] CRS Manual 430-7.

[68] CRS Manual 430-7.

[69] No Adverse Impact. 2017. *NAI How-To Guide for No Adverse Impact Regulations and Standards*. Retrieved from www.floods.org/ace-images/ASFPMRegulationsGuideApril2017.pdf.

[70] Liberty County, GA, Buildings, Construction and Related Activities, Chapter 8, Article III, Sec. 8-152 (2019).

[71] CRS Manual 430-11.

[72] CRS Manual 430-13.

[73] Chatham County Flood Damage Prevention Ordinance, 24-118(1)(2018).

[74] CRS Manual 430-16.

[75] CRS Manual 430-18.

[76] CRS Manual 430-21.

[77] CRS Manual 430-26.

[78] Georgia State International Building Code, Appendix N, Disaster Resilient Construction (2012 Ed.). Retrieved from www.dca.ga.gov/sites/default/files/2013_drbc_ibc_appendixn.pdf.

[79] See 2017 Florida Building Code, 6th ed., Chapter 24 Glass and Glazing, Sec. 2413, High-Velocity Hurricane Zones – Storm Shutters/External Protective Devices, codes.iccsafe.org/content/FBC2017/chapter-24-glass-and-glazing#FBC2017_Ch24_Sec2413.

[80] CRS Manual 430-32.

[81] CRS Manual 430-37.

[82] CRS Manual 430-48.

[83] Liberty County, GA, Appendix A – Zoning, Article IV, 4.1 (2019).

[84] Association of State Floodplain Managers. *CRS for Community Resilience, 412.c. Erosion and Sediment Control Regulations*. Retrieved from www.floodsciencecenter.org/products/crs-community-resilience/element-profiles/452-c-erosion-sediment-control-regulations/.

[85] CRS Manual 510-30.

[86] CRS Manual 520-2.

[87] CRS Manual 520-2.