NORTH CAROLINA
RESILIENT COASTAL COMMUNITIES PROGRAM

# CAPE CARTERET

Final Deliverable - **Resilience Strategy**

**MAY 2022**

Dewberry


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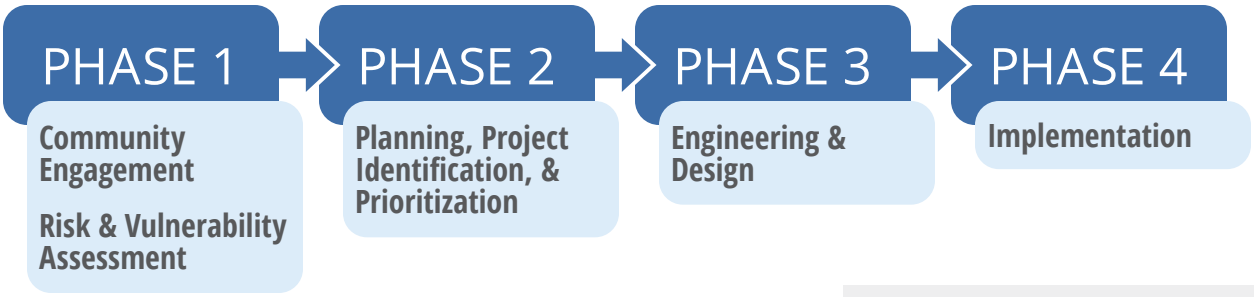
# SUMMARY

The Resilient Coastal Communities Program (RCCP) is a grant program administered by the North Carolina Division of Coastal Management (NCDCM). The program objectives are to address barriers to coastal resilience in North Carolina, to assist communities in the preparation of risk and vulnerability assessments and the development of projects to address community risks, to advance coastal resilience projects to construction, and to link communities to funding streams for project implementation. The RCCP emphasizes the identification of, and outreach to, traditionally underserved communities. It also emphasizes the incorporation of natural or nature-based solutions (NNBS) to address community vulnerabilities. As of May 2022, the first two phases of the RCCP are underway, with two additional phases scheduled to begin later in 2022 and subsequent years. The phases of the RCCP are illustrated below.




The Town of Cape Carteret, North Carolina was selected for both Phase 1 and Phase 2 of the RCCP in 2021. Phases 1 and 2 of the process included the preparation of a Risk and Vulnerability Assessment, public engagement, and the development of a Project Portfolio to list opportunities to address community vulnerabilities. The entire effort was guided by the input of a Community Action Team (CAT).

Using the Risk and Vulnerability Assessment and knowledge of previous flooding events, the CAT identified areas throughout Cape Carteret at risk for flooding. While flooding from major storm events such as hurricanes and tropical storms cause damage to private properties and community infrastructure, more frequent, heavy rainfall events also impact these areas. Based on feedback from the community and the CAT, an inventory and analysis of the Town's existing stormwater facilities were determined as critical to identifying strategic projects to address current flooding issues. However, long-term strategies to protect the natural environment were also cited as important to meet future resiliency needs.

Ultimately, the CAT identified nine projects for the RCCP project portfolio, which may be implemented under later phases of the RCCP or under other federal, state, or local resilience programs. The enclosed report provides a more in-depth look at the RCCP process and the major outcomes of the effort.

## Project Portfolio Focus

- **Stormwater Facility Improvements**
- **Stormwater Infrastructure Mapping**
- **Stormwater Pretreatment**
- **Living Shoreline Construction**
- **Tree Canopy Replacement**

# I. Vision and Goals

Cape Carteret is bordered by Bogue Sound to the south and, Pettiford Creek to the north, with Deer Creek bisecting the southern section of the Town before flowing into Bogue Sound. As a result of the Town's proximity to the water as well as the low topography, Cape Carteret experiences flooding from storm surge, higher than usual tides (King Tides), riverine, and heavy rainfall events. Based on input from the Community Action Team (CAT), Cape Carteret's vision is to develop environmentally friendly projects to build resiliency to protect both and life and property from the events that can cause frequent flooding. To meet this vision, community goals include developing an environmentally friendly stormwater infrastructure, producing shovel-ready plans to address current and future stormwater infrastructure needs, accommodating growth, educating the community on coastal flooding hazards, and ensuring improvements have minimal impacts to the natural and coastal environment.

## Community Vision

*To develop environmentally friendly projects to build resiliency to protect both life and property from the events that can cause frequent flooding.*

# II. Community Action Team (CAT)

The Resilient Coastal Communities Program (RCCP) process requires each community to establish a multi-disciplinary CAT composed of diverse stakeholders to provide input throughout the process and to engage the community. Under-represented communities should be reflected in the CAT and in community engagement efforts. Cape Carteret's CAT was established through input from Town staff and is listed in **Table 1**.

CAT meetings were held in September 2021 as well as January and March 2022; a summary of each meeting is included in **Appendix A**. The CAT membership included Town staff and community members with a range of experience, and each provided insight on historic hazard planning efforts and current infrastructure needs. During initial discussions, the CAT noted previous damage and issues caused by flooding from storm surge, extreme high/King Tides, and sea level rise. Access to major services can be cut off during major storm events. There are several locations where frequent flooding occurs mainly due to a lack of adequate

**TABLE 1: COMMUNITY ACTION TEAM**

| NAME | POSITION |
|---|---|
| Will Baker | Mayor |
| Zach Steffey | Town Manager |
| Heather Leffingwell | Town Clerk |
| Ryan Hutchinson | Public Works |
| David Figowy | Community Member |
| Erik Heden | National Oceanic and Atmospheric Administration (NOAA) |

stormwater system devices (maintained ditches and swales, right-sized culverts). Other concerns noted included private homes using septic tanks that can overflow and degrade water quality, the need for an adequate shelter, and the wastewater treatment plant that handles commercial development does not have a backup generator. Wind damage and tree loss following storm events were also cited as community concerns. Several possible solutions to meet these needs were listed as a starting point for the Town's RCCP project portfolio. Since the RCCP process was underway at the same time as the new CAMA Land Use Plan (CAMA LUP) update, findings from the CAMA LUP can also inform development of the project portfolio.

Cape Carteret typically uses community events to engage the public in various efforts that need public input, and the CAT provided recommendations on several events that could be utilized for public engagement. Additional public involvement recommendations included providing materials to local businesses and the use of virtual options (online surveys, etc.); public events can be advertised using the existing Town email listserv, if available. The public engagement effort is detailed in **Section III**.

The CAT provided recommendations on the initial draft of the Risk and Vulnerability Assessment, specifically noting road segments that were not included in the initial findings. Additional materials to consider in the assessment were provided for further analysis, as discussed in **Section V**.

Following the public engagement process, the CAT reviewed the public feedback and provided recommendations for the final project portfolio. As discussed in **Section VI**, stormwater facility improvements, infrastructure mapping, and stormwater treatment projects were identified as top community priorities; additional projects to include living shoreline construction and tree canopy replacement were also recommended for implementation.

# III. Stakeholder Engagement Strategy

The stakeholder engagement approach expanded upon previous community experience with the CAMA Core Land Use Plan and other Town planning efforts. The approach included attendance at festivals and community events that draw the community out for fun in place of traditional public meeting events. Public engagement efforts included attendance at the Fall Festival in November 2021 and a St. Patrick's Day Food Truck Rodeo on March 17, 2022. Additionally, Cape Carteret posted an online survey to the Town's website and provided a QR code residents could use to access the survey on mobile devices to ensure a virtual option was available for their more vulnerable population or those whose schedules did not allow them to attend events in the evenings or weekends. A copy of the survey and other public engagement materials is included in **Appendix B**.

Community interest in the RCCP was high, as evidenced from the survey responses and input from the input received at the community events. In total, 45 responses to the survey were received. Flooding was the major concern noted by respondents, who recommended projects that would facilitate infrastructure repair and power restoration after major events. However, stormwater management upgrades were the most recommended ways to address coastal hazards, along with additional recommendations to elevate flood prone homes and to implement natural or nature-based solutions. Respondents noted locations throughout the Town for recommended stormwater management upgrades, with the results consistent with previous CAT input.


# IV. Review of Existing Local and Regional Plans

Cape Carteret participated in the Pamlico Sound Hazard Mitigation Plan efforts in 2015 and 2020. However, risk and vulnerability at the Town level has not been recently assessed. The Town is currently working on an update to the previous (2007) CAMA Core Land Use Plan. **Table 2** summarizes existing plans and ordinances the Town has adopted.

**TABLE 2: EXISTING LOCAL AND REGIONAL PLANS**

| YEAR | TITLE | DESCRIPTION |
|---|---|---|
| 2003 | Cape Carteret Town Ordinances, Title XV, Chapter 151 | Code requirements aimed at minimizing losses due to flooding, including special requirements for known floodplains. |
| 2007 | Cape Carteret CAMA Core Land Use Plan | Addresses land use issues such as natural hazard areas, water quality, and areas of environmental and local concern. |
| 2012 | Carteret County Comprehensive Transportation Plan | Identifies transportation needs and recommendations for addressing those needs. |
| 2014 | Cape Carteret Strategic Plan | Defines Town's vision for the future and acts as a guide to keep the Town economically viable and competitive while maintaining its character. |
| 2017 | Hurricane Matthew Resilient Redevelopment Plan for Carteret County | Identifies county-wide needs for recovery and redevelopment from Hurricane Matthew. |
| 2019 | Carteret County Emergency Operations Plan | An all-hazards plan defining Carteret County response to significant incidents or events. |
| 2020 | Pamlico Sound Hazard Mitigation Plan | Includes hydrology data, demographics, housing characteristics, and land development trends for Beaufort, Carteret, Craven, and Pamlico Counties. Contains risk assessment and goals and objectives for mitigation strategy. |

Carteret County's Comprehensive Plan Update was initiated in 2019, with an expected completion in 2022.

# V. Risk and Vulnerability Assessment Report

As outlined in the RCCP Handbook (June 2021), a risk and vulnerability assessment was conducted to evaluate the susceptibility of the Town's critical built and natural infrastructure to coastal hazards. Previous studies dealing with vulnerability and risk and/or highlighting critical assets were used as a starting point for the assessment. Process steps included the following:

- Identify and Map Hazards
- Assess Vulnerability
- Estimate Risk

The results of the risk and vulnerability assessment are summarized on the following pages, and the full report is included in **Appendix C**.

## Critical Built Infrastructure

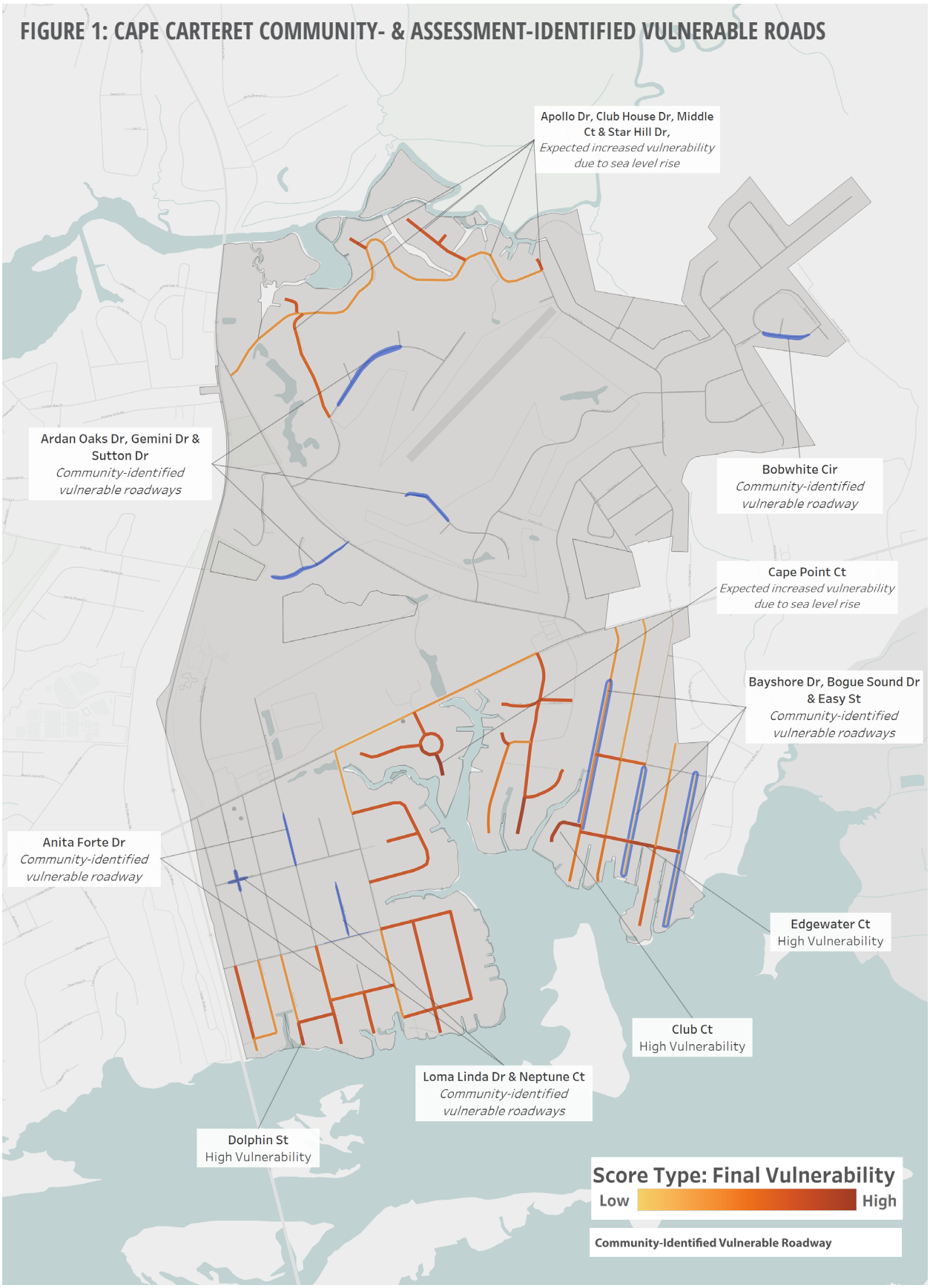
Critical built infrastructure includes the physical structures that house or perform essential functions to maintain government operations along with economic and human health and safety. The initial assessment found that approximately 42% of all road segments, totaling 11 miles, are exposed to coastal or riverine flooding today and/or in the future; none of Cape Carteret's building-level assets were exposed based on the analysis (Figure 1). Of exposed assets, the built infrastructure most vulnerable to coastal hazards are the roadways adjacent to Bogue Sound. These findings confirm previous assessment results. Due to limited data, this assessment does not include stormwater flooding. The vulnerability of assets to stormwater flooding is included qualitatively based on input from the CAT.

Of exposed roadways, approximately 39% experience moderate-high or high vulnerability. Many of these roadways were previously identified by the CAT as problem areas, including Anita Forte Drive, Club Court, Dolphin Street, Edgewater Court, Holly Lane, and Live Oak Drive. These roadways, as well as others in Cape Carteret, likely also experience stormwater flooding, which is not captured in the overall assessment due to limited data. Additional roadways identified as vulnerable to stormwater flooding based on past experience include Bogue Sound Drive, Gemini Drive, Neptune Drive, Quailwood Court, Starlight Drive, and Sutton Drive.

The assessment identified several roadways as vulnerable that do not currently experience flooding, but are expected to in the future due to sea level rise. In the future, roadways exhibiting the highest increases in vulnerability include segments of Anita Forte Drive, Club House Drive, Kear Drive, and Park Avenue. Other roadways facing increased vulnerability include known problem areas like Edgewater Court, Lejeune Road, Star Hill Drive, and WB McLean Drive (NC 24).

Social vulnerability factors into determining an asset's risk because communities with high social vulnerability are more likely to experience adverse impacts. Based on the CDC SVI, Cape Carteret exhibits low social vulnerability relative to the State of North Carolina.

## FIGURE 1: CAPE CARTERET COMMUNITY- & ASSESSMENT-IDENTIFIED VULNERABLE ROADS



## FIGURE 2: CAPE CARTERET VULNERABLE NATURAL INFRASTRUCTURE

## Natural Infrastructure

To assess the vulnerability of natural infrastructure, this assessment leveraged NOAA's Sea Level Affecting Marshes Model (SLAMM) to identify changes in marsh land cover. SLAMM effectively incorporates a habitat's exposure, sensitivity, and adaptive capacity into one metric: projected habitat loss to open water due to sea level rise.

Existing natural infrastructure in Cape Carteret primarily consists of tidal and non-tidal wetlands along the Bogue Sound and Pettiford Creek and some upland habitat north of WB McLean Drive (NC 24) and unconsolidated shores in Bogue Sound.

By 2050, Cape Carteret is projected to lose approximately 75 acres of natural infrastructure to open water, with tidal wetlands and unconsolidated shores (including sandy beaches and tidal mudflats) along the Bogue Sound projected to experience the most significant impacts (Figure 2).

Roughly 51 of the existing 102 acres of tidal wetlands are expected to be lost to open water, a habitat loss of nearly 50%. Practically all unconsolidated shore habitat is expected to be lost to open water under future conditions.

# VI. Project Portfolio

Utilizing input from the Risk and Vulnerability Assessment, feedback from the public, and input from the CAT, a list of projects to address specific coastal hazards and recommended locations was developed. The Project Portfolio, detailed in **Appendix D**, lists the following information on each project:

- Project title and description
- Anticipated cost and needs addressed
- Funding status
- Natural or Nature-Based Solution (NNBS) opportunity
- Project timeline and priority

Factors considered in the development of the Project Portfolio include:

- Inclusion of natural or nature-based solutions (included in the RCCP criteria)
- The need(s) addressed and the scope of the project's benefit
- Project implementation timeline (i.e. an emphasis on shovel-ready projects)
- Other potential funding sources for the project
- Community input and support

**Table 3** highlights the top five project priorities included in the Portfolio; the remaining projects are detailed in **Appendix D**.

**TABLE 3: PROJECT SUMMARY**

| PROJECT | DESCRIPTION |
|---|---|
| Stormwater Facility Improvements | Improve stormwater facilities on multiple Town streets, including Sutton Drive, Ardan Oaks Drive, Anita Forte Drive/Loma Linda Court, Dolphin Street, Neptune Drive, Neptune Court, and Bogue Sound Drive. |
| Stormwater Infrastructure Mapping | Map all stormwater infrastructure within Town limits to determine service gaps and needs. |
| Stormwater Pretreatment | Construct stormwater treatment facilities to minimize water quality impacts to Bogue Sound and Pettiford Creek at multiple locations, including Sutton Drive, Ardan Oaks Drive, Anita Forte Drive, Loma Linda Court, Dolphin Street, Neptune Drive, Neptune Court, and Bogue Sound Drive. |
| Living Shoreline Construction | Construct an oyster reef or living shoreline along the Bogue Sound and Deer Creek shoreline. |
| Tree Canopy Replacement | Plant young trees to increase overall tree canopy within the Town and replace trees lost during storm events. |

# VII. Conclusions and Lessons Learned

The RCCP process provided Cape Carteret an opportunity to build upon previous planning efforts and establish a strategic Project Portfolio to guide the Town in applying for project funding. Potential funding sources include Phases 3 and 4 of the RCCP, which funds the engineering and construction, respectively, for projects that meet specific identified community needs. As not all of the projects identified in this process will be eligible for funding under the RCCP, other potential funding opportunities at the federal, state, and local level have been identified to the extent possible.

The initial risk and vulnerability assessment, which used available data on storm events, sea level rise scenarios, roadway vulnerability, and asset condition, did not initially yield the results the CAT expected. Some of the roadway segments known to flood frequently in typical rainfall events were not determined as vulnerable in the quantitative analysis, but were instead noted in a qualitative discussion and considered in the final assessment. However, this analysis gap highlights the need for more robust localized rainfall data in order to model the impacts of these events on community assets.


In addition to infrastructure improvements, the importance of continued public education and community outreach was discussed. The CAT noted that continued community education, building upon the RCCP effort, the CAMA Land Use Plan update, and the National Weather Service StormReady community effort, is critical to educating community residents and business owners on the challenges to be faced due to coastal hazards. A broader public engagement plan, along with targeted outreach to developers, home builders, and the real estate community on the benefits of low-impact development, is included in the Project Portfolio to address continued education needs.

## Acknowledgments

*We would like to thank the Town of Cape Carteret for its efforts associated with the development of this report and the Project Portfolio. In particular, we would like to thank Zachary Steffey, Heather Leffingwell, and the rest of the Community Action Team for their honest feedback on the community's needs and the challenges that have been faced historically in addressing these needs. We also thank Mackenzie Todd of the N.C. Division of Coastal Management for the guidance and insight she provided throughout this process.*

APPENDIX A

# COMMUNITY ACTION TEAM MEETING SUMMARIES

**MAY 2022**

Dewberry

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# CAPE CARTERET CAT MEETING #1 DISCUSSION

**DATE:** September 28, 2021

**TIME:** 4:00 p.m.

**LOCATION:** Virtual (GoToMeeting)

**PURPOSE:** Cape Carteret Community Action Team Meeting Discussion Notes

## Discussion Topics

1. **Community Vision and Goals**

   Existing Vision Statements? N/A

   Vision:

   - Developing environmentally friendly stormwater infrastructure improvements to protect both life and property within the Town of Cape Carteret. (goal vs. vision?)

   Goals:

   - Get shovel-ready plans together to address stormwater infrastructure needs
   - Plan not just for current events, but for future storms (increasing intensity and frequency)
   - Plan for increased population and related infrastructure capacity
   - Communication with the community on likelihood of events and community vulnerability
   - Ensuring improvements or other development has minimal impact to the natural/coastal environment (pre-treatment of stormwater, etc.)

   Other feedback: Primary hazards are storm surge, flooding inundation

2. **Threats/Challenges to Community Resilience:**

   Identified during initial meeting (June 2021): *The Town has many low elevation areas which it would like to address for resiliency. The houses off of **Arden Oaks Drive** are of particular concern because of the flooding that occurred during Florence which required the road to be pumped by the National Guard. The streets ending **south of Edgewater Court**, facing the Sound, were all flooded during Florence. **Bogue Lane** also floods due to storm surge. Rain events lead to flooding on **Anita Forte Drive, Gemini Drive, Starlight Drive, Quailwood Court, and Dolphin Street**. Storms also lead to overtopping at a stretch of **Star Hill Drive** between the ponds and Pettiford Creek. A thunderstorm in June washed out **Bogue Sound Drive from Park Avenue to the Sound**.*

   What should be added to this list?

   - Sutton Drive
   - Loss of trees following storms (Florence) and through development, exacerbating flooding
   - Town egress from all sides due to flooding around town; getting fuel, etc.

   What costs have been associated with these threats? (Includes damage costs from specific weather events, costs of prior improvements to increase resilience, etc.)

   - Tree removal, clearing debris

- Florence is benchmark for worst-case scenario, especially in terms of debris/tree removal
- 5" rain event in 2020, including flooding and property damage; resulting addition of impervious surfaces limits ability to absorb rainfall
- Street debris impacts ability of emergency services to respond to 911 calls, events

Of these challenges, which are the most important (or have the most impact) to the overall community?

- Flooding events, storm surge inundation
- Wind damage, tree destruction (loss of tree canopy)
- Impassible roads following events, impacts to public safety
- Following storm events, impacts to water quality, including runoff, septic tank damage; impacts within coastal marsh (throughout the county)
- No dedicated shelter in this part of the county; anticipate this being addressed by county- new elementary school gym intended to address.

Other feedback:

3. **Community Engagement Strategy:**

What techniques (in-person meetings, virtual options) have been the most effective at getting feedback?

- Fall Festival on November 6, likely several thousand to attend; use a tent
- Christmas in the Cape in December
- Work with businesses in town to provide maps/surveys

If in-person, are drop-in events or formal presentations preferred?

- Outdoor events provide good engagement
- Can also use town's email listserv
- Monthly video update (announced through listserv and social media)
- Have held stand-alone events, weren't well attended
- Typically receive comments following storm events re: damage severity, etc.

What strategy do you recommend for this effort? Are there upcoming efforts/events that we can partner with on community outreach?

Other feedback:

- If using virtual option, provide information as soon as possible; have used paper surveys, QR codes, email notices, etc.

## Action Items

| ACTION ITEM | ASSIGNED TO | DATE DUE | STATUS |
|---|---|---|---|
| Schedule Public Engagement event/prepare online survey #1 | Dewberry | 10/15/21 | |
| Provide feedback on Meeting #1 discussion | CAT | 10/8/21 | |
| | | | |
| | | | |

Dewberry

# Resilient Coastal Communities Program

Cape Carteret- Community Action Team Meeting #1

**September 28, 2021**

1

## Agenda

- Welcome and Introductions
- Resilient Coastal Communities Program Overview
- Discussion
- Wrap-up: Action Items, Next Steps



2

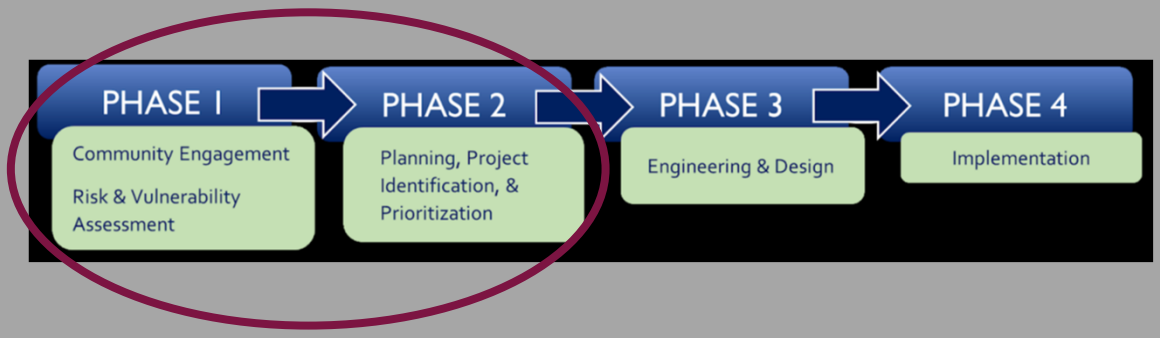
# Program Objectives

- Address barriers to coastal resilience in North Carolina at the local level, such as limited capacity, economic constraints, and social inequities;
- Assist communities with risk and vulnerability assessments and developing a portfolio of planned and prioritized projects;
- Advance coastal resilience projects to shovel-readiness, or ready for implementation; and
- Link communities to funding streams for project implementation



3

# Program Overview



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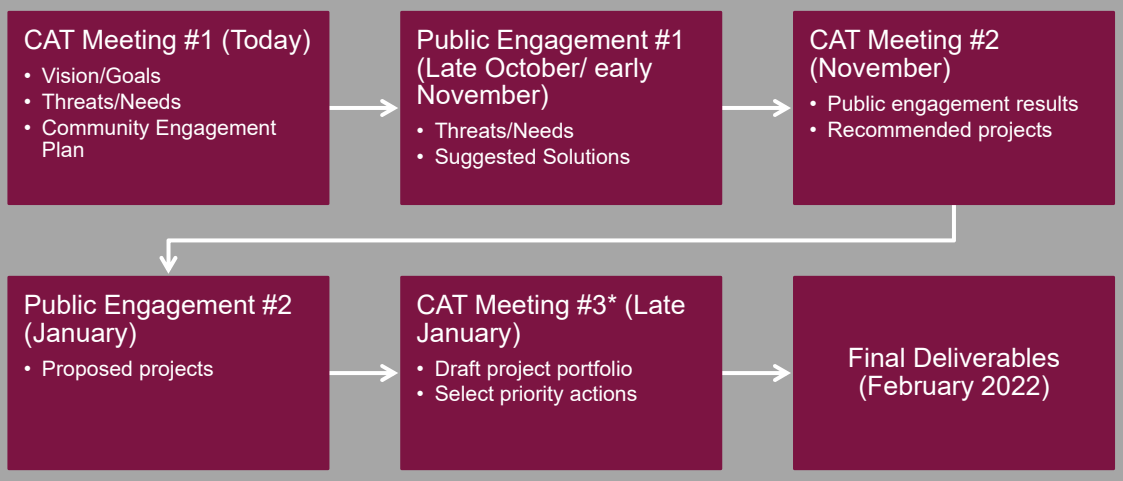
# Deliverables

- Risk and Vulnerability Assessment Report
- Project Portfolio



5

# Schedule



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# Discussion

- Community Vision and Goals
- Threats/Challenges to Community Resilience
- Community Engagement Strategy



7

# Next Steps

- Action Items
  - Dewberry/CC: Schedule Public Engagement event/survey #1
  - CAT: Provide feedback on today's discussion questions



8

# Thank you!

Beth Smyre, PE 919-424-3771
esmyre@dewberry.com



9

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# CAPE CARTERET CAT MEETING #2 DISCUSSION

**DATE:** January 25, 2022

**TIME:** 2:00 p.m.

**LOCATION:** Cape Carteret Town Hall and Microsoft Teams Meeting

**PURPOSE:** Cape Carteret Community Action Team Meeting Discussion - Summary

## Discussion Topics

1. **Risk and Vulnerability Assessment**

Comments on the Draft Assessment:

Dewberry staff reviewed the draft Risk and Vulnerability Assessment (RVA), including the analysis parameters and the initial risk summary. The assets identified as having higher risk scores include:

- Cape Point Court
- Channel View Court
- Edgewater Court
- Club Court
- Dolphin Street

Attendees were asked to provide overall feedback on the draft RVA and specifically on the summary of assets list.

- The results do not align with the information contained in Cape Carteret's Resilient Coastal Communities Program (RCCP) grant application, nor the observations of Town staff (with the exception of Dolphin Street). The CAT felt the assessment missed some critical infrastructure, and the CAT will provide input on the additional assets that need to be considered (including asset location). The RVA utilized NC OneMap information for asset identification, but will be revised to incorporate the CAT's input.
- A question was asked about whether the RVA accounts for the increase in population Cape Carteret is currently (and expects to continue) experiencing. The RVA considered the critical built infrastructure such as roads, public buildings, EMS facilities, etc., as prescribed in the NCDCM procedures outlined for this program. It did not look at residential areas, or areas where population is increasing or is expected to increase in the future. However, Dewberry can provide a recommendation to NCDCM to consider adding these two criteria for future assessments for the program.
- The CAT was surprised that Cape Point Court and Club House Drive had higher risk scores than some other roads in the draft assessment. Both roads are higher than surrounding areas and have not historically flooded. Cape Carteret submitted a Building Resilient Infrastructure and Communities (BRIC) Grant application for stormwater pretreatment at seven locations. Sutton Drive and Arden Oaks Drive are two very critical roads because they provide the only access to residents in these areas. There are several roads that historically flood during a thunderstorm that are not identified as high-risk. Cape Carteret will provide the BRIC Grant application and a list of additional critical infrastructure to consider for the final assessment. The seven projects / areas in the BRIC Grant should be added to the Project List spreadsheet. It was noted that the datasets used in the development of the RVA focused on coastal storm surge flooding, sea level rise, and other risks included in the RCCP handbook; rainfall data was not included in the assessment. However, the observational data provided by the CAT can be incorporated into the RVA.
- Beth will send the presentation to the CAT members to allow for additional review and comment on the draft RVA. (The presentation is attached to this meeting summary.)

**2. Projects to Address Community Needs:**

What projects do you think should be implemented to address the community's needs?

A list of projects, generated from previous studies (including the Hurricane Matthew Resilient Redevelopment Plan and the regional Pamlico Hazard Mitigation Plan), was reviewed in the context of the information presented from the draft RVA.

- The CAT feels that innovative stormwater improvements such as bioretention basins, improved swales, and improved drainage infrastructure should be a top priority as these facilities are most affected by climate change. Stormwater improvements would slow and treat runoff before traveling into Bogue Sound. Obviously, there are some areas where stormwater improvements will not feasible due to the water level.
- Improving shelter facilities in the area is also a top priority. These facilities serve surrounding communities as well as Cape Carteret. A project to address this might be in process, and there are current plans to construct a new gym at White Oak Elementary with shelter capabilities. The CAT will confirm this information.
- The CAT discussed the potential for an emergency operations center behind Carteret Crossing Shopping Center. The emergency operations center would also benefit surrounding towns, like Emerald Isle, by providing a base of operations and coordination during storm events.
- Constructing living shorelines should be another priority project to keep on the list. These types of projects would address the natural environment as well as the built infrastructure.

Other projects not listed/new ideas:

- Add the seven projects from the BRIC application. Can funds from this program be used as the matching funds for the BRIC Grant? The BRIC Grant requires a large local match, so these seven projects would be a top priority. Will the RCCP use the same evaluation criteria as the BRIC Grant? The criteria might be similar, it is difficult to know given the funds will come from a different funding source. Dewberry will clarify these questions with NCDCM.
- Using a topographic heat map, the CAT identified additional areas that experience frequent flooding. Additionally, during a recent update to their CAMA Land Use Plans, citizens provided input on areas of reoccurring flooding. All of these areas would be considered priority areas after the seven locations submitted in the BRIC Grant. Zach will provide the topographic heat map and a draft of the CAMA Land Use Plans to Dewberry to assist with the final assessment. The CAT would like these areas on the project list so that citizens understand that past input is still being considered. Briefly, these areas that experience reoccurring flooding are:
    - Neptune Drive and Neptune Court
    - Loma Linda Drive, especially at the intersection of Anita Forte Drive
    - Dolphin Street
    - Bogue Sound Drive
    - Lejeune Road and Bayshore Drive; Lejeune Road drains toward Bayshore Drive.
    - Gemini Drive: The golf course drains toward this roadway and floods at the cul-de-sac.
    - Quailwood Court
    - Bobwhite Circle - has a big elevation difference locally that causes backyard flooding. This problem is easily solved with improving the ditches in this area.

- Star Hill Drive between Taylor Notion Road and Club House Drive – during hurricane events the road is overtopped where it crosses a tributary to Pettiford Creek Bay. This cuts access to a large section of the neighborhood it serves.
- Sutton Drive (as noted above) – included in the BRIC Grant application
- Arden Oaks Drive (as noted above) – Taylor Notion Road is at a higher elevation and drains toward Arden Oaks Drive.

- Zach noted that the NWS Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model correlates well to the Flood Insurance Rate Maps (FIRM). The community can even experience flooding in the parks and along the waterfront areas from exceptionally high tides (called king tides).
- The CAT is still interested in pursuing the mapping projects identified on the draft project list.
- The CAT wants to be intentional with projects they identify in Phase 3. They do not want the list to be so large that none of the projects get funding. The goal will be to submit only one or two projects in the application phase. This process will advise the CAT on the project(s) to submit as well as supplying background information for the application. The process will produce a final prioritized project list that will also help guide future funding requests.
- The community has tried to get funding to raise homes in flood prone areas but has not been successful. Homes must meet the severe competitive loss criteria.
- Mayor Baker noted that the community lost a large number of mature trees during Florence. Additionally, the community is losing trees due to development. He would like to add, if feasible, a project for replanting trees as a long-term solution.

<u>Of these projects, which are the most important (or have the most impact) to the overall community?</u>

- Projects related to improving stormwater management are the most important.

**3. Other Feedback:**

- The CAT asked if Dewberry would be able to assist them with the application to submit projects. Dewberry can assist with the application, using the information compiled for Phases 1 and 2 of the program.

**4. Public Involvement:**

- Beth discussed the timeline for completing the assessment phase of the program. Due to the impacts of COVID on communities and particularly public involvement, NCDCM is extending application period for Phase 3 (project engineering funds) until the end of April or early May. She suggested scheduling the public involvement event for a day during one of the following weeks: February 21st, February 28th, or March 7th.
- It was decided to schedule the public involvement event on March 17th from 4:00 pm – 7:00 pm. The event will be live streamed to provide a virtual option. It will be held in conjunction with a community St. Patrick's Day event.
- Dewberry will produce a two-part online survey. Part one of the survey will be placed on the Cape Carteret website in February to generate interest in the public involvement event. A second survey will be posted at the beginning of March and open until the end of March. The online survey will incorporate earlier questions asked at the November 2021 festive due to the small number of comments received from the public.
- The CAT will pass out paper copies of the survey at the town council meeting in February.

- The next CAT meeting will be held on March 29th at 2:00 pm.

## Action Items

| ACTION ITEM | ASSIGNED TO | DATE DUE | STATUS |
|---|---|---|---|
| Schedule Public Engagement Event | Dewberry/CAT | 2/4/22 | Complete |
| Provide feedback on Meeting #2 discussion, draft project list | CAT | 2/11/22 | In Progress |
| Provide additional material for the RVA: topographic heat map(s), CAMA land use plan, critical infrastructure | CAT | 2/11/22 | In Progress |

## Attachments

Meeting Presentation
Draft Project List

Dewberry

# Resilient Coastal Communities Program

Cape Carteret- Community Action Team Meeting #2

**January 25, 2022**

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## Agenda

- Status of RCCP Phase I/II Effort
- Risk and Vulnerability Assessment
- Projects to Address Community Resilience
- Wrap-up: Action Items, Next Steps



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## Previous Meeting

- Threats/Challenges to Community Resilience
- Community Vision and Goals
- Community Engagement Strategy



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# Risk and Vulnerability Assessment



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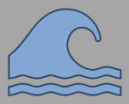
# Why Assess Risk & Vulnerability?



Understand how flood hazards are changing in Cape Carteret

Determine areas and assets that are susceptible to flood damage today and in the future

Identify resilience projects based on assessment results



5

# Defining Vulnerability & Risk

- **Vulnerability** – *the degree to which an asset or system is expected to experience adverse impacts due to flooding.*
- **Risk** – *the potential for adverse consequences on lives, livelihoods, health and well-being, ecosystems, economic, social and cultural assets, services, and infrastructure due to flooding.*



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# Impact Types

- **Critical Built Infrastructure** – *physical structures that house or perform functions that are essential to government and business functions, and human health and safety.*
- **Natural Infrastructure** – *naturally occurring landscapes and systems that perform ecosystem services that benefit surrounding communities.*



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# Assessment Process




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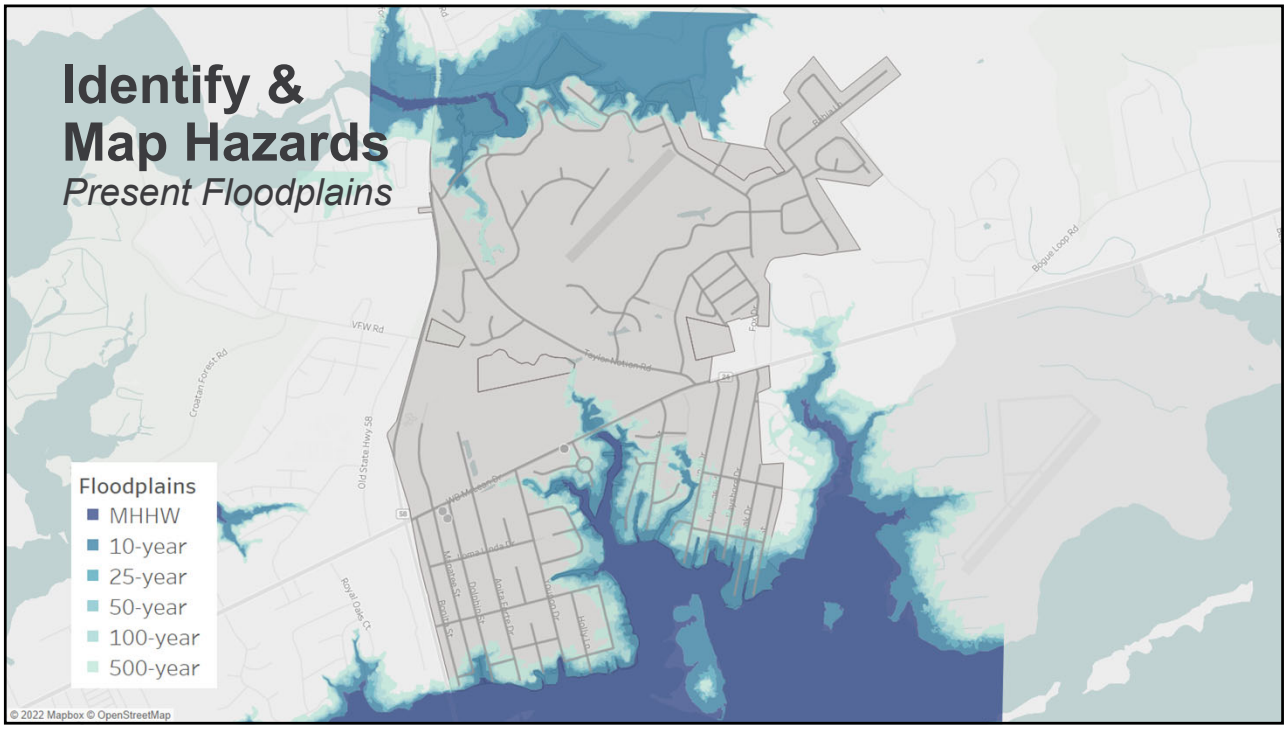
Identify &
Map Hazards
Present Floodplains
Floodplains
MHHW
10-year
25-year
50-year
100-year
500-year
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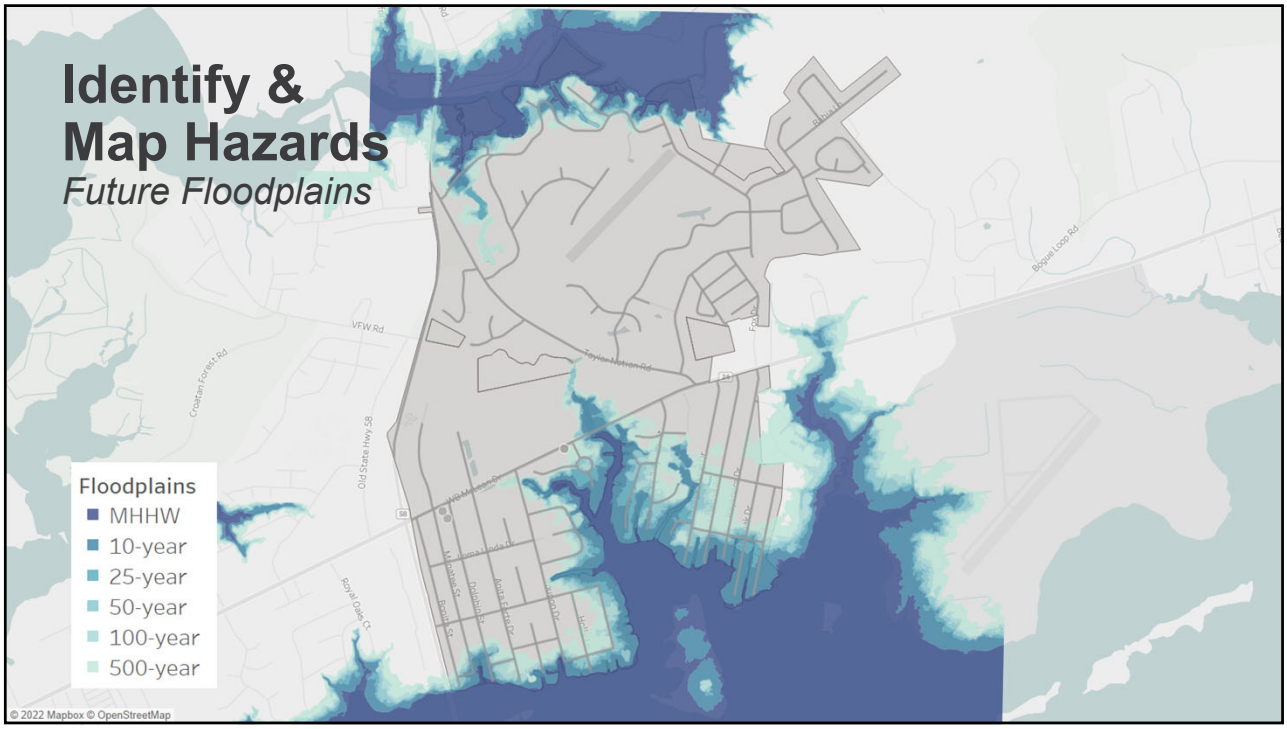
Identify &
Map Hazards
Future Floodplains
Floodplains
MHHW
10-year
25-year
50-year
100-year
500-year
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# **Vulnerability**: Critical Built Infrastructure

**Vulnerability** = Exposure + Sensitivity − Adaptive Capacity

*Probability of physical contact between an asset and a hazard*

*Degree to which an asset may be affected by a hazard*

*Ability of an asset to change characteristics or behavior in response to a hazard*



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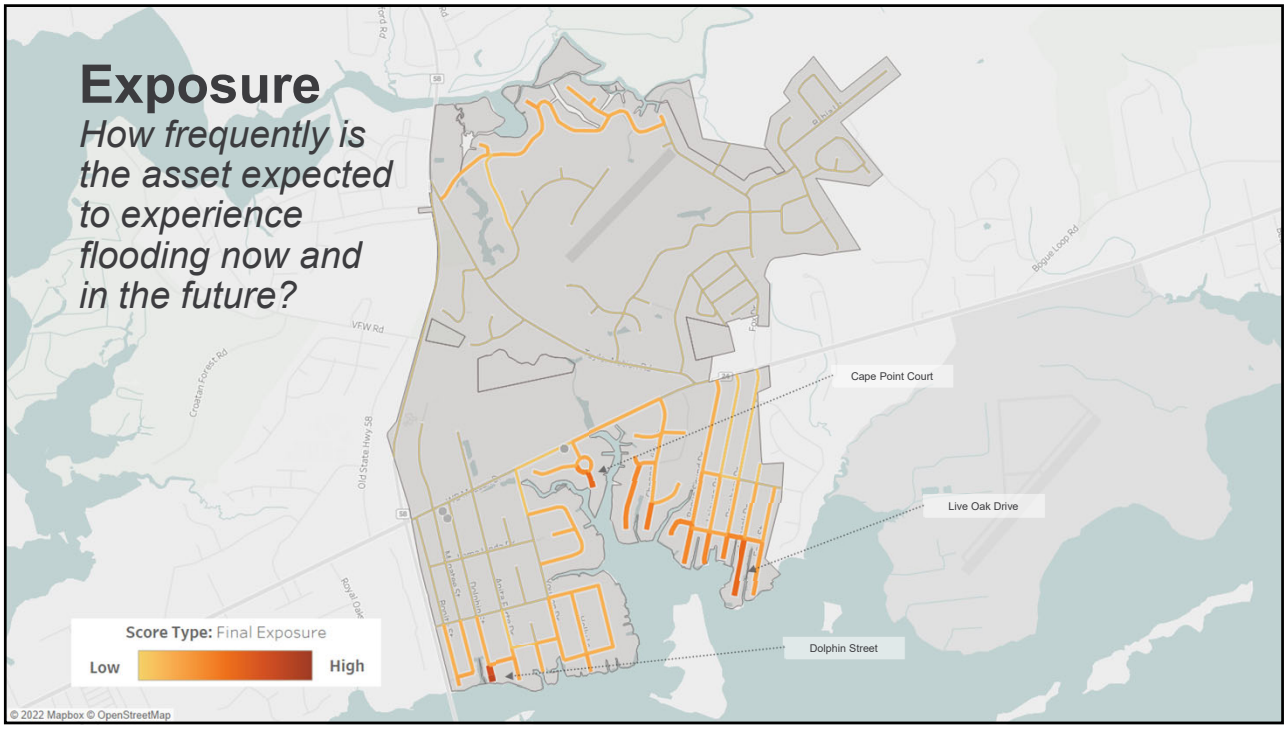


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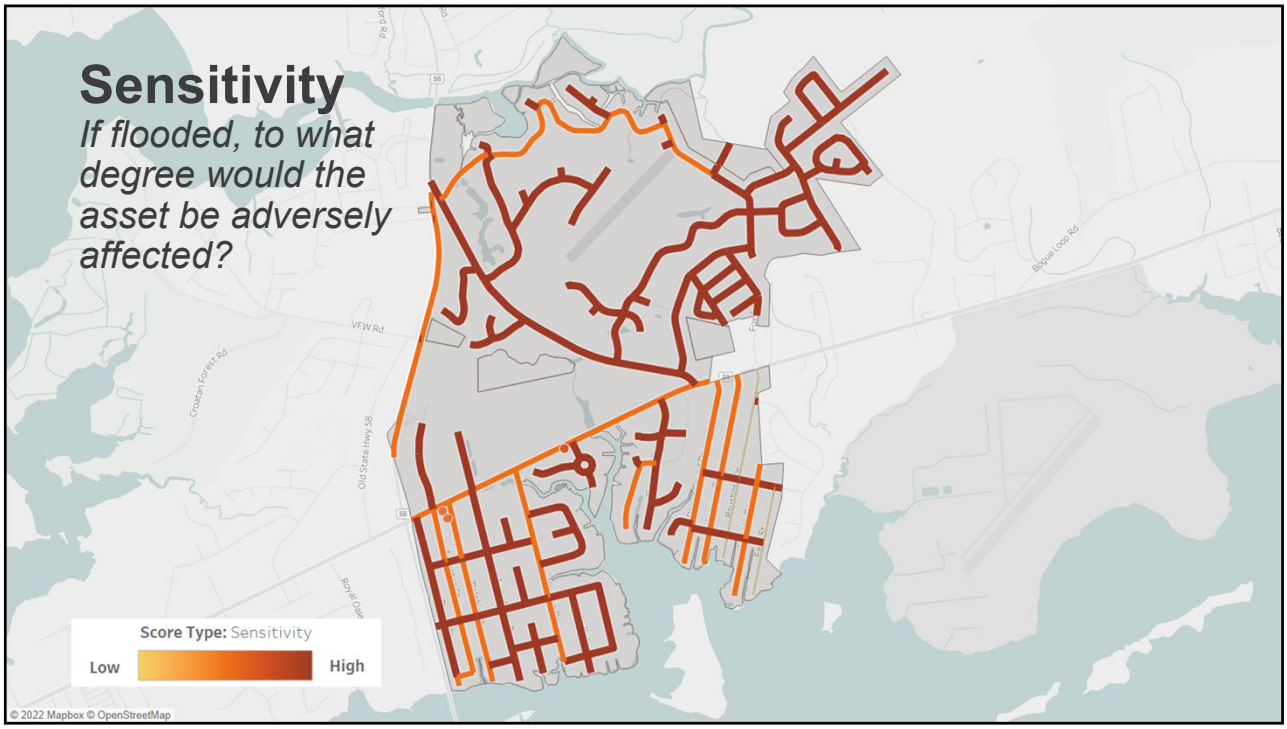
Sensitivity
If flooded, to what degree would the asset be adversely affected?
Score Type: Sensitivity
Low
High
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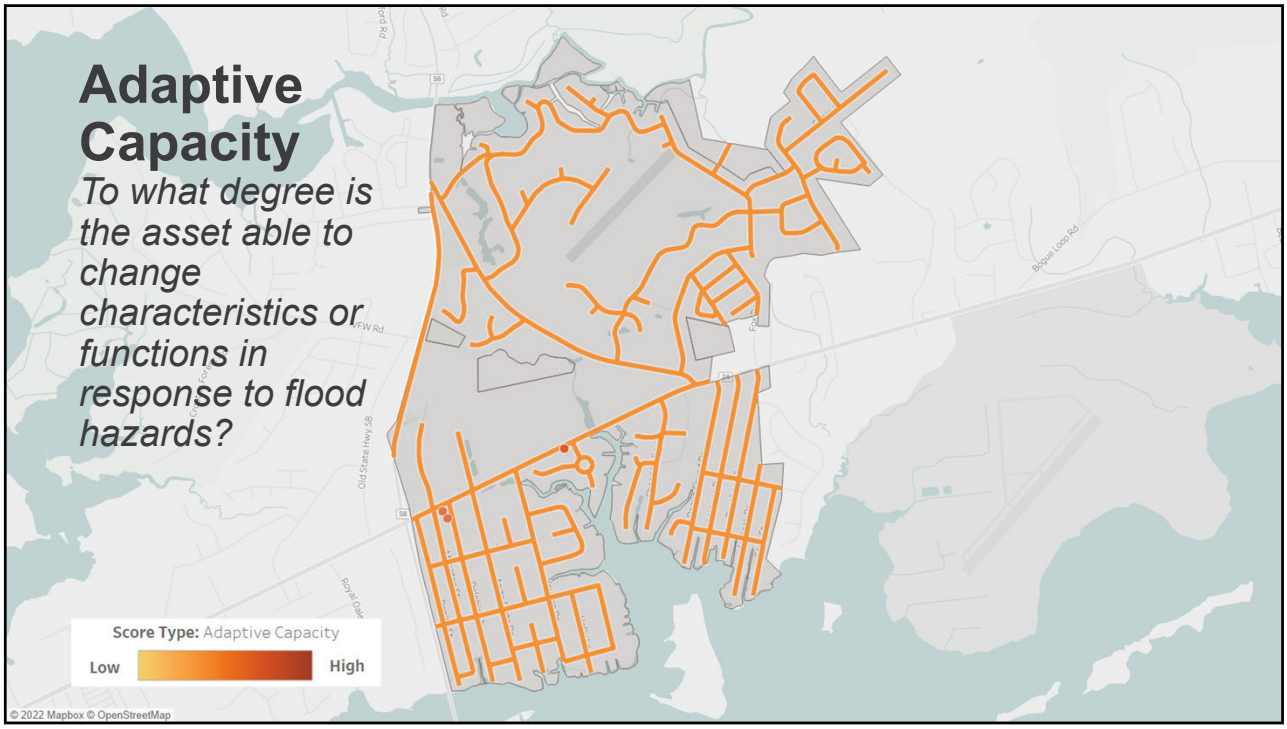
Adaptive Capacity
To what degree is the asset able to change characteristics or functions in response to flood hazards?
Score Type: Adaptive Capacity
Low
High
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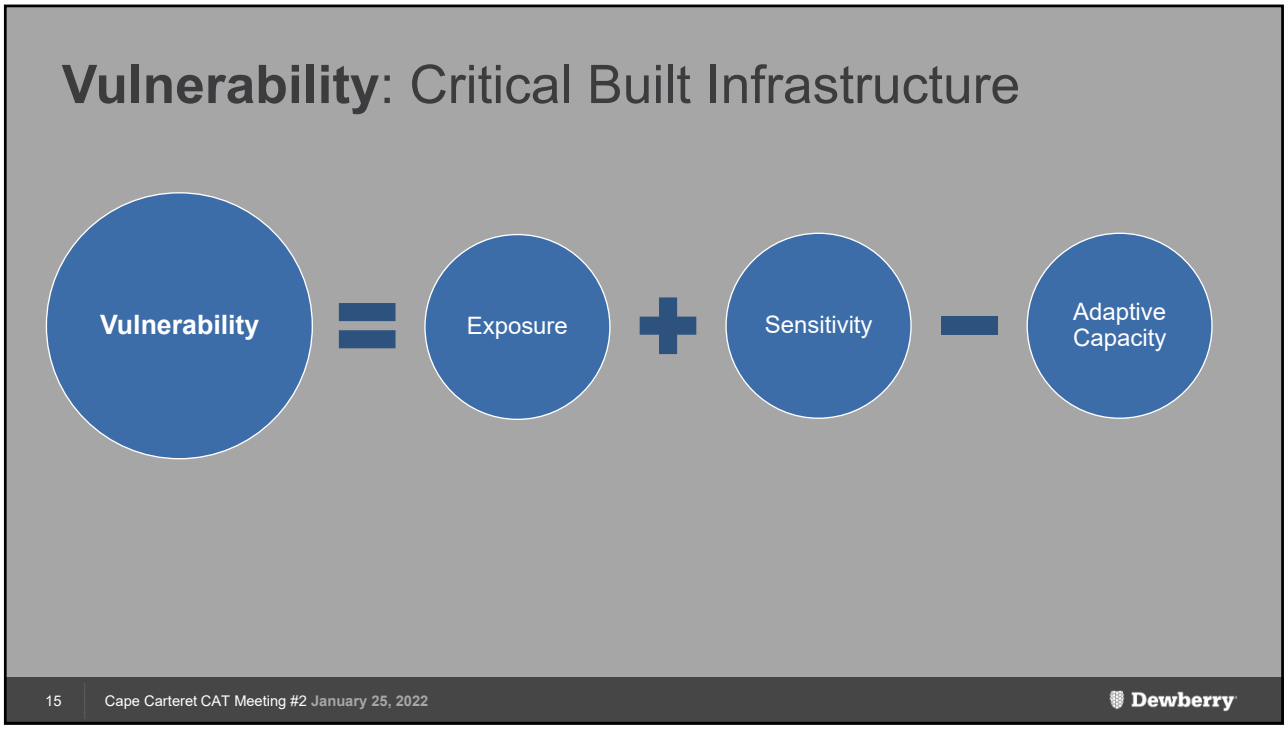
Vulnerability: Critical Built Infrastructure
Vulnerability
Exposure
Sensitivity
Adaptive Capacity
15
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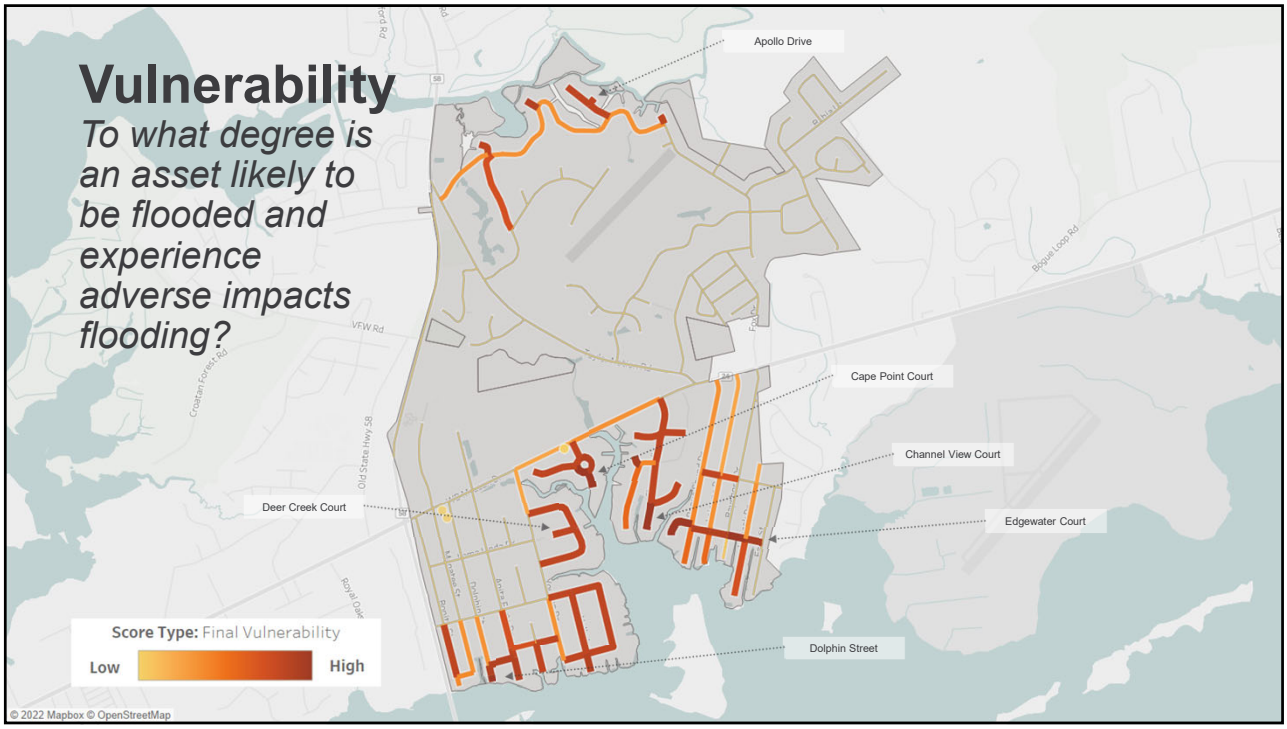
Vulnerability
To what degree is an asset likely to be flooded and experience adverse impacts flooding?
Apollo Drive
Cape Point Court
Channel View Court
Deer Creek Court
Edgewater Court
Dolphin Street
Score Type: Final Vulnerability
Low
High
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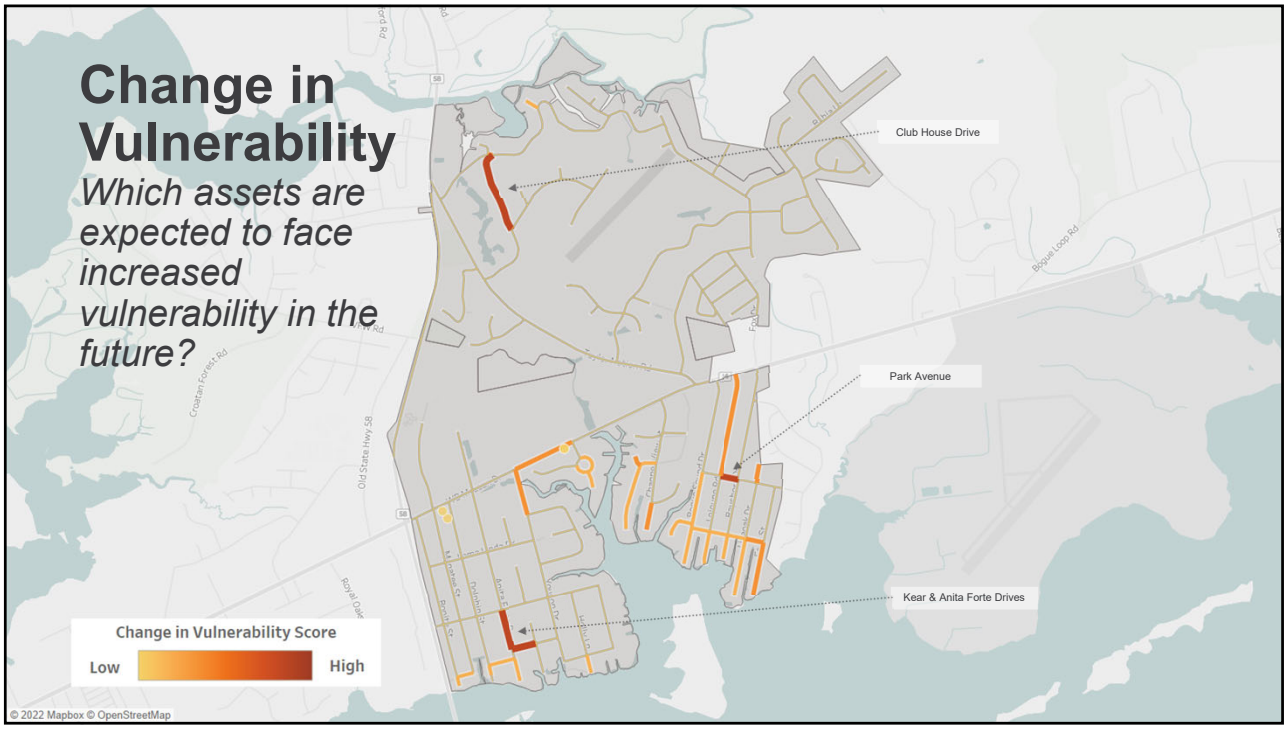


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## **Vulnerability**: Natural Infrastructure

- NOAA Sea Level Affecting Marshes Model (SLAMM)
- Provides baseline and projected marsh land cover under future conditions, based on net sea level rise
- Model effectively incorporates habitat's exposure, sensitivity, and adaptive capacity into one metric (habitat loss)



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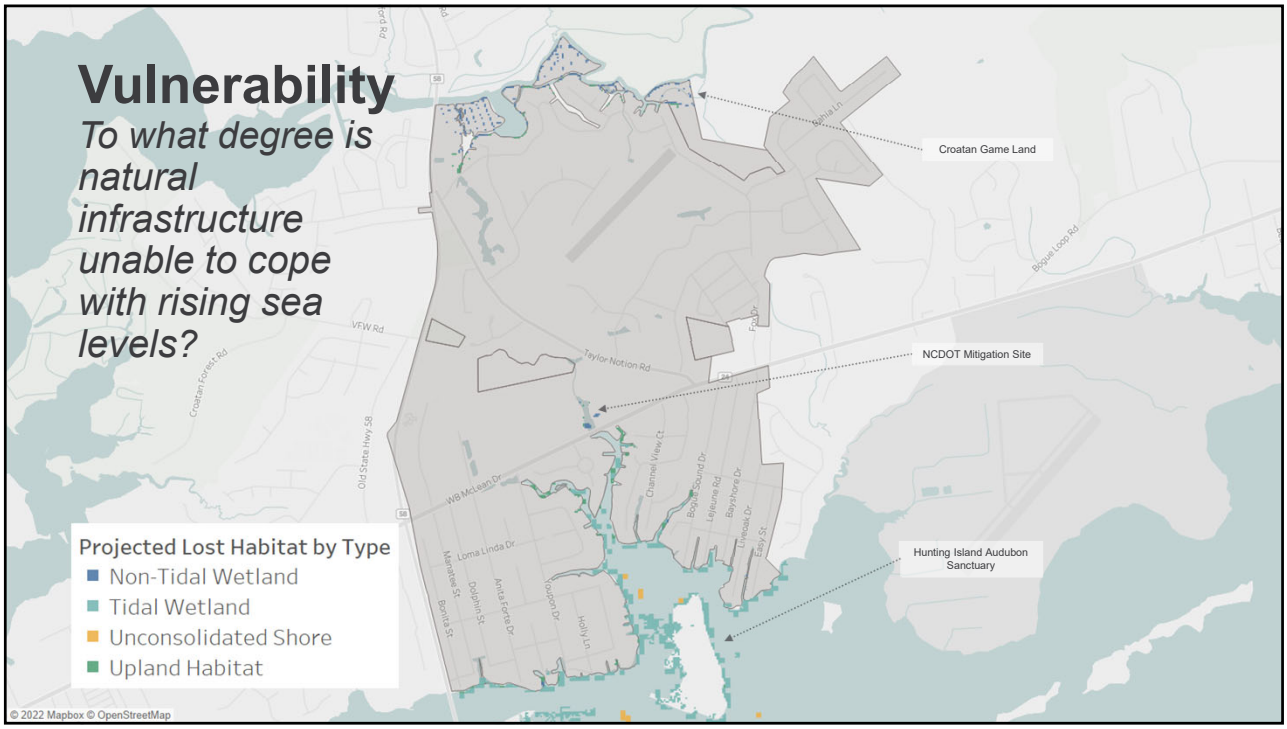
Vulnerability
To what degree is natural infrastructure unable to cope with rising sea levels?
Croatan Game Land
NCDOT Mitigation Site
Hunting Island Audubon Sanctuary
Projected Lost Habitat by Type
Non-Tidal Wetland
Tidal Wetland
Unconsolidated Shore
Upland Habitat
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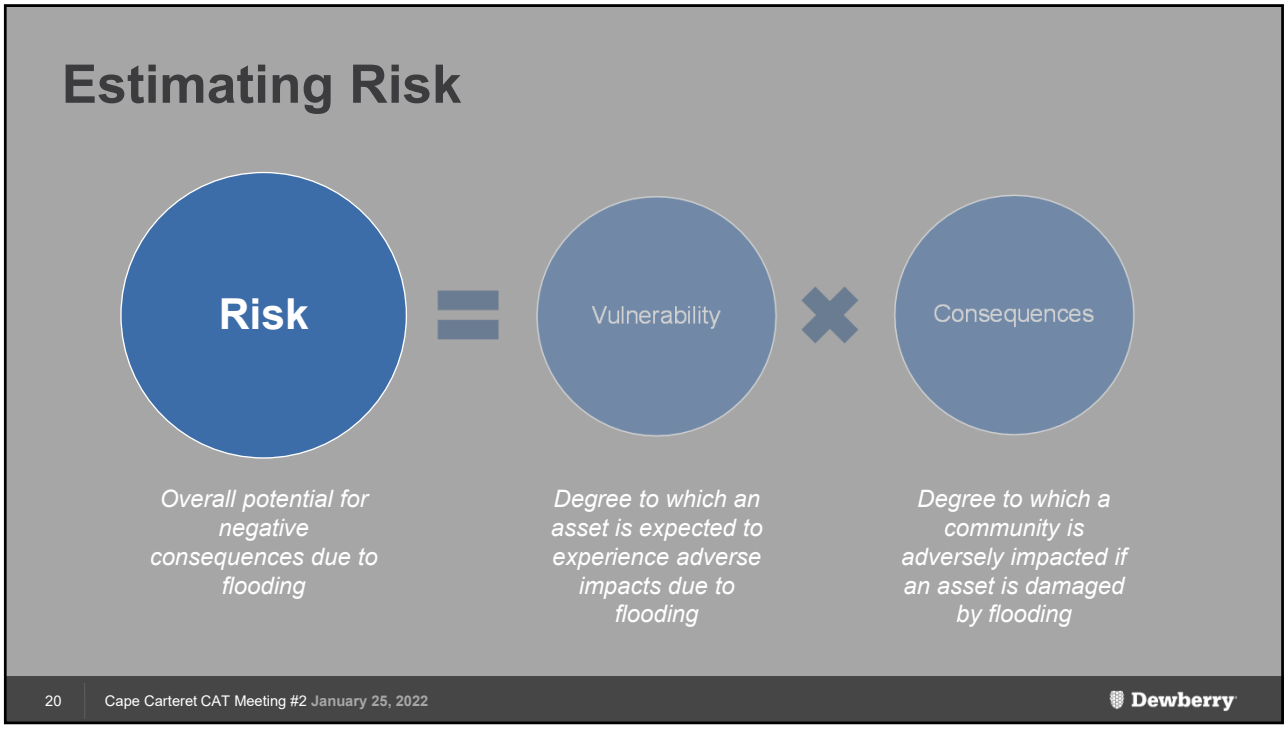
Estimating Risk
Risk
=
Vulnerability
×
Consequences
Overall potential for negative consequences due to flooding
Degree to which an asset is expected to experience adverse impacts due to flooding
Degree to which a community is adversely impacted if an asset is damaged by flooding
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# Estimating Consequences


*Degree to which a community is adversely impacted if an asset is damaged by flooding*

*Susceptibility of population to experience adverse impacts due a hazard event*

*An asset's importance to the surrounding community*



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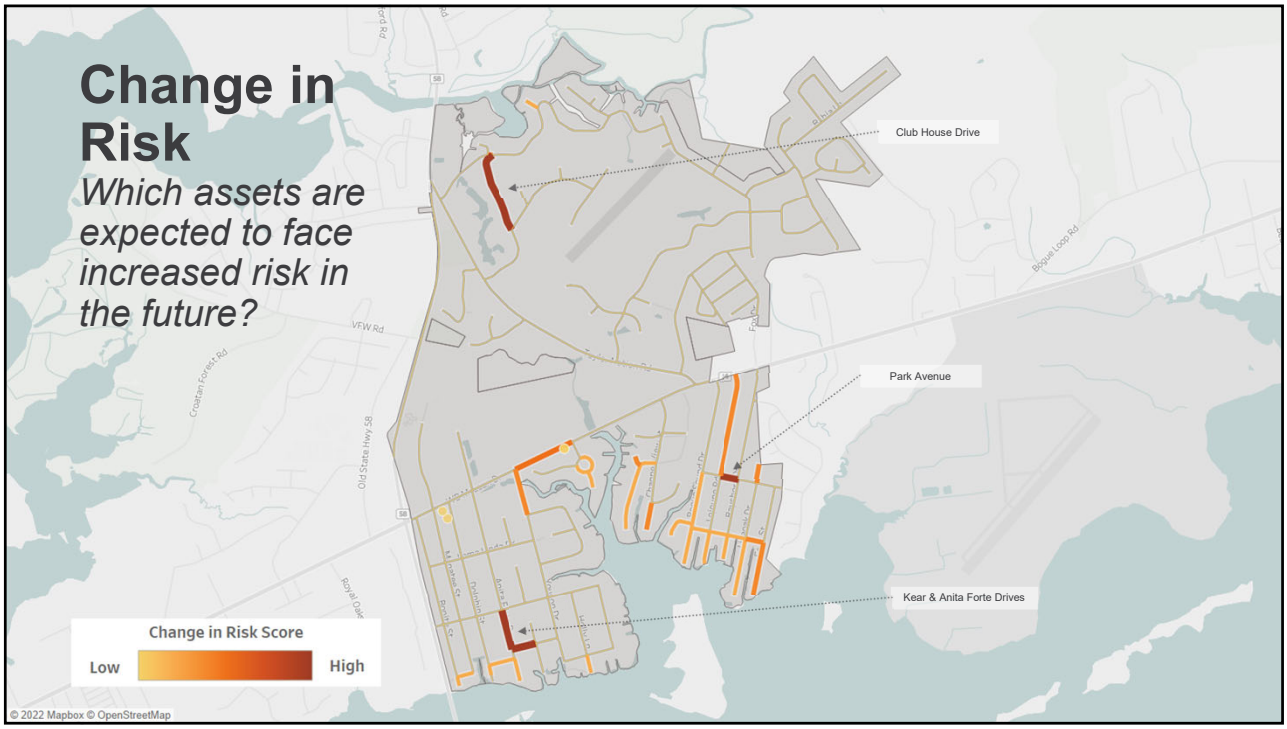
# Risk

*What is the magnitude of adverse impacts expected due to the asset flooding?*


22

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# Assessment Summary

*Roadways with Higher Risk Scores*

- Cape Point Court
- Channel View Court
- Edgewater Court
- Club Court
- Dolphin Street



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# Projects to Address Community Resilience



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# Projects to Address Community Resilience

- Draft List (Based on Prior Plans)
- Additional/New Projects
- Project Priorities



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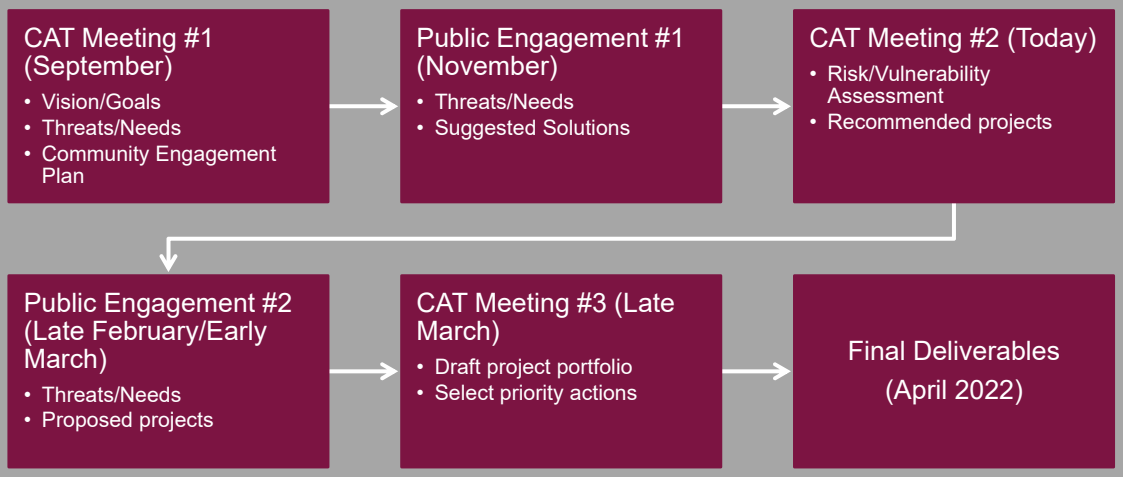
# Schedule



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# Next Steps

- Action Items
  - Dewberry/Cape Carteret: Schedule Public Engagement event/survey
  - CAT: Provide feedback on proposed projects



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# Thank you!

Beth Smyre, PE 919-424-3771
esmyre@dewberry.com



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# CAPE CARTERET CAT MEETING #3 DISCUSSION

**DATE:** March 29, 2022

**TIME:** 2:00 p.m.

**LOCATION:** Cape Carteret Town Hall, with virtual option

**PURPOSE:** Cape Carteret Community Action Team Meeting Discussion - Summary

## Discussion

The purpose of the meeting was to finalize the list of projects to be included in the project portfolio for the Resilient Coastal Communities Program (RCCP). Before discussing the current draft of the portfolio, the Community Action Team (CAT) reviewed the results of the public engagement, including the feedback gathered during the March 17 Community Food Truck Rodeo and the online public survey. As summarized in the meeting presentation, flooding was overwhelmingly listed as the main concern of survey respondents. Stormwater facility improvements, along with living shoreline and swale construction, were cited as the most popular options for addressing coastal hazards.

As of March 2022, the draft project portfolio listed eight potential projects to address coastal hazards and overall community resilience; all eight projects were included in the public survey for comment. Based on the community feedback and further input from the CAT, the following adjustments were made to the project portfolio:

- The Swale Construction project was combined with the Stormwater Facility Improvements, as the two projects include the same potential locations for improvements. The combined project is to be listed as the top project priority.
- The Stormwater Infrastructure Mapping project was shifted to be the number 2 priority on the list, as this is a critical community need in order to determine what further stormwater improvements are needed. The Stormwater Pretreatment project was shifted to priority number 3.
- Projects that involve coordination with Carteret County were shifted to a lower priority, due to the coordination that would be needed to implement the projects. This includes the Emergency Shelter Improvements and Emergency Operations Center projects.
- In order to increase public awareness of coastal hazards and community resilience, two projects (Public Engagement and Education Campaign, Low-Impact Development Education Campaign) were added to the list. The Low-Impact Development Education Campaign was added in response to the suggestion received through the public survey. It was noted that there is a plan to update the Town's stormwater ordinance, so the public education effort could be started as part of the ordinance update.

The CAT discussed other suggestions that were received through the public involvement process but did not add any further projects to the list. A revised copy of the project portfolio will be provided to the CAT for final review and comment.

Beth reviewed the next steps in the process, which include finalizing the project portfolio as well as the overall report for Phase 2 of the RCCP. The Phase 3 (funding for project engineering) application period opened in late March and will close in early June.

## Attendance

| Name | ✓ | Organization | Email |
|---|---|---|---|
| Beth Smyre | ✓ | Dewberry | esmyre@dewberry.com |
| Zach Steffey | ✓ | Cape Carteret | zsteffey@capecarteret.org |

| | | | |
|---|---|---|---|
| Heather Leffingwell | ✓ | Cape Carteret | hleffingwell@capecarteret.org |
| Mackenzie Todd | | NC Division of Coastal Management | Mackenzie.Todd@ncdenr.gov |
| Mayor Will Baker | ✓ | Cape Carteret | wbaker@capecarteret.org |
| Ryan Hutchinson | ✓ | Cape Carteret Public Works | publicworks@capecarteret.org |
| David Figowy | ✓ | Community Member | dfigowy@ec.rr.com |
| Erik Heden | | NOAA | erik.heden@noaa.gov |

## Attachments

Meeting Presentation

Dewberry

# Resilient Coastal Communities Program

## Cape Carteret- Community Action Team Meeting #3

**March 29, 2022**

1

## Agenda

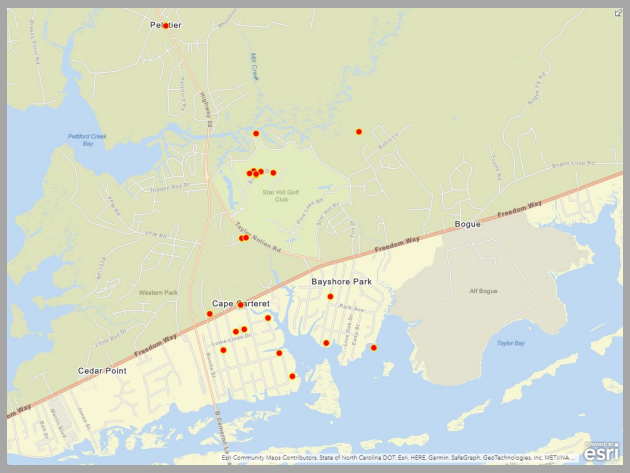
- Welcome and Meeting Objectives
- Public Engagement Summary
- Draft Project Portfolio
- Wrap-up: Final Deliverable Outline, Action Items, Next Steps




2

# Public Engagement Summary

- Total of 45 responses (32 online survey responses and 13 hard copy surveys)
- Flooding listed as main concern (85%) – evenly split between riverine and storm surge



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# Public Engagement Summary

- Project preferences: (all projects received support)
  - Most common responses – Stormwater facility improvements, living shoreline construction and swale construction
- Write-in project suggestions:
  - Educate developers, home builders, etc. on low-impact development strategies



4

# Project Portfolio

- Projects listed that should be removed?
- Projects that should be added?
- Project priorities? Candidate for RCCP Phase 3?
- Details on project scope, estimated cost, completion timeline?



5

# Final Deliverable Outline

- Vision and Goals
- Community Action Team
- Stakeholder Engagement Strategy/Summary
- Existing Local/Regional Plans
- Risk and Vulnerability Assessment
- Project Portfolio
- Conclusions/Lessons Learned



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# Next Steps

- Action Items
  - CAT: Provide feedback on today's discussion/proposed projects
  - Dewberry: Develop final project portfolio and report for CAT review

**RCCP Phase 2**
- Final Deliverables: April 2022

→

**RCCP Phase 3 (Engineering)**
- Application Window: March 2022 – May 2022

→

**RCCP Phase 4 (Construction)**
- Application Window: TBD



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# Thank you!

Beth Smyre, PE 919-424-3771
esmyre@dewberry.com



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APPENDIX B

# PUBLIC ENGAGEMENT MATERIALS AND SUMMARY RESULTS

**MAY 2022**

Dewberry

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# CAPE CARTERET PUBLIC INVOLVEMENT SUMMARY

**DATE:** March 17, 2022

**TIME:** 5:00 p.m.-7:00 p.m.

**LOCATION:** Cape Carteret Town Hall

**PURPOSE:** Cape Carteret Public Involvement for the Resilient Coastal Communities Program

**SUMMARY DATE:** March 29, 2022

A Public Involvement opportunity for the Resilient Coastal Communities Program (RCCP) was held on March 17, 2022, in conjunction with a community-led St. Patrick's Day food truck rodeo. The purpose of the event was to gather the community's feedback on the Town's perceived vulnerabilities to coastal hazards and the proposed projects to address these concerns.

There were three stations for participants to visit. The first was a sign-in station with a welcome poster that described the purpose of the meeting. At the sign-in station, participants could complete a hard copy of the public survey or scan a QR code to access the online version.

The second and third stations had two interactive maps. The respondents used the first map to indicate areas where they have witnessed or knew of flooding or other coastal hazards (wind damage, erosion, etc.). The second map instructed respondents to indicate what types of projects they would like to see implemented in order to address coastal hazards and where they should be implemented.

## Attendance

Given the nature of the event, formal attendance was not logged.

A total of 47 responses to the survey were received: 33 online responses and 14 hard copies.

## Interactive Station Results

Locations of concern:

- Flooding at various properties off Sutton Drive
- Flooding on Club House Drive near West Court
- Flooding off of Ardan Oaks Drive
- Flooding at various properties off Anita Forte Drive
- Flooding off of Loma Linda Drive
- Flooding at the corner or Neptune Drive and Yaupon Drive
- Flooding on Neptune Drive
- Flooding on Holly Lane
- Flooding on a property off Live Oak Drive
- Flooding on the corner of Park Avenue and Live Oak Drive
- Flooding on Pine Lake Road near Fore Lane Drive

Locations and ideas for projects:

- More drainage under the golf course using either an open ditch or a swale
- A new skate park and playground equipment for children near the school
- A new drain at 200 Bayshore Drive
- A new skate park, similar to the one in Atlantic Beach, on the south side of NC 24
- A living shoreline or bulkheads at the Town dock

- A shelter with picnic tables and swing set at the Town dock
- A new Town-owned slip to take pressure off the road. It is possible that a current park could be converted to hold this.

## Survey Results

### 1. Coastal hazards of concern

What type of coastal or climate hazards concern you the most in your community?

- Flooding, shoreline erosion, hurricanes and tropical storms, wildfires, and severe weather were all noted as concerns.
- Of the coastal hazards listed, the top two responses were flooding (78%) and hurricanes and tropical storms (72%).
- Write-in answers also included:
  - Unchecked development.
  - Sunny day flooding.
  - Water pollution from septic tank effluent.
  - Boat access for Old Cape Carteret residents.

If selected flooding, what kind of flooding concerns you the most?

- All four types of flooding are a concern to respondents, with storm surge the highest at 50% followed by stormwater or rainfall at 30%.

On a scale of 1 to 5, how significant of a risk are coastal hazards and/or flooding to your community?

- Over 70% of respondents ranked the risk from flooding presently as a 4 or 5 out of 5
- Over 90% of respondents ranked the risk from flooding in the future as a 4 or 5 out of 5.

### 2. Damage and Resilience

Have you ever witnessed property or infrastructure damage due to coastal or climate hazards in your community?

- Almost 90% of respondents answered in the affirmative.

What type of damage did you witness?

- Respondents indicated they have seen property damage, damage to transportation systems, utility disruption, injury or personal health issues, and limited access to services.
- Property damage was the most common response at 89%, followed closely by damage to transportation systems (67%) and utility disruption (67%).
- Some write-in responses included:
  - Loss of land use.
  - Downed trees and damaged homes.
  - High water during Hurricane Florence, including water under structures.
  - Roads completely impassable at times.
  - Pettiford Creek has completely overtopped Star Hill Drive at times.
  - Electricity unable to come back on because of high water at transformers.
  - Shoreline erosion.

- Sutton Place flooded anytime there is significant rainfall.
- Stormwater runs off faster than drainage works at the golf course, which contributes to the flooding of nearby properties.
- Trees down during storms.

What are the top three challenges facing the Town of Cape Carteret immediately after a storm, flood, or other coastal hazard event?

- The top three challenges were repairing or rebuilding physical infrastructure (83%), restoring power, electricity, or other utilities (80%), and re-opening businesses, government offices, or other community facilities (43%).
- Some write-in responses included:
  - The Town is challenged by repairing water-damaged homes.
  - Stagnant water stays after storms and is a breeding ground for disease.
  - Roadways flood often.
  - Roadways which have been washed out need to be repaired.

**3. Resilience projects to be implemented**

What type of projects would make the Town more resilient?

- All project types received some level of support.
- Of the top five project types selected, increased stormwater drainage capacity received the largest support (89%), followed by resilience planning (72%) and nature-based solutions (70%).
- Acquisition and conservation of flood-prone land (51%) and structural protection, such as floodwalls or tide gates (49%), and elevations of homes, businesses, and public infrastructure (47%) were also strongly supported.

Where do you think the Town of Cape Carteret should implement resilience projects?

- Town-wide, the need for low-impact development that works with nature to manage stormwater.
- Drainage ditches in the Pine Lake area.
- Total shoreline improvements.
- Property drainage on the golf course and in the problematic neighborhoods.
- Construction of a multi-family home away from the water.
- Bulkhead walls to protect the shorelines.
- Some mitigation for the flooding on Neptune Drive.
- Better drainage at the intersection of Kerr and Anita Forte Drive
- Entrance to the Ardan Oaks neighborhood, one suggestion was for a natural project with aesthetic appeal.
- Improved stormwater drainage at Sutton Drive
- Protect the wetland between NC 24 and Taylor Notion Road, next to White Oak School.
- Eastern portion of Neptune Drive
- Decrease flooding on Dolphin Street
- Address runoff on Bogue Sound Drive

- Construction of a pump or bulkhead to keep water out of homes on Loma Linda Court.
- Construction of a living shoreline to protect waterfront parks.
- Raise Star Hill Drive so it is not overtopped by Pettiford Creek as often.
- Address the flooding on McLean near White Oak School.
- Maintain greenspace within the Town limits.

The Town of Cape Carteret is considering several projects to increase resilience. Please rank the top three projects that would generate the greatest benefit to the community.

- All proposed projects received support from respondents.
- 80% of respondents said that improvements to stormwater facilities would make the community more resilient.
- Swale construction and stormwater pretreatment were also strongly supported, 45% and 40% respectively.
- A write-in answer suggested that education for developers, homebuilders, realtors, etc. on low-impact development strategies would increase the community's resilience.

What options would you support for paying for these projects?

- All payment options received some level of support.
- 92% of respondents wanted state or federal funding for these projects.
- Some write-in options included:
    - Support for the most cost-effective solutions for property owners.
    - Owner of the golf course.

**North Carolina Resilient Coastal Communities Program** **February 2022**
**Cape Carteret**
**Public Input Questionnaire**

***The Town of Cape Carteret is gathering public feedback on proposed options to improve the Town's resilience to coastal hazards. The Town received a grant under North Carolina's Resilient Coastal Communities Program to develop a list of projects to address critical infrastructure needs, and public input is a key part of the process to determine what improvements are most important to the community.***

***Thank you for your feedback!***

1. What type of coastal or climate hazards concern you the most in your community? (*Select all that apply.*)

| | | | |
|---|---|---|---|
| | Flooding | | Severe Weather (Thunderstorm Winds, Lightning, & Hail) |
| | Shoreline or Beach Erosion | | Wildfires |
| | Extreme Heat | | Other: |
| | Hurricanes and Tropical Storms | | |

2. If you selected flooding, what kind of flooding concerns you the most? Rank these options from **least (1)** to **most (4)** concerning.

| | | | |
|---|---|---|---|
| | Tidal (from king tides, nor'easters, etc.) | | Stormwater/Rainfall |
| | Storm surge (from hurricanes, tropical storms, etc.) | | Riverine (rising river water levels, etc.) |

3. On a scale of 1 to 5, how significant of a risk do you think coastal hazards and/or flooding currently pose to your community? (Check one)

| **1** ***(not a concern)*** | **2** | **3** | **4** | **5** ***(extreme risk)*** |
|---|---|---|---|---|

4. On a scale of 1 to 5, how significant of a risk do you think coastal hazards and/or flooding will pose to your community in the future? (Check one)

| **1** ***(not a concern)*** | **2** | **3** | **4** | **5** ***(extreme risk)*** |
|---|---|---|---|---|

5. Have you ever witnessed property or infrastructure damage due to coastal or climate hazards in your community? (Circle one: **YES/NO**) If **Yes**, where did you witness the damage?

_____

_____

**Please send your comments to:**
Beth Smyre, Dewberry, 2610 Wycliff Road, Suite 410, Raleigh NC 27607
or esmyre@dewberry.com

6. If you answered **Yes** to question 5, what type of damage did you witness?

| | | | |
|---|---|---|---|
| | Property damage, including homes, businesses, or personal possessions (including vehicles) | | Damage or disruption to transportation systems (e.g., flooded roadways, transportation delays) |
| | Utility disruption, including power loss or lack of access to clean drinking water | | Limited access to services, such as healthcare, education, or government offices |
| | Injury, illness, and/or concerns for personal health and safety | | Other: |

7. Based on your experience, please rank the **top <u>three</u> challenges** facing Cape Carteret immediately after a storm, flood, or other coastal hazard event.

| | | | |
|---|---|---|---|
| | Repairing or rebuilding physical infrastructure | | Re-opening businesses, government offices, or other community facilities |
| | Loss of income or wages | | Informing citizens about available assistance and resources |
| | Loss or damage of natural infrastructure, including parks and recreation areas | | Restoring power, electricity, or other utilities |
| | Other: | | |

8. Please select the **top <u>five</u> project types** that you think would make your community more resilient to storms, floods, and other coastal hazards. (Check up to **5** options.)

| | | | |
|---|---|---|---|
| | Nature-based solutions, such as living shorelines or habitat restoration | | Elevations of homes, businesses, and public infrastructure, including roads |
| | Acquisition and conservation of flood-prone land | | Utility upgrades for community facilities, such as increased generator capacity for hospitals |
| | Increased stormwater drainage capacity | | Resilience planning, policies, and development standards |
| | Structural protection, such as floodwalls or tide gates | | Public education and outreach |
| | Other: | | |

9. Where do you think Cape Carteret should implement resilience projects to minimize future damage from storms, floods, and other coastal hazards? What type of projects should the Town consider?

10. Cape Carteret is considering several projects to increase its resilience to coastal and climate hazards. Based on this list, please rank the **three projects** you think would generate the greatest benefit to the community (1 = greatest benefit).

| | | | |
|---|---|---|---|
| | **Stormwater Facility Improvements:** Improve stormwater facilities on multiple Town streets, including Sutton Drive, Arden Oaks Drive, Anita Forte Drive/Loma Linda Court, Dolphin Street, and Bogue Sound Drive. | | **Stormwater Infrastructure Mapping:** Map all stormwater infrastructure within Town limits to determine service gaps and needs. |
| | **Stormwater Pretreatment:** Construct stormwater treatment facilities to minimize water quality impacts to Bogue Sound and Pettiford Creek at multiple locations, including Sutton Drive, Arden Oaks Drive, Anita Forte Drive/Loma Linda Court, Dolphin Street, Neptune Drive, Neptune Court, and Bogue Sound Drive. | | **Swale Construction:** Construct a stormwater management project (grassy swale) at various locations, including Sutton Drive, Arden Oaks Drive, Anita Forte Drive/Loma Linda Court, Dolphin Street, Neptune Drive, Neptune Court, and Bogue Sound Drive. |
| | **Living Shoreline Construction:** Construct an oyster reef or living shoreline along the Bogue Sound and Deer Creek shoreline. | | **Emergency Shelter Improvements:** Work with Carteret County to address shelter needs and on upgrades to existing facilities. |
| | **Tree Canopy Replacement:** Plant young trees to increase overall tree canopy within the Town and replace trees lost during storm events. | | **Emergency Operations Center:** Establish center for western Carteret County, to be located in a new Town municipal complex located along Main Street outside of the modeled storm surge inundation on a Category 5 storm event. |

11. In addition to the projects previously listed, are there other resilience strategies that Cape Carteret should consider?

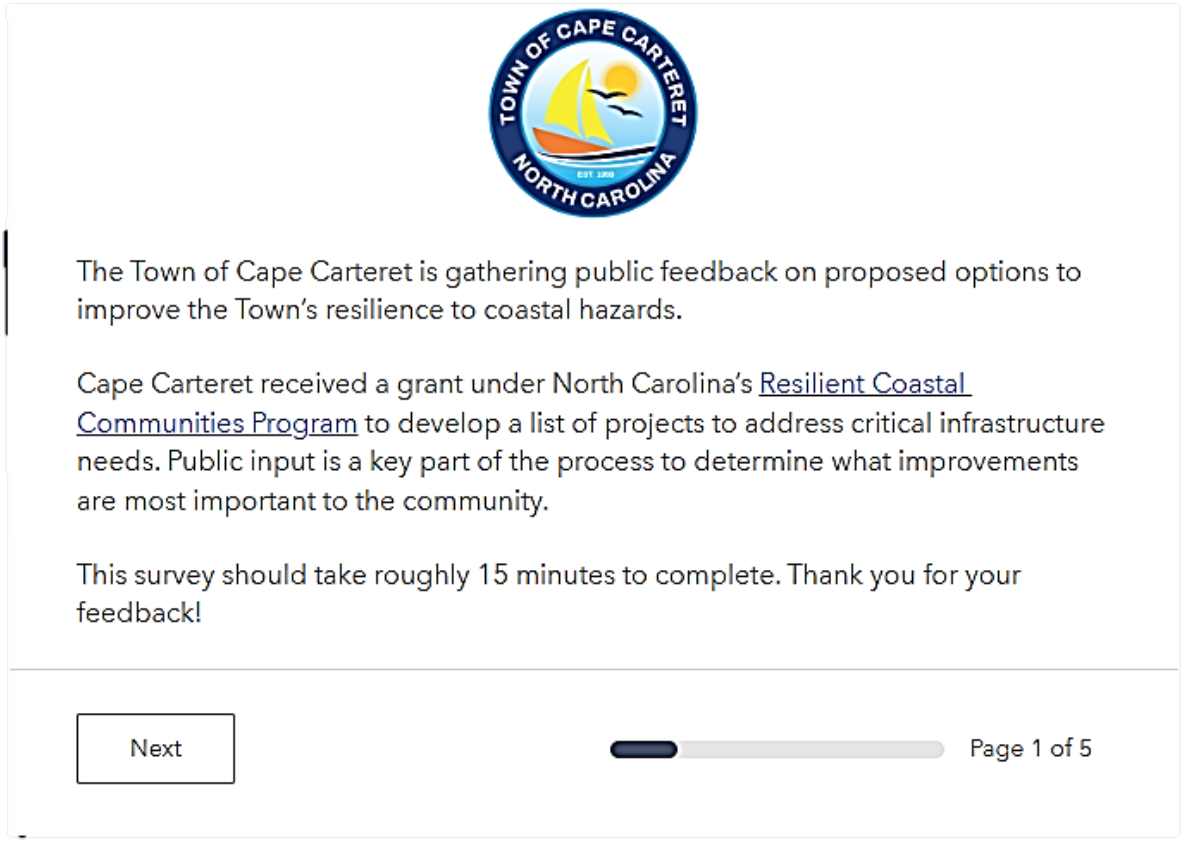
_____

_____

12. What options would you support for paying for these projects? (Select all that apply.)

| | | | |
|---|---|---|---|
| | Local taxes or levies | | Loans |
| | State or federal funding (grant funds, budget allocations, etc. | | Public-private partnerships |
| | Local bonds | | Other: |

# Online Public Engagement Screenshots



## Hazard Perceptions and Experiences

The following section includes questions about which hazards you believe most affect your community and your experiences with hazards in the past.

**What type of coastal or climate hazards concern you the most in your community?***

Select all that apply.

- [ ] Flooding
- [ ] Shoreline or Beach Erosion
- [ ] Extreme Heat
- [ ] Hurricanes and Tropical Storms
- [ ] Severe Weather (including thunderstorm winds, lightning, & hail)
- [ ] Wildfires
- [ ] Other

**What kind of flooding concerns you the most?***

Please rank these options from least (1) to most (4) concerning by dragging the boxes in order.

- Riverine
- Storm Surge (from hurricanes, tropical storms, etc.)
- Tidal (from king tides, nor'easters, etc.)
- Stormwater or Rainfall

Reset

**Current Risk: On a scale of 1 to 5, how significant of a risk do you think coastal hazards and/or flooding currently pose to your community?***

1 (Not a concern) 2 3 4 5 (Extreme risk)

**Future Risk: On a scale of 1 to 5, how significant of a risk do you think coastal hazards and/or flooding will pose to your community in the future?***

1 (Not a concern) 2 3 4 5 (Extreme risk)

## Locating Community Hazard Areas

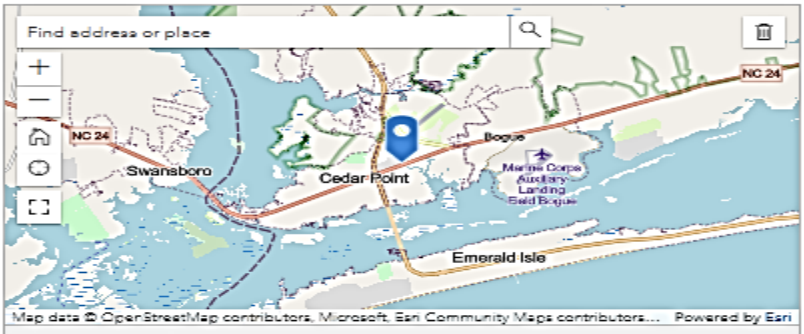
The following section aims to understand what areas and assets in Cape Carteret are vulnerable to coastal hazards and flooding to help identify potential resilience projects.

**Have you ever witnessed property or infrastructure damage due to coastal or climate hazards in your community?***

- ○ Yes
- ○ No

**Optional: Identify a location where you have witnessed damage from coastal or climate hazards in Cape Carteret.**

**Place a point on the map by zooming and clicking on the map, or entering an address into the search bar.**




Lat: 34.69127 Lon: -77.06321

**Optional: What hazard affected this location?**

- ○ Flooding
- ○ Shoreline or Beach Erosion
- ○ Extreme Heat
- ○ Hurricanes and Tropical Storms
- ○ Severe Weather (including thunderstorm winds, lightning, & hail)
- ○ Wildfires
- ○ Other

**Optional: Please provide a description of the damage you witnessed at this location.**

Based on your experiences, please select the top three challenges facing your community immediately after a storm, flood, or other coastal hazard event.*

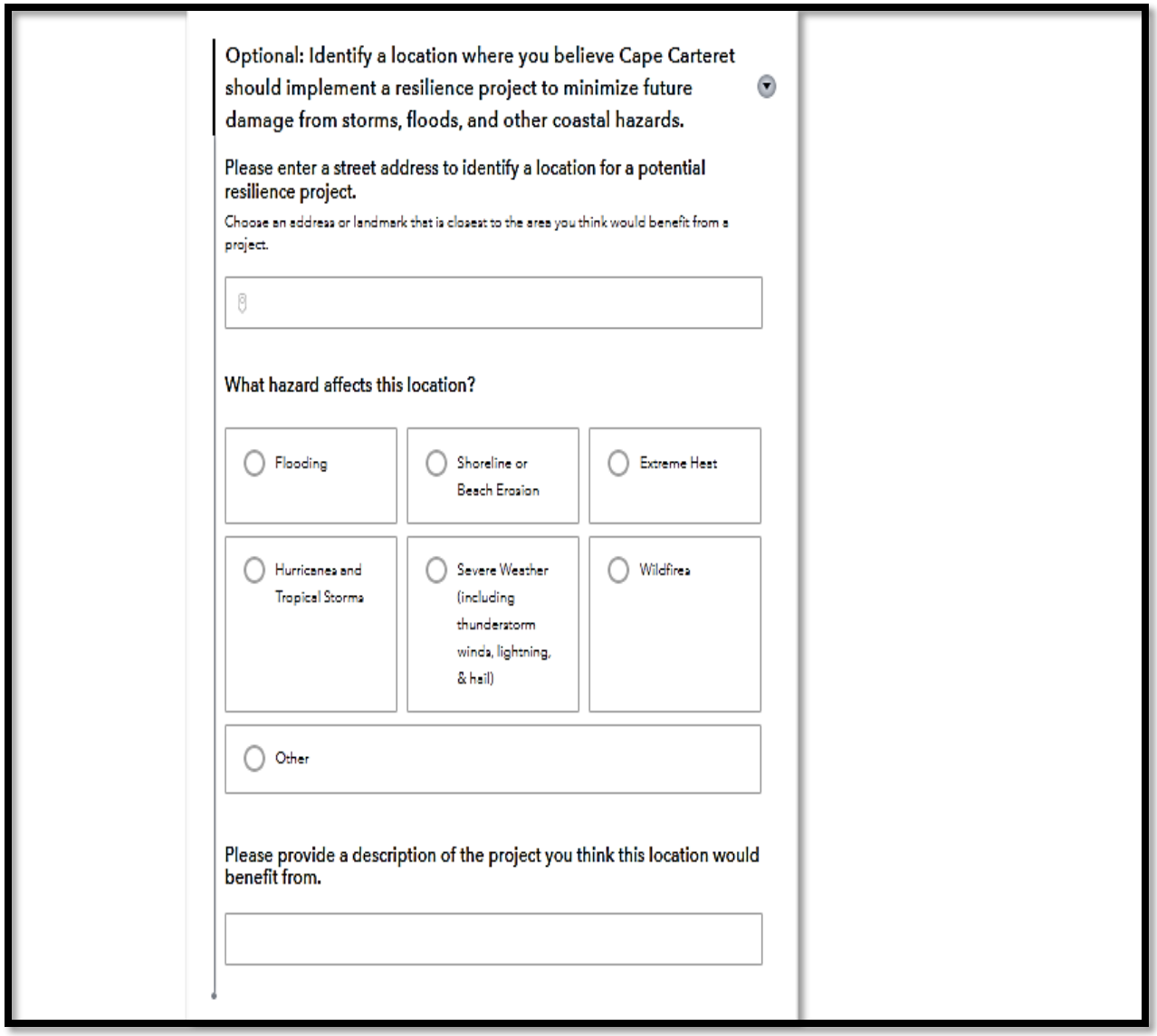
- [ ] Repairing or rebuilding physical infrastructure
- [ ] Loss of income or wages
- [ ] Loss or damage of natural infrastructure, including parks and recreation areas
- [ ] Re-opening businesses, government offices, or other community facilities
- [ ] Informing citizens about available assistance and resources
- [ ] Restoring power, electricity, or other utilities
- [ ] Other

## Resilience Project Identification

The following section aims to understand which types of projects you believe would benefit the Town of Cape Carteret the most.

**Please select the top five project types that you think would make your community more resilient to storms, floods, and other coastal hazards.***

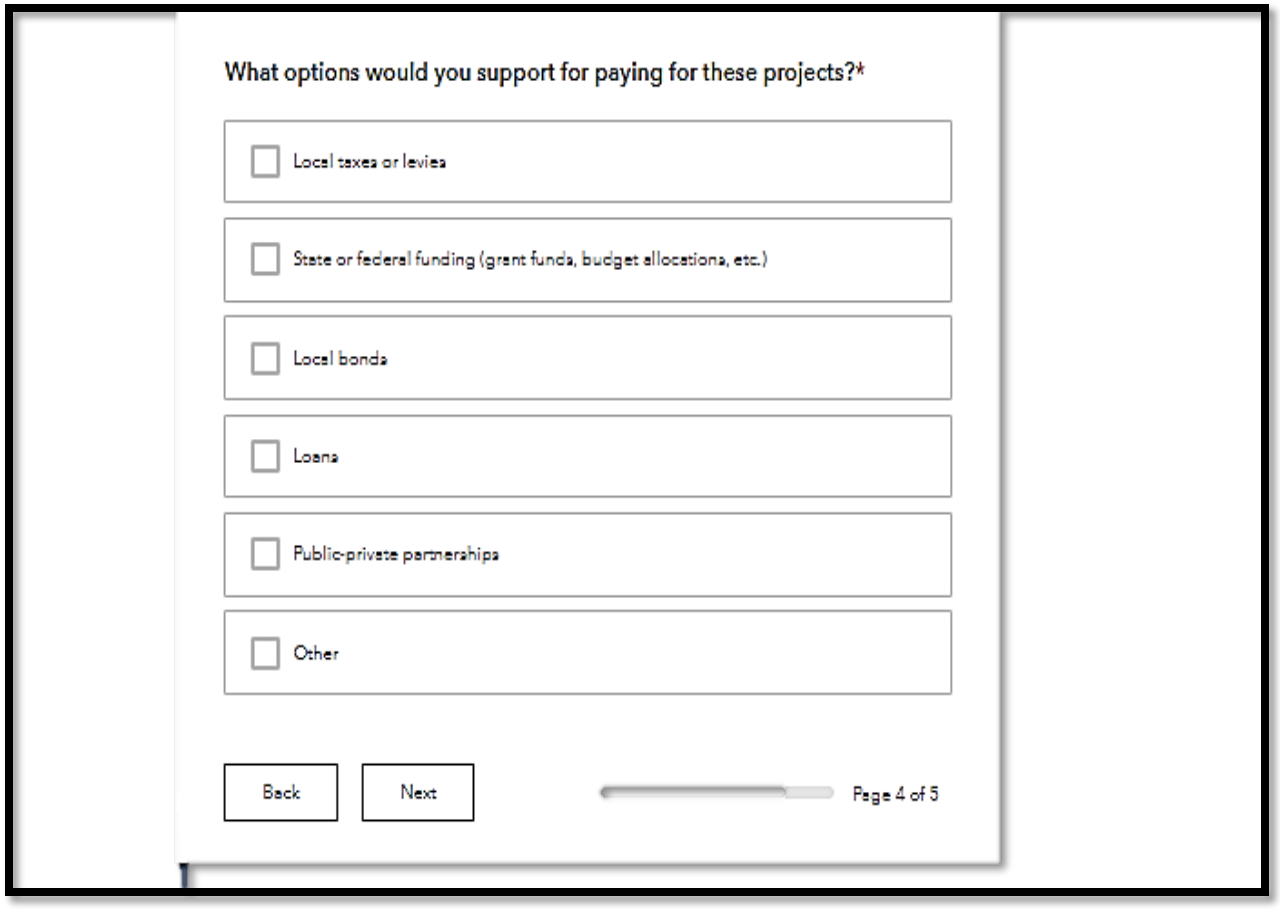
- [ ] Nature-based solutions, such as living shorelines or habitat restoration
- [ ] Acquisition and conservation of flood-prone land
- [ ] Increased stormwater drainage capacity
- [ ] Structural protection, such as floodwalls or tide gates
- [ ] Elevations of homes, businesses, and public infrastructure, including roads
- [ ] Utility upgrades for community facilities, such as increased generator capacity for hospitals
- [ ] Resilience planning, policies, and development standards
- [ ] Public education and outreach
- [ ] Other


Optional: Identify a location where you believe Cape Carteret should implement a resilience project to minimize future damage from storms, floods, and other coastal hazards.
Please enter a street address to identify a location for a potential resilience project.
Choose an address or landmark that is closest to the area you think would benefit from a project.
What hazard affects this location?
Flooding
Shoreline or Beach Erosion
Extreme Heat
Hurricanes and Tropical Storms
Severe Weather (including thunderstorm winds, lightning, & hail)
Wildfires
Other
Please provide a description of the project you think this location would benefit from.

**Cape Carteret is considering several projects to increase its resilience to coastal and climate hazards. Based on this list, please select the three projects you think would generate the greatest benefits to the community.***

- [ ] Stormwater Facility Improvements: Improve stormwater facilities on multiple Town streets, including Sutton Drive, Arden Oaks Drive, Anita Forte Drive, Loma Linda Court, Dolphin Street, Neptune Drive, Neptune Court, and Bogue Sound Drive.
- [ ] Stormwater Pretreatment: Construct stormwater treatment facilities to minimize water quality impacts to Bogue Sound and Pettiford Creek at multiple locations, including Sutton Drive, Adren Oaks Drive, Anita Forte Drive, Loma Linda Court, Dolphin Street, Neptune Drive, Neptune Court, and Bogue Sound Drive.
- [ ] Swale Construction: Construct a stormwater management project (grassy swale) at various locations, including Sutton Drive, Adren Oaks Drive, Anita Forte Drive, Loma Linda Cort, Dolphin Street, Neptune Drive, Neptune Court, and Bogue Sound Drive.
- [ ] Living Shoreline Construction: Construct an oyster reef or living shoreline along the Bogue Sound and Deer Creek shoreline.
- [ ] Stormwater Infrastructure Mapping: Map all stormwater infrastructure within Town limits to determine service gaps and needs.
- [ ] Emergency Shelter Improvements: Work with Carteret County to address shelter needs and on upgrades to existing facilities.
- [ ] Tree Canopy Replacement: Plant young trees to increase overall tree canopy within the Town and replace trees lost during storm events.
- [ ] Emergency Operations Center: Establish center for Western Carteret County to be located in a new Town municipal complex located along Main Street outside of the modeled storm surge inundation on a Category 5 storm event.

**Optional: Besides the projects previously listed, are there other resilience strategies Cape Carteret should consider?**


What options would you support for paying for these projects?*
Local taxes or levies
State or federal funding (grant funds, budget allocations, etc.)
Local bonds
Loans
Public-private partnerships
Other
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## Residency & Demographics

The following section includes questions about your relationship to the Town of Cape Carteret, as well as optional demographic questions.

**Which best describes you?***

- [ ] Full-time resident
- [ ] Part-time resident
- [ ] Work or own business in the Town of Cape Carteret
- [ ] Represent a jurisdiction, agency, or organization with vested interest in the Town of Cape Carteret
- [ ] Other

**What is your zip code?***

123

**Optional: Select your race or ethnicity.**

Select all that apply.

- [ ] American Indian or Alaska Native
- [ ] Asian
- [ ] Black or African American
- [ ] Native Hawaiian or Pacific Islander
- [ ] White
- [ ] Hispanic/Latino
- [ ] Other

**Optional: Select your age bracket.**

- ○ Under 18
- ○ 18 to 39
- ○ 40 to 66
- ○ Over 66

Back | Submit

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# MARCH 2022 COMMUNITY ENGAGEMENT PHOTOS



TOWN
CLERK

# Summary of Public Engagement Results - Areas of Flooding/Hazard Concern


Prepared for:

Sources: USGS, NC OneMap, Carteret County

**TOWN OF CAPE CARTERET**

0 0.2 0.4 0.8 Miles

N

Date: 5/3/2022

Drwn/Chkd: AB/ES

Prepared by Dewberry

APPENDIX C

# RISK AND VULNERABILITY ASSESSMENT

**MAY 2022**

Dewberry

# TOWN OF CAPE CARTERET RISK & VULNERABILITY ASSESSMENT

## North Carolina Resilient Coastal Communities Program

**APRIL 2022**

Dewberry


**SUBMITTED BY**
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Cover Image Credit: Town of Cape Carteret. Retrieved from http://www.townofcapecarteret.org/

## 1.0 Background

With support from the North Carolina Division of Coastal Management's Resilient Coastal Communities Program (RCCP), a Risk and Vulnerability Assessment was conducted to evaluate the susceptibility of the region's critical assets and natural infrastructure to coastal hazards. The RCCP facilitates a community-driven process for setting coastal resilience goals, assessing existing and needed local capacity, and identifying and prioritizing "shovel-ready" projects to enhance community resilience to coastal hazards.[1] This report summarizes the assessment process and results for the Town of Cape Carteret.

As part of Phase 1 of RCCP (Figure 1), this assessment supports the program objectives by identifying and mapping structures and areas vulnerable to potential damage or harm from coastal hazards. Determining whether these assets are or will be exposed to hazards facilitates the identification and prioritization of resilience projects in Phase 2 of the Program. These projects and strategies are critical to bolstering Cape Carteret's resilience to existing and future coastal risks. ***Resilience*** refers to the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions.[2]

Figure 1. RCCP Program Phases


[1] North Carolina Department of Environmental Quality. *North Carolina Resilient Coastal Communities Program.* Division of Coastal Management. https://deq.nc.gov/about/divisions/coastal-management/coastal-adaptation-and-resiliency/nc-resilient-coastal-communities-program

[2] Executive Order No. 13653, 78 FR (66817- 66824). 2015. https://obamawhitehouse.archives.gov/the-press-office/2015/03/19/executive-order-planning-federal-sustainability-next-decade

## 2.0 Assessment Framework

The RCCP Handbook (June 2021) provides the basis for this framework to assess the risk and vulnerability of Cape Carteret's assets. Based on the RCCP Handbook, this method and the following section is organized in the following three steps:

**Identify and Map Hazards**
*Review Pamlico Sound Regional Hazard Mitigation Plan. Augment hazard assessment based on inputs from the Community Action Team (CAT). Collect relevant spatial asset and hazard data.*

**Assess Vulnerability**
*Examine the likelihood that an asset will be affected by coastal hazards. Develop an index to assign Vulnerability Scores to estimate asset susceptibility to coastal hazards.*

**Estimate Risk**
*Determine potential risk to assets to prioritize actions that increase resilience to future hazards. Develop an index to assign Risk Scores to estimate potential impacts on the surrounding community.*

This assessment focuses on coastal flooding hazards and their potential impacts on Cape Carteret. As identified in the RCCP Handbook, this process considers the following hazards: rainfall, riverine, storm surge and tidal flooding, and sea level rise. Due to the limited available data, rainfall-driven flooding is summarized qualitatively in the results section.

A primary goal of the RCCP is to support the identification and implementation of resilient projects in participating communities. In support of this goal, this assessment focuses on potential impacts on critical built infrastructure and natural infrastructure, defined as the following:

**Critical Built Infrastructure**
*Physical structures that house or perform functions that enable the continuous operation of government and business functions and are essential to human health and safety or economic safety.*[3]

**Natural Infrastructure**
*Naturally occurring landscapes and systems that perform ecosystem services that benefit nearby communities, like flood protection or abatement, erosion control, and water purification.*

After mapping hazards, the assessment determines which critical built infrastructure and natural infrastructure assets are vulnerable – the degree to which they are expected to experience adverse impacts – to flooding. This framework considers three components that contribute to vulnerability: exposure, sensitivity, and adaptive capacity.

Metrics are developed for each component, and assets are scored zero to three. As outlined in the RCCP Handbook, an asset's Vulnerability Score is determined by adding the Exposure and Sensitivity Score and subtracting the Adaptive Capacity Score (Figure 2).

[3] Federal Emergency Management Agency. *Community Lifelines.* https://www.fema.gov/emergency-managers/practitioners/lifelines

Figure 2. Components of Vulnerability

| Exposure | + | Sensitivity | – | Adaptive Capacity | = | Vulnerability |
|---|---|---|---|---|---|---|
| *The probability of physical contact between an asset and a hazard* | | *The degree to which an asset may be affected by a hazard* | | *The ability of an asset to change its characteristics or behavior in response to a hazard* | | *The degree to which an asset or system is expected to experience adverse impacts due to flooding.* |

As noted in Figure 2, an asset's ***Vulnerability*** defines the degree to which coastal hazards threaten its physical structure or core function. However, interruption to services or physical damage to assets can affect entire communities, depending on the asset's importance to the region and the regional context. These consequences can amplify an asset's vulnerability to adverse impacts of flooding.

After examining vulnerability, the assessment estimates ***Risk*** – the overall potential for negative consequences – by considering two components: vulnerability and consequences. Vulnerability is measured using the Vulnerability Score. Consequences refer to the degree to which a community is adversely impacted if an asset is damaged by flooding.

The assessment examines two factors that contribute to its severity to understand the consequences of potential coastal flood hazards: social vulnerability and asset criticality. *Social vulnerability* refers to the susceptibility of social groups, indicated by certain social conditions such as poverty, to experience adverse impacts during hazard events. *Asset criticality* aims to characterize how important an asset is to its surrounding community based on the potential scale of economic loss caused by its damage during a flood.

Consequence metrics are multiplied by the Vulnerability Score to produce a Risk Score for each asset (Figure 3). Due to limited data for natural infrastructure, this step is only applied to critical built infrastructure assets.

Figure 3. Components of Risk

| Vulnerability | x | Consequences | = | Risk |
|---|---|---|---|---|
| *The degree to which an asset or system is expected to experience adverse impacts due to flooding.* | | *The degree to which a community is adversely impacted if an asset is damaged by flooding* | | *The overall potential for negative consequences due to flooding* |

This report summarizes the process and key results from Cape Carteret's vulnerability and risk assessment. This report's results and findings support the identification and prioritization of resilience projects for the Town as part of Phase 2 of the RCCP.

# 3.0 Identify & Map Hazards

## 3.1 Hazard Identification

Based on a review of recent community plans and CAT meeting discussions, three relevant hazards were selected to examine in the assessment process: coastal (tidal and storm surge), riverine, and rainfall-driven flooding. Cape Carteret has experienced each of these hazards, and each is considered a high-priority hazard in the 2020 Pamlico Sound Regional Hazard Mitigation Plan.

**Coastal flooding** is assessed using floodplain data produced for the North Carolina Sea Level Rise Impact Study. Present (baseline) and future flood conditions are considered for six frequency events: mean higher high water (MHHW), 10-year, 25-year, 50-year, 100-year, and 500-year. Future flood conditions approximate a 30-year projection for sea level rise by using a 1.3-feet (40-centimeter) sea level rise scenario to estimate coastal hazards for 2050.

**Riverine flooding** is assessed using floodplain data from the North Carolina Floodplain Mapping Program. This data provides present conditions for the 100-year frequency event.

**Rainfall-driven flooding** is incorporated qualitatively in the results section due to limited spatial data. This hazard is assessed using information from the Town's RCCP application, CAT feedback, and historical rainfall maps from Hurricanes Matthew (2016) and Florence (2018).

## 3.2 Asset Identification

### 3.2.1 Critical Built Infrastructure

Critical built infrastructure refers to physical structures that house or perform functions that enable the continuous operation of government and business functions and are essential to human health and safety or economic safety. The assessment identified critical built infrastructure assets using multiple datasets available on NC One Map. Assets include both individual sites – point-level data representing structures, facilities, and other buildings – and components of systems, such as roadways. The Federal Emergency Management Agency's (FEMA) Community Lifeline framework served as a starting point to identify and categorize critical built infrastructure assets.

Table 1 summarizes the individual sites examined within Cape Carteret. For assets that perform multiple functions, such as a public school serving as an emergency shelter, the asset is evaluated separately under each category. Using NC Department of Transportation (NCDOT) data, the assessment also examined approximately 26 miles of road segments within Cape Carteret. These assets, floodplain extents, and all other maps can be found in Appendix B.

Table 1. Summary of Critical Built Infrastructure Sites by Type

| TYPE | INCLUDES… | NO. OF ASSETS |
|---|---|---|
| Emergency Shelters | *Buildings identified for use as a temporary shelter during disasters or emergencies.* | 1 |
| Emergency Medical Services | *Locations where EMS personnel are stationed, based out of, or store the equipment used to carry out their job functions, including independent ambulatory services.* | 0 |
| Fire Stations | *Buildings that house firefighting personnel and their equipment.* | 0 |
| Government Buildings | *Buildings that house governmental operations, such as town halls.* | 1 |
| Law Enforcement Sites | *Buildings that house local, state, federal, and special jurisdiction law enforcement agencies, e.g., municipal police, county sheriffs, and park police.* | 1 |
| Medical Facilities | *Facilities that provide health and medical services, including hospitals, nursing homes, mental health homes, and hospices.* | 0 |
| Public Schools | *Locations of pre-kindergarten, elementary, middle, high, and early college schools.* | 1 |
| Wastewater Facilities | *Locations of wastewater discharge sites and treatment plants.* | 0 |
| Water Supplies | *Locations of public water supply sources, including both ground, spring, and surface water sources.* | 0 |
| **Total** | | **4** |

### 3.2.2 Natural Infrastructure

Areas containing natural infrastructure were identified using marsh land cover data from the National Oceanic and Atmospheric Administration's (NOAA) Sea Level Affecting Marshes Model (SLAMM). This data focuses on marsh habitats, such as tidal and non-tidal wetlands, and identifies upland habitats and parks in developed areas.

## 4.0 Assess Vulnerability

An asset's vulnerability is a function of its exposure, sensitivity, and adaptive capacity to coastal hazards. Assessing the vulnerability of a structure, like critical built infrastructure, differs from that of natural infrastructure. In recognition of these differences, metrics for evaluating exposure, sensitivity, and adaptive capacity differ for the two types of assets considered.

A Vulnerability Score is calculated for **critical built infrastructure** by assessing exposure, sensitivity, and adaptive capacity separately to produce scores for each component. For each metric, assets are assigned a score from zero to three. Following the equation outlined in Figure 4 (for reference only; identical to Figure 2), the Vulnerability Score equals exposure plus sensitivity minus adaptive capacity. This process makes it possible for critical built infrastructure to receive a negative Vulnerability Score, but a negative score does not indicate an asset would be unaffected or resistant to actual flood events. Instead, an asset with a negative score can be interpreted as potentially less vulnerable to coastal hazards relative to other assets examined in this assessment.

Figure 4. Components of Vulnerability (Identical to Figure 2)

| **Exposure** | + | **Sensitivity** | – | **Adaptive Capacity** | = | **Vulnerability** |
|---|---|---|---|---|---|---|
| *The probability of physical contact between an asset and a hazard* | | *The degree to which an asset may be affected by a hazard* | | *The ability of an asset to change its characteristics or behavior in response to a hazard* | | *The degree to which an asset or system is expected to experience adverse impacts due to flooding.* |

For **natural infrastructure**, this assessment leverages NOAA's Sea Levels Affecting Marshes Model (SLAMM) to identify changes in marsh land cover. SLAMM assumes that specific types of wetlands can exist within an established range of tidal elevations, based on which vegetation can thrive given the varying frequency, time, and salinity impacts of inundation.[4] The model incorporates a habitat's exposure, sensitivity, and adaptive capacity into one metric: projected habitat lost to open water due to sea level rise. Vulnerability Scores are assigned to a habitat type based on its overall projected land loss.

[4] NOAA Office for Coastal Management. 2017. "Detailed Method for Mapping Sea Level Rise Marsh Migration." NOAA. https://coast.noaa.gov/data/digitalcoast/pdf/slr-marsh-migration-methods.pdf

## 4.1 Critical Built Infrastructure

### 4.1.1 Coastal & Riverine Flood Exposure

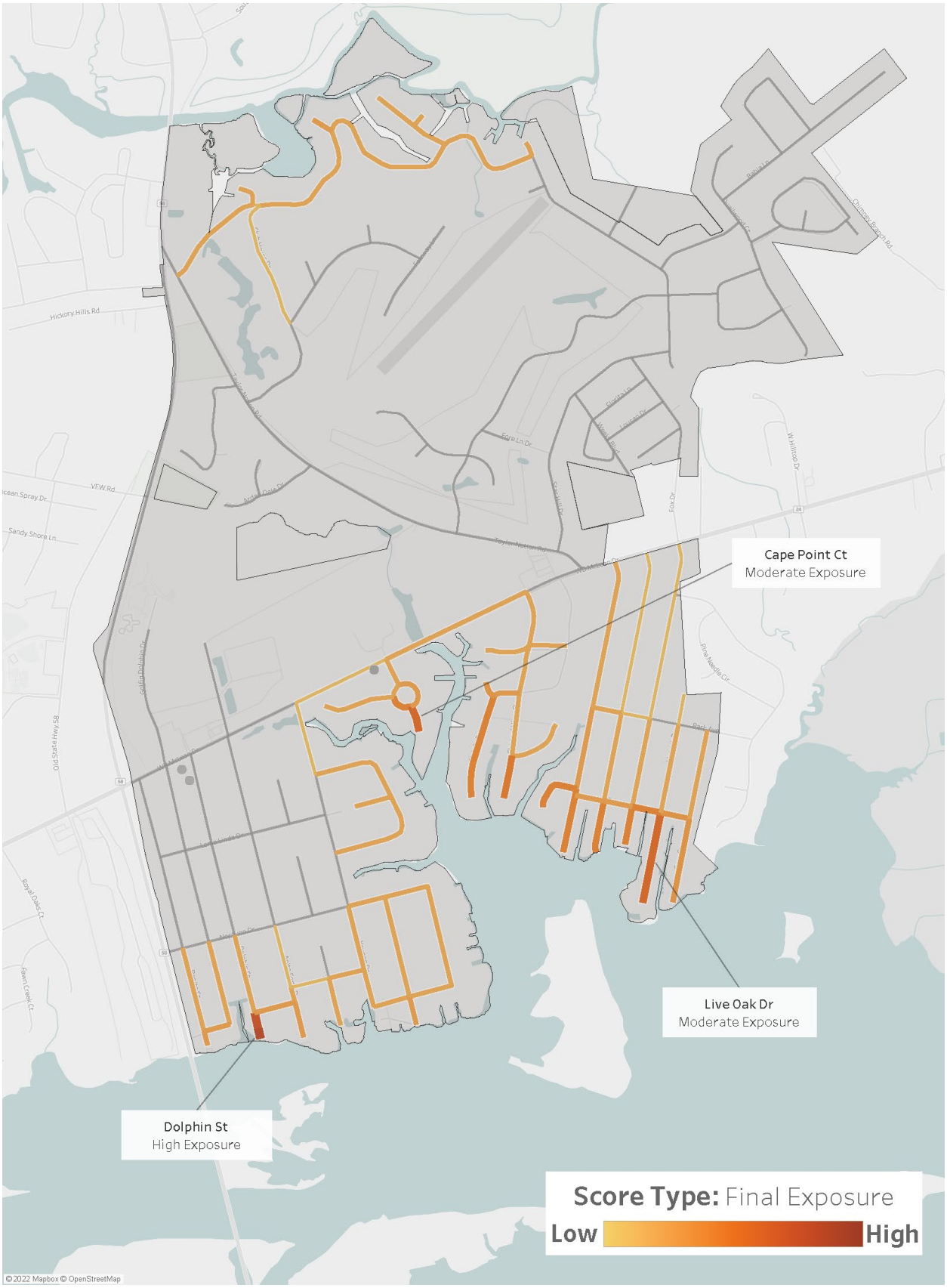
Critical Built Infrastructure assets are assigned an **Exposure Score** from zero (no flood exposure) to three (frequent flood exposure) based on whether it is expected to be exposed to flooding during flood events considered in this assessment. Exposure Scores are determined by considering both present and future flood conditions. Future flood conditions incorporate a 1.3-foot sea level rise scenario to approximate a 30-year projection for the year 2050.

Assets' Exposure Scores are referenced from low to high exposure, as summarized in Table 2, to facilitate the discussion of these results.

Table 2. Summary of Exposure Scores

| ASSET EXPOSURE | EXPOSURE SCORE | POTENTIALLY EXPOSED TO… |
|---|---|---|
| High | 2.5 and higher | Mean higher high water **or** 10-year flood event |
| Moderate-High | Between 2 and 2.5 | 25-year flood event |
| Moderate | Between 1.5 and 2 | 50-year flood event |
| Moderate-Low | Between 1 and 1.5 | 100-year flood event |
| Low | Less than 1 | 500-year flood event |
| None | Zero | No flood exposure |

Figure 5. Critical Built Infrastructure Coastal and Riverine Flood Exposure



#### 4.1.1.1 Site-Level Assets

As summarized in Table 3 below, none of Cape Carteret's critical built infrastructure sites were exposed to coastal or riverine flooding under current or future conditions. Appendix A contains a complete list of assets and their scores.

Table 3. Summary of Critical Built Infrastructure Asset Exposure

| ASSET EXPOSURE | ASSET TYPE* | | | | | |
|---|---|---|---|---|---|---|
| | ES | GB | LE | PS | TOTAL | % |
| High | 0 | 0 | 0 | 0 | **0** | **0%** |
| Moderate-High | 0 | 0 | 0 | 0 | **0** | **0%** |
| Moderate | 0 | 0 | 0 | 0 | **0** | **0%** |
| Moderate-Low | 0 | 0 | 0 | 0 | **0** | **0%** |
| Low | 0 | 0 | 0 | 0 | **0** | **0%** |
| None | 1 | 1 | 1 | 1 | **4** | **100%** |
| *Total Assessed* | *1* | *1* | *1* | *1* | *4* | |
| **Total Exposed** | **0** | **0** | **0** | **0** | **0** | |
| **% Exposed** | **0%** | **0%** | **0%** | **0%** | **0%** | |

*ES = Emergency Shelter
GB = Government Building
LE = Law Enforcement
PS = Public School

#### 4.1.1.2 Roadways

Approximately 11 miles of roadway in Cape Carteret – representing 42% of all roadways assessed – are exposed to flooding, as summarized in Table 4. Of exposed road segments, the majority exhibited low flood exposure.

The two road segments facing high and moderate-high exposure are located on Dolphin Street near the Bogue Sound, a known problem area for flooding in Cape Carteret. Other identified problem areas – including Live Oak Drive, Club Court, Edgewater Court, Bogue Sound Drive, Lejeune Road, and Bayshore Drive – exhibited moderate and moderate-low exposure to coastal and riverine flooding. Several of these roadways have previously experienced rainfall-driven flooding, which is not captured in this assessment, and may face additional flood hazards.

Rainfall-driven flooding is already a concern in Cape Carteret, due to its low elevation and existing stormwater infrastructure. Areas near existing waters, particularly the Bogue Sound, that lack drainage infrastructure experience recurring flooding issues. Town officials identified additional roadways that experience rainfall-driven flooding, including the following: Arden Oaks Drive, Anita Forte Drive, Bogue Sound Drive, Dolphin Street, Gemini Drive, Neptune Drive, Quailwood Court, Starlight Drive, and Sutton Drive. Additional analysis may be required to characterize rainfall-driven flood hazards.

Appendix A contains a complete list of roadways and their scores organized by individual segments.

Table 4. Summary of Roadway Exposure

| ASSET EXPOSURE | ROAD SEGMENTS | ROAD MILES | % TOTAL (MILES) |
|---|---|---|---|
| High | 1 | < 0.1 | **0%** |
| Moderate-High | 1 | < 0.1 | **0%** |
| Moderate | 2 | 0.3 | **0.1%** |
| Moderate-Low | 9 | 0.9 | **0.4%** |
| Low | 66 | 9.7 | **37%** |
| None | 134 | 15.2 | **58%** |
| *Total Assessed* | *213* | *26.2* | |
| **Total Exposed** | **79** | **11** | |
| **% Exposed** | **37%** | **42%** | |

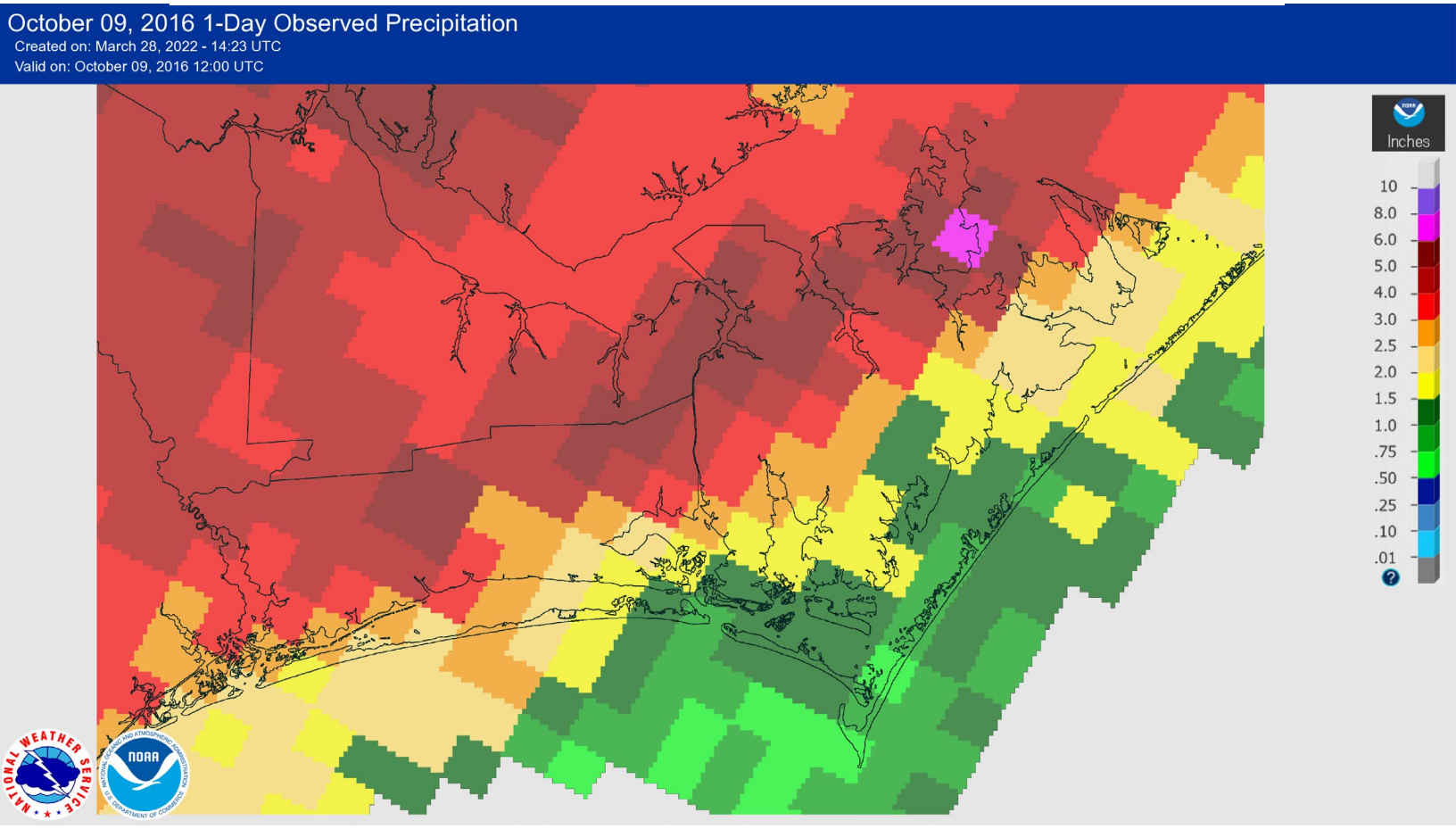
### 4.1.2 Rainfall-Driven Flood Exposure

Due to limited available data, rainfall-driven flood hazards were not included in the spatial exposure assessment. However, previous events in Cape Carteret can illustrate how this type of flooding can affect the region's critical built infrastructure. In 2016 and 2018, Hurricanes Matthew and Florence produced historic precipitation in North Carolina, resulting in significant flooding.

During Hurricane Matthew, portions of Cape Carteret received up to four inches of precipitation in a single day (Figure 6).[5] In Carteret County, areas directly facing the Atlantic Ocean recorded less precipitation (between three-quarters to three inches) than those protected by barrier islands and bordering the Bogue Sound or Neuse River.

The storm led to flooding along W.B. McLean Drive (NC 24) and residential areas, including Bayshore Park and Star Hill North. The Town did not report any housing or infrastructure damage due to Hurricane Matthew. However, the storm underscored Cape Carteret's need for safe egress and accessible evacuation routes, especially for roadways that experience nuisance flooding or may become impassable due to floodwater levels and poor drainage.

Figure 6. Rainfall Amounts for Hurricane Matthew

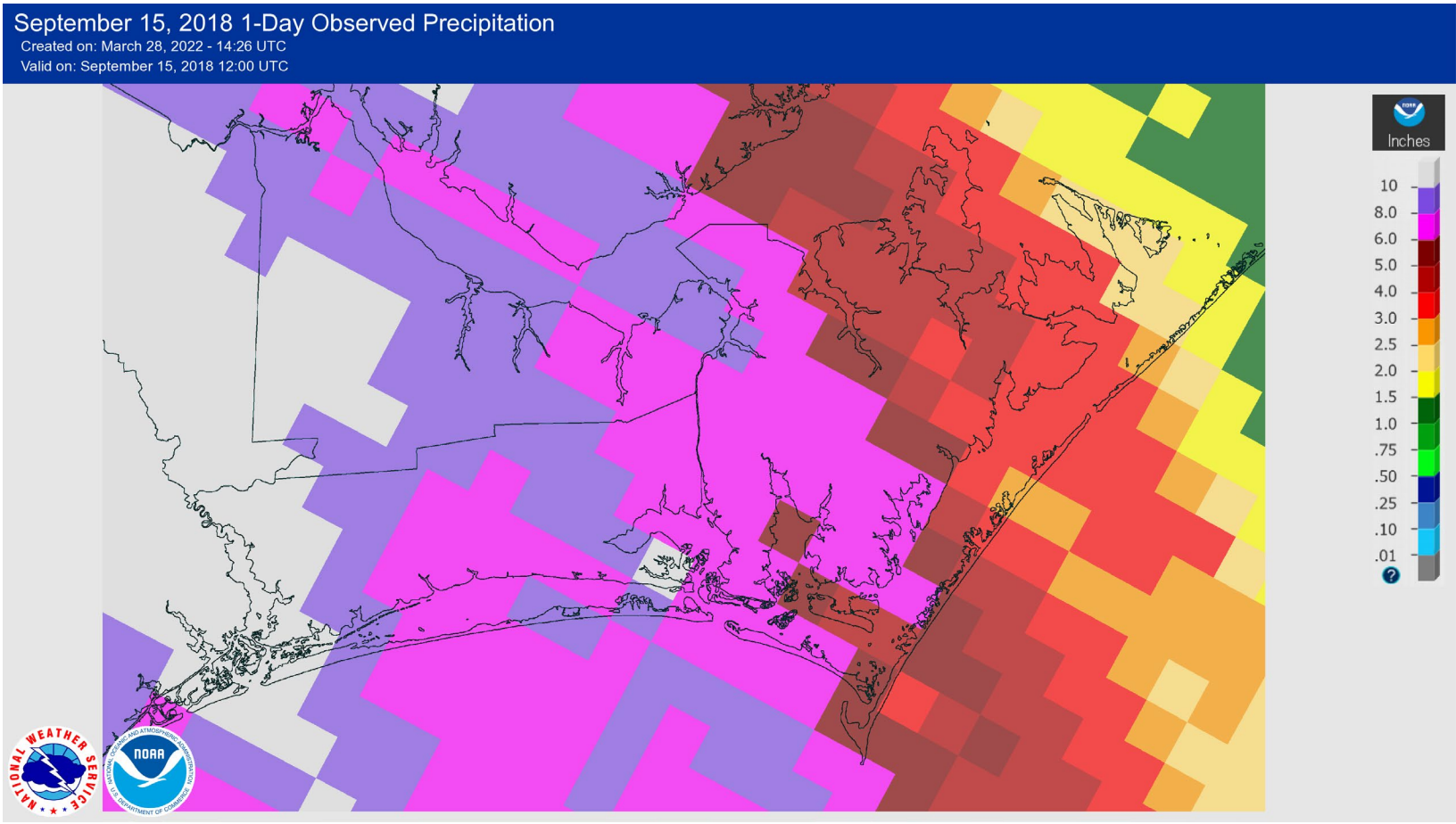



[5] NOAA. 2016. "Quantitative Precipitation Estimates: October 9, 2016 1-Day Observed Precipitation." Retrieved from https://water.weather.gov/precip/

During Hurricane Florence, parts of Cape Carteret recorded between eight and 10 inches of precipitation in a single day, while others, particularly to the northeast, recorded more than 10 inches (Figure 7).[6] The storm flooded W.B. McLean Drive (NC 24) and several residential subdivisions, including Bayshore Park and Arden Oaks. In the Bayshore Park neighborhood, the storm severely damaged the Harborlight Bed and Breakfast, which was ultimately demolished and not rebuilt. In Arden Oaks, the storm's floodwaters blocked the neighborhood entrance. This area is located outside of designated flood zones but is a known recurring flood problem area that the Town seeks to mitigate.

All assets in Cape Carteret are exposed to rainfall events. However, the vulnerability to adverse impacts depends on multiple factors, such as the event's intensity and duration and the drainage capacity of stormwater infrastructure in the surrounding area. Future assessments may consider these factors to assess individual asset exposure and vulnerability. Already, the Town has identified several roadways and neighborhoods vulnerable to rainfall-driven flooding for potential mitigation funding under FEMA's Building Resilient Infrastructure and Communities (BRIC) grant program.

Figure 7. Rainfall Amounts for Hurricane Florence




[6] NOAA. 2018. "Quantitative Precipitation Estimates: September 15, 2018 1-Day Observed Precipitation." Retrieved from https://water.weather.gov/precip/

### 4.1.3 Sensitivity

Sensitivity reflects the potential damage to critical built infrastructure's materials, functions, or the surrounding environment if it were flooded. Critical built infrastructure that cannot immediately accommodate floodwaters or increased water levels is more likely to experience higher damage levels. **Sensitivity Scores** are assigned by asset types and consider the potential for damage and disruption of essential services or functions.

Sensitivity depends on the physical characteristics and functions of critical built infrastructure, which are shared across asset types. For sites, this metric is determined by answering three questions that illustrate an asset's sensitivity to flooding, using information from the Consequence Analysis Tables for Floods, Hurricanes, and Tropical Storm hazards in the 2020 Pamlico Sound Regional Hazard Mitigation Plan. For each "yes" response, the asset type receives one point. The final score is a sum of the responses to the following three questions:

- If flooded, is the essential service/function likely to be disrupted?
- If flooded, is the asset likely to endure physical damage?
- If flooding caused damage or disruption, would the asset likely be offline longer than 24 hours?

For roadways, sensitivity was determined using storm surge inundation data provided by the NC Department of Transportation. This dataset included road segment elevations and flood depths for multiple storm surge conditions. The assessment selected storm surge levels that align with observations recorded during Hurricanes Matthew (2016) and Florence (2018).

Based on this process, assets were assigned Sensitivity Scores from zero (low potential for damage) to three (high potential for damage), as outlined in Table 5. Many roadways that exhibited high sensitivity also experienced flooding during previous storms, including Anita Forte Drive, Dolphin Street, Edgewater Court, and Star Hill Drive. If flooded, roadways may be impassable for vehicles, blocking egress from Cape Carteret, which Town officials have identified as a significant concern.

Table 5. Summary of Sensitivity Scores

| ASSET SENSITIVITY | DESCRIPTION | SENSITIVITY SCORE |
|---|---|---|
| High | Significant potential for damage and disruption during a flood | 3 |
| Moderate-High | Some potential for damage or disruption during a flood | 2 |
| Moderate-Low | Limited potential for damage or disruption during a flood | 1 |
| Low | Unlikely to experience damage or disruption | Zero |
| Not Scored | Not exposed | None |

### 4.1.4 Adaptive Capacity

Adaptative capacity illustrates the ability of an asset to change its characteristics or behavior in response to a hazard. An asset's potential to adapt depends on the potential suite of options available and a community's ability to implement those actions. The **Adaptive Capacity Score** is determined by answering three questions that illustrate an asset's adaptive capacity. For each question answered "yes," the asset type receives one point. The final score is a sum of each "yes" response to the following three questions:

- Are relevant high priority mitigation strategies identified in recent community plans?
- Can the asset be relocated?
- Is the asset located in a community with at least a moderate capability to mitigate risk from and vulnerability to hazards?

Based on this assessment, assets are assigned an Adaptive Capacity from zero (low ability to change characteristics or behaviors) to three (high ability), as outlined in Table 6. Many site-level assets can technically be relocated without compromising their functions, while assets that cannot be easily relocated, like roads or water supplies, are assigned lower adaptive capacity scores.

Table 6. Summary of Adaptive Capacity Scores

| ASSET ADAPTIVE CAPACITY | DESCRIPTION | ADAPTIVE CAPACITY SCORE |
|---|---|---|
| High | Asset behaviors, functions, **and** asset location can be modified to better withstand coastal hazards | 3 |
| Moderate-High | Asset behaviors, functions, **or** asset location can be modified to better withstand coastal hazards | 2 |
| Moderate-Low | Modification of asset behaviors, function, or location may be possible | 1 |
| Low | Modification of asset behaviors, function, or location is difficult or not feasible | Zero |
| Not Scored | Not exposed | None |

### 4.1.5 Vulnerability Assessment Results

After assessing exposure, sensitivity, and adaptive capacity, the vulnerability of assets can be determined. Based on the framework in Figure 8 (for reference only; identical to Figure 2), assets can receive potential **Vulnerability Scores** from a high of six (high vulnerability) to a low of negative three (low vulnerability).

Figure 8. Components of Vulnerability (Identical to Figure 2)

| Exposure | + | Sensitivity | – | Adaptive Capacity | = | Vulnerability |
|---|---|---|---|---|---|---|
| *The probability of physical contact between an asset and a hazard* | | *The degree to which an asset may be affected by a hazard* | | *The ability of an asset to change its characteristics or behavior in response to a hazard* | | *The degree to which an asset or system is expected to experience adverse impacts due to flooding.* |

The assessment produced a range of Vulnerability Scores from a low of -0.83 to a high of 3.67 for roadways. To facilitate the discussion of these results, asset Vulnerability Scores are referenced from low to high vulnerability relative to the actual range of results, summarized in Table 7.

As illustrated in Figure 9, assets in Cape Carteret with higher Vulnerability Scores tend to be clustered along Bogue Sound, where there are known flooding issues.

Table 7. Summary of Vulnerability Scores

| ASSET VULNERABILITY | VULNERABILITY SCORE |
|---|---|
| High | Greater than 3 |
| Moderate-High | Between 2.25 and 3 |
| Moderate | Between 1.5 and 2.25 |
| Moderate-Low | Between 0 and 1.5 |
| Low | Less than zero |
| Not Scored | None (Not Exposed) |

Figure 9. Vulnerability Scores for Critical Built Infrastructure

#### 4.1.5.1 Site-Level Assets

No site-level assets in Cape Carteret exhibit flood exposure under present or future conditions. Due to the lack of exposure, site-level assets were not assigned Vulnerability Scores, as summarized in Table 8. Appendix A contains a complete list of assets and their scores.

Table 8. Summary of Critical Built Infrastructure Asset Vulnerability

| ASSET VULNERABILITY | ASSET TYPE* | | | | | |
|---|---|---|---|---|---|---|
| | ES | GB | LE | PS | TOTAL | % |
| High | 0 | 0 | 0 | 0 | **0** | **0%** |
| Moderate-High | 0 | 0 | 0 | 0 | **0** | **0%** |
| Moderate | 0 | 0 | 0 | 0 | **0** | **0%** |
| Moderate-Low | 0 | 0 | 0 | 0 | **0** | **0%** |
| Low | 0 | 0 | 0 | 0 | **0** | **0%** |
| None | 1 | 1 | 1 | 1 | **4** | **100%** |
| *Total Assessed* | *1* | *1* | *1* | *1* | *4* | |
| **Total Scored** | **0** | **0** | **0** | **0** | **0** | |

*ES = Emergency Shelter
GB = Government Building
LE = Law Enforcement
PS = Public School

#### 4.1.5.2 Roadways

Approximately six miles of roadway in Cape Carteret face at least moderate vulnerability to coastal hazards, as outlined in Table 9. Many roadways experiencing high and moderate-high vulnerability include municipal, private, and non-system segments near the Bogue Sound that have been previously identified as problem areas, including the following: Anita Forte Drive, Club Court, Deer Creek Drive, Dolphin Street, and Edgewater Court.

Additionally, Town officials identified several roadways that have historically experienced rainfall-driven flooding, which is not captured in this assessment, including Arden Oaks Drive, Quailwood Court, Starlight Drive, and Sutton Drive. These roads may require additional analysis to characterize potential hazards.

Appendix A contains a complete list of roadways and their scores organized by individual segments.

Table 9. Summary of Roadway Vulnerability

| ASSET VULNERABILITY | ROAD SEGMENTS | ROAD MILES | % TOTAL (MILES) |
|---|---|---|---|
| High | 6 | 0.4 | **2%** |
| Moderate-High | 5 | 3.9 | **15%** |
| Moderate | 9 | 1.4 | **5%** |
| Moderate-Low | 36 | 4.2 | **16%** |
| Low | 23 | 1.0 | **4%** |
| None | 134 | 15.2 | **58%** |
| *Total Assessed* | *213* | *26.2* | |
| **Total Scored** | **79** | **11** | |

#### 4.1.5.3 Vulnerability Change Over Time

The assessment of both present and future flood conditions allows Vulnerability Scores to be calculated under both present and future conditions. Future flood conditions are approximated by using floodplain data that incorporates a 1.3-foot (40 centimeters) sea level rise scenario to estimate coastal flood hazards for 2050.

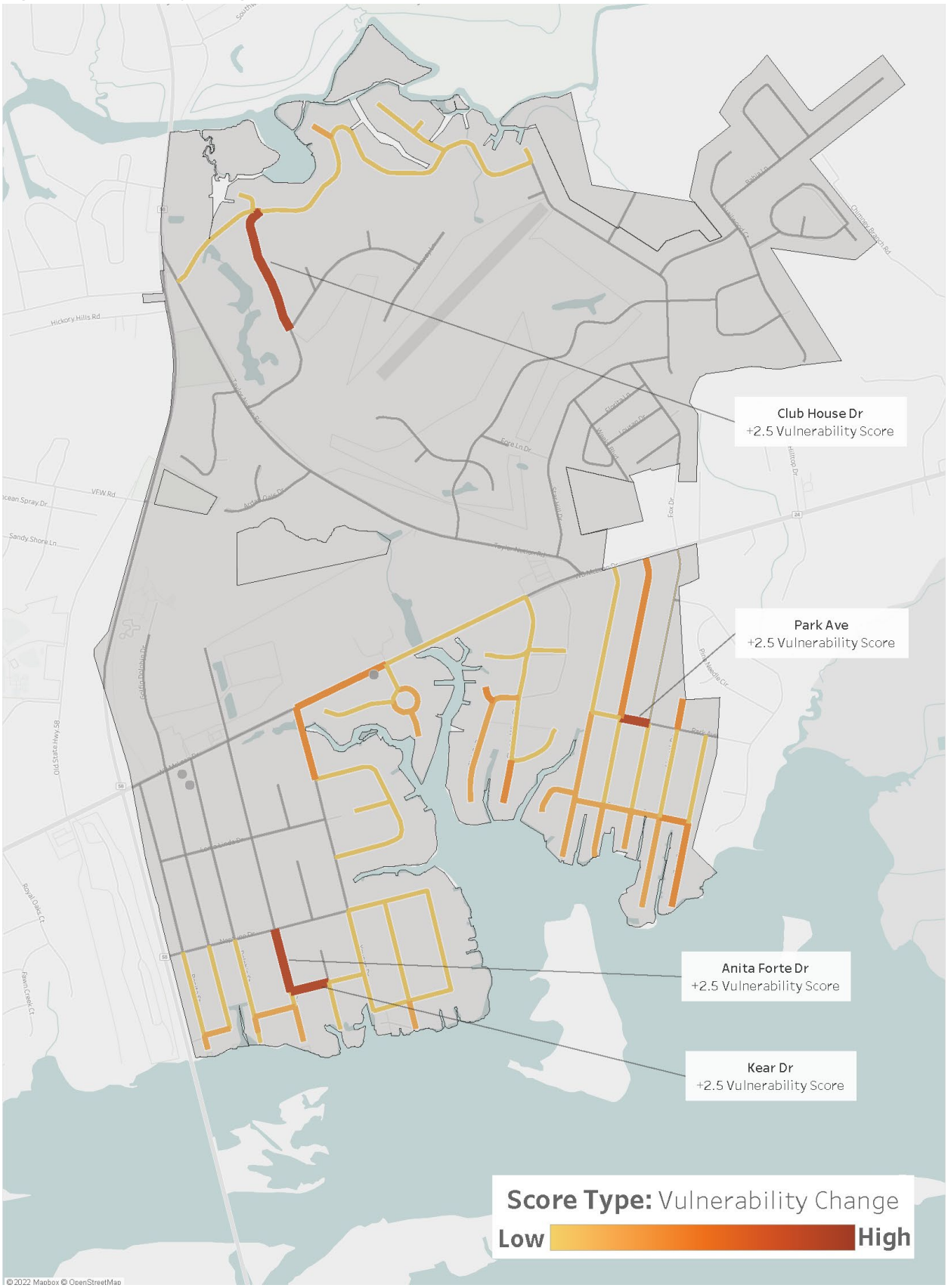
By comparing present and future Vulnerability Scores, Cape Carteret can identify assets and areas expected to face growing vulnerabilities to coastal hazards in the coming decades. Figure 10 depicts the change in Vulnerability Scores by subtracting the Present Vulnerability Score from the Future Vulnerability Score. Assets with a higher resultant number are expected to face increased vulnerability to coastal hazards.

No site-level assets are exposed to flood hazards under present or future conditions. As a result, these assets did not receive Vulnerability Scores.

Of exposed roadways, those exhibiting the highest increases in vulnerability include segments of Anita Forte Drive, Club House Drive, Kear Drive, and Park Avenue that are expected to experience increased exposure. Other roadways facing increased vulnerability include known problem areas like Edgewater Court, Lejeune Road, Star Hill Drive, and WB McLean Drive (NC 24).

As noted previously, this assessment does not incorporate rainfall-driven hazards due to limited available data. However, Town officials identified rainfall-driven flooding as an area of growing concern for Cape Carteret. Roadways that exhibit vulnerability to rainfall-driven flooding tend to be low-lying and lack adequate stormwater drainage infrastructure. Town officials identified several roadways that experience recurring rainfall-driven flood problems, including Anita Forte Drive, Arden Oaks Drive, Bogue Sound Drive, Dolphin Street, and Sutton Drive. Additional analyses may be required to fully characterize the vulnerability of Cape Carteret's critical built infrastructure to rainfall-driven flood hazards.

Figure 10. Vulnerability Change for Critical Built Infrastructure



## 4.2 Natural Infrastructure

### 4.2.1 Exposure, Sensitivity, and Adaptive Capacity

An ecosystem's vulnerability to flooding depends on the type of ecosystem and its surrounding landscapes. Some natural infrastructure can dynamically respond to rising salinity and sea levels to a certain extent. Evaluating the vulnerability of these systems requires complex models that consider multiple factors which affect an ecosystem's ability to adapt to changing conditions. This assessment aims to measure the vulnerability of natural infrastructure by estimating the potential land loss due to rising sea levels between now and future conditions.

This assessment leverages NOAA's SLAMM to identify changes in marsh land cover. This model provided baseline land cover and projected land cover for multiple future conditions based on net sea level rise. As sea levels rise, higher elevations will face more frequent flooding, allowing some marshes to migrate landward. Meanwhile, lower elevations will face such frequent inundation that marshes will no longer thrive, becoming lost to open water.

SLAMM effectively incorporates a habitat's exposure, sensitivity, and adaptive capacity into one metric: projected habitat loss to open water due to sea level rise. The Vulnerability Score for Natural Infrastructure represents the percentage of existing habitat lost to open water under future conditions. The 1.5-foot increment was selected for this assessment because it most closely aligns with the sea level rise projection to assess the future vulnerability of critical built infrastructure. This 1.5-foot increment approximates a 30-year projection for roughly 2050.

### 4.2.2 Vulnerability Results

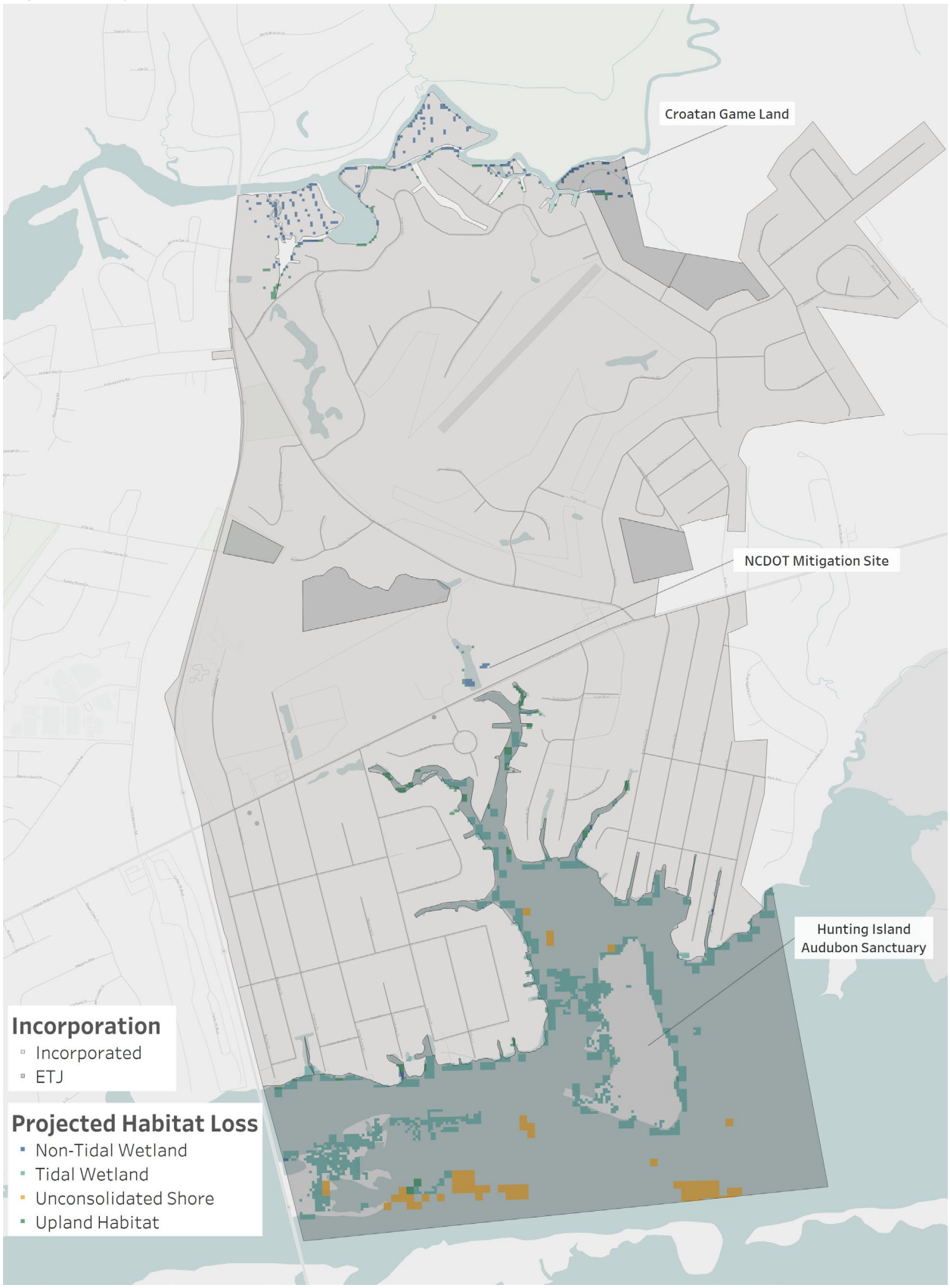
This assessment examined approximately 634 acres of habitat in Cape Carteret, a portion of which exists in the extra-territorial jurisdiction of the Town. Existing natural infrastructure in Cape Carteret primarily consists of tidal and non-tidal wetlands along the Bogue Sound and Pettiford Creek and some upland habitat north of WB McLean Drive (NC 24). Small islands of unconsolidated shores – including sandy beaches and tidal mudflats – lie in the Bogue Sound.

By 2050, Cape Carteret is projected to lose approximately 75 acres of natural infrastructure to open water. Of affected habitats, tidal wetlands and unconsolidated shores are projected to experience the most dramatic impacts (Figure 11). Roughly 51 of the existing 102 acres of tidal wetlands are expected to be lost to open water, a habitat loss of nearly 50%. Cape Carteret's extra-territorial jurisdiction contains just 13 acres of unconsolidated shores, which include sandy beaches and tidal mudflats scattered throughout the Bogue Sound. Nearly all unconsolidated shore habitat is expected to be lost to open water under future conditions. Overall, projected habitat loss is more concentrated along the edges of the Bogue Sound. The total land loss represents approximately 12% of Cape Carteret's existing habitat acreage.

Table 10. Habitat Loss by Type

| HABITAT TYPE | STARTING ACREAGE | ACREAGE LOST | % LOST | VULNERABILITY |
|---|---|---|---|---|
| Non-Tidal Wetland | 68 | 6 | 16% | Low |
| Tidal Wetland | 102 | 51 | 50% | Moderate |
| Unconsolidated Shore | 13 | 13 | 100% | High |
| Upland Habitat | 452 | 5 | 1% | Low |
| **Total Habitat Acres** | 634 | **75** | 12% | |

Figure 11. Projected Habitat Lost to Open Water



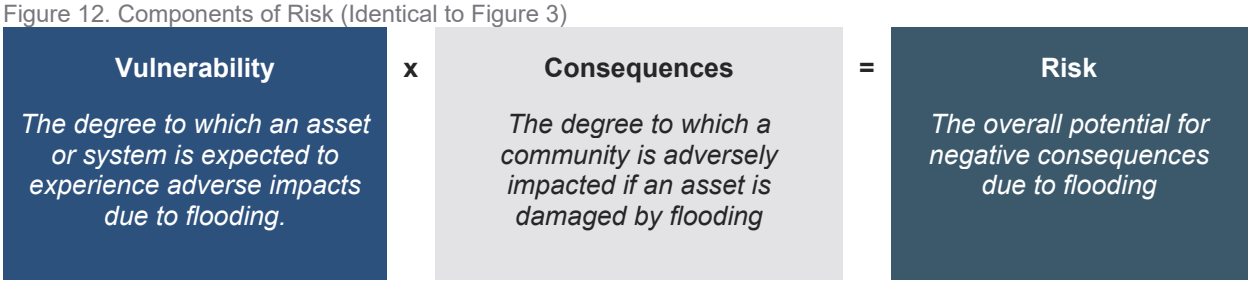
# 5.0 Estimate Risk

## 5.1 Critical Built Infrastructure

After assessing the vulnerability of identified assets, the risk – referring to the overall potential for negative impacts – to each asset is estimated by considering two components: vulnerability and consequences. An asset's vulnerability is determined using the Vulnerability Score calculated in the previous step. Consequences refer to the potential impacts on the surrounding systems and community if an asset is badly damaged or cannot function due to flooding. Due to limited data, this assessment does not quantify the risk to natural infrastructure assets.

Consequences are determined by considering the social vulnerability of the surrounding community and the asset's criticality, or importance, to the community. These metrics are converted into scores ranging from zero to three that are summed to produce a single Consequence Score for each asset. This score is divided by the maximum possible score (six) to produce a percentage that is then multiplied by the Vulnerability Score, as outlined in Figure 12 (for reference only; identical to Figure 3).

Figure 12. Components of Risk (Identical to Figure 3)



### 5.1.1 Social Vulnerability

Social vulnerability refers to the susceptibility of social groups to adverse impacts. This susceptibility is indicated by certain social conditions, such as high poverty, limited vehicle access, or crowded households, that affect a community's ability to prevent human suffering and financial loss in the event of a flood.[7] Social vulnerability is a compounding factor to risk because communities with high social vulnerability are more likely to experience adverse impacts.

The assessment leverages the Centers for Disease Control and Prevention's (CDC) Social Vulnerability Index (SVI) to measure social vulnerability. This index uses census data to assess characteristics that indicate social vulnerability within a community. Census tracts are assigned a percentile ranking compared to the rest of the State of North Carolina. A **Social Vulnerability Score**, ranging from zero to three, is assigned to an asset based on its surrounding tract's SVI percentile compared to the rest of the state. Higher social vulnerability reflects a higher susceptibility of a community surrounding the asset to the adverse impacts of coastal hazards. Based on the CDC SVI, Cape Carteret exhibits low social vulnerability relative to the State of North Carolina.

Table 11. Summary of Social Vulnerability Scores

| SOCIAL VULNERABILITY | INCLUDES… | SOCIAL VULNERABILITY SCORE |
|---|---|---|
| High | 75$^{th}$ percentile and higher | 3 |
| Moderate-High | Between 50$^{th}$ and 75$^{th}$ percentile | 2 |
| Moderate-Low | Between 25$^{th}$ and 50$^{th}$ percentile | 1 |
| Low | Less than 25$^{th}$ percentile | Zero |

[7] Centers for Disease Control and Prevention. 2020. *CDC Social Vulnerability Index Documentation 2018.* https://www.atsdr.cdc.gov/placeandhealth/svi/documentation/SVI_documentation_2018.html

### 5.1.2 Criticality

#### 5.1.2.1 Site-Level Assets

For site-level assets, criticality is determined by sourcing the structure value from building footprint data. Some assets, like water supplies and wastewater treatment facilities, could not be assigned to a building footprint. This metric assumes that structures with higher values are more critical to the surrounding community. Additionally, an asset's value can illustrate the scale of potential costs required to repair or replace the structure if damaged in a flood. To produce a Risk Score for each asset, these values were converted into scores from zero (low) to three (high) to produce an **Asset Criticality Score**. Assets for which a value could not be determined received a score of zero, as outlined in Table 13.

Table 12 summarizes structure values across asset types, noting how many assets those values could be determined. The total value of critical built infrastructure sites in Cape Carteret equals approximately $11.6 million. This figure does not incorporate the value of the services provided to the surrounding community. No site-level assets were exposed to coastal or riverine flood hazards, but further analysis may be required to determine their exposure to rainfall-driven flood hazards.

Table 12. Summary of Exposed Assets and Values

| TYPE | NUMBER EXPOSED | VALUE DETERMINED | TOTAL VALUE |
|---|---|---|---|
| Emergency Shelter* | 0 | 1 | $5,572,972 |
| Government Building | 0 | 1 | $259,563 |
| Law Enforcement | 0 | 1 | $273,333 |
| Public School* | 0 | 1 | $5,572,972 |
| **Total*** | **0** | **4** | **$11,678,040** |

* Cape Carteret's White Oak Elementary School serves as a public school and an emergency shelter. This asset was evaluated under criteria for both Emergency Shelter and Public School asset types.

Table 13. Summary of Asset Value (Criticality) Scores

| CRITICALITY | INCLUDES… | CRITICALITY SCORE |
|---|---|---|
| High | Greater than $500,000 | 3 |
| Moderate-High | Between $250,000 and $500,000 | 2 |
| Moderate-Low | Less than $250,000 | 1 |
| Low | No value determined | Zero |

#### 5.1.2.2 Roadways

For roadways, criticality is determined by the road segment's functional classification, derived from NC Department of Transportation data. This classification is based on the character of the traffic service the road segment aims to provide. Road segments that serve larger traffic volumes are assumed to be more critical to the community, as outlined in Table 14.

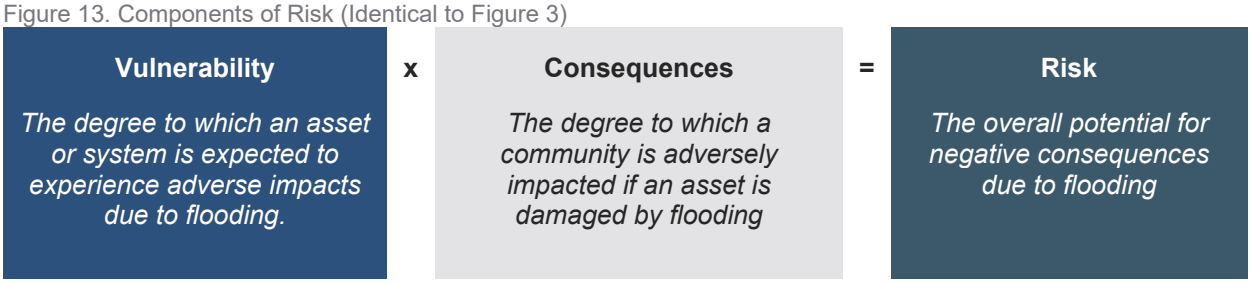
Table 14. Summary of Road Criticality Scores

| CRITICALITY | INCLUDES… | CRITICALITY SCORE |
|---|---|---|
| High | Interstates, highways | 3 |
| Moderate | Minor arterials, major collectors | 2 |
| Low | Local roads | 1 |

### 5.1.3 Risk Assessment Results

After assessing vulnerability and consequences, assets are assigned **Risk Scores** that characterize the potential for adverse consequences if the asset were flooded. Based on the equation presented in Figure 13 (for reference only; identical to Figure 3), assets can receive potential Risk Scores from a high of 12 (high risk) to a low of negative three (low risk). Because a negative Vulnerability Score is possible, negative Risk Scores are also possible. However, a negative score does not indicate an asset would be unaffected or resistant to actual flood events. Instead, an asset with a negative score can be interpreted as facing lesser risk to coastal hazards than other assets examined in this assessment.

Figure 13. Components of Risk (Identical to Figure 3)




The actual assessment produced a range of Risk Scores from a low of -0.97 to a high of 4.27 for roadways. To facilitate the discussion of these results, assets' Risk Scores are referenced from low to high risk relative to the actual range of results, summarized in Table 15.

As depicted in Figure 14, assets in Cape Carteret with higher Risk Scores lie adjacent to the Bogue Sound. This pattern is consistent with previous results showing that these assets exhibit higher exposure and vulnerability to coastal hazards.

Table 15. Summary of Risk Scores

| ASSET RISK | RISK SCORE |
|---|---|
| High | Greater than 3.5 |
| Moderate-High | Between 3 and 3.5 |
| Moderate | Between 2 and 3 |
| Moderate-Low | Between 1 and 2 |
| Low | Less than 1 |
| Not Scored | None (Not Exposed) |

Figure 14. Final Risk Scores for Critical Built Infrastructure

### 5.1.3.1 Site-Level Assets

No site-level assets in Cape Carteret exhibit flood exposure under present or future conditions. Due to the lack of exposure, site-level assets were not assigned Vulnerability Scores, as summarized in Table 16. Appendix A contains a complete list of assets and their scores.

Table 16. Summary of Critical Built Infrastructure Asset Risk

| ASSET RISK | ASSET TYPE* | | | | | |
|---|---|---|---|---|---|---|
| | ES | GB | LE | PS | TOTAL | % |
| High | 0 | 0 | 0 | 0 | **0** | **0%** |
| Moderate-High | 0 | 0 | 0 | 0 | **0** | **0%** |
| Moderate | 0 | 0 | 0 | 0 | **0** | **0%** |
| Moderate-Low | 0 | 0 | 0 | 0 | **0** | **0%** |
| Low | 0 | 0 | 0 | 0 | **0** | **0%** |
| None | 1 | 1 | 1 | 1 | **4** | **100%** |
| *Total Assessed* | *1* | *1* | *1* | *1* | *4* | |
| **Total Scored** | **0** | **0** | **0** | **0** | **0** | |

*ES = Emergency Shelter
GB = Government Building
LE = Law Enforcement
PS = Public School

### 5.1.3.2 Roadways

As outlined in Table 17, approximately six miles of roadways within Cape Carteret exhibit moderate-high or high risk to coastal or riverine flood hazards, representing approximately 20% of the Town's total road mileage. The significant share of high risk roadways can be attributed to a combination of high Sensitivity Scores and expected increases in exposure between now and 2050, captured through the Exposure Score.

Many roadways experiencing high risk include those previously identified by the Town as problem areas, including Anita Forte Drive, Club Court, Dolphin Street, Edgewater Court, Holly Lane, and Live Oak Drive. These roadways, and others in Cape Carteret, may likely experience additional rainfall-driven flooding that is not captured in this assessment.

Appendix A contains a complete list of roadways and their scores organized by individual segments.

Table 17. Summary of Roadway Risk

| ASSET RISK | ROAD SEGMENTS | ROAD MILES | % TOTAL (MILES) |
|---|---|---|---|
| High | 47 | 5.2 | **20%** |
| Moderate-High | 6 | 0.8 | **3%** |
| Moderate | 20 | 3.8 | **14%** |
| Moderate-Low | 1 | < 0.1 | **0%** |
| Low | 5 | 1 | **4%** |
| None | 134 | 15.2 | **58%** |
| *Total Assessed* | *213* | *26.2* | |
| **Total Scored** | **79** | **11** | |

#### 5.1.3.3 Risk Change Over Time

The assessment of present and future flood conditions allows Risk Scores to be calculated under present and future scenarios. Future flood conditions are approximated using floodplain data that incorporates a 1.3-foot (40 centimeters) sea level rise scenario to estimate coastal flood hazards for 2050.

The comparison of present and future Risk Scores can support the identification of assets and areas that are expected to face increased risk. Figure 15 illustrates the change in Risk Scores by subtracting the Present Risk Score from the Future Risk Score. Assets with a higher resultant number are expected to face an increased risk of coastal hazards.

No site-level assets are exposed to flood hazards under present or future conditions. As a result, these assets did not receive Risk Scores.

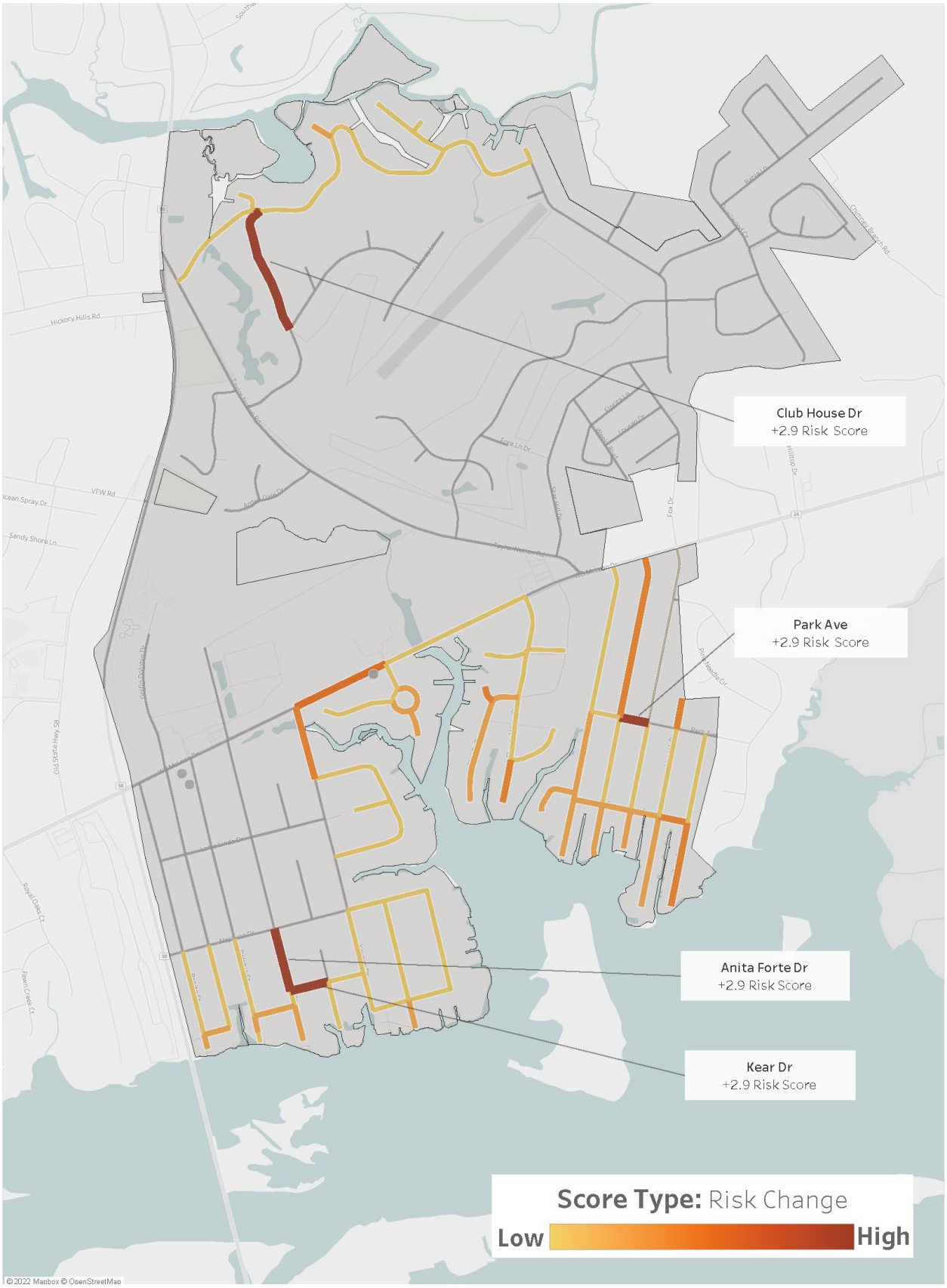
Those exhibiting the highest increases in risk include segments of Anita Forte Drive, Club House Drive, Kear Drive, and Park Avenue that are expected to experience increased exposure. Other roadways facing increased risk include known problem areas like Lejeune Road, WB McLean Drive (NC 24), and Live Oak Drive.

As noted previously, this assessment does not incorporate rainfall-driven hazards due to limited available data. However, Town officials have noted that rainfall-driven flooding already affects several roadways in Cape Carteret, particularly low-lying ones that lack adequate stormwater drainage infrastructure. Identified problem areas for rainfall-driven flooding include Anita Forte Drive, Arden Oaks Drive, Bogue Sound Drive, Dolphin Street, and Sutton Drive. Additional analyses may be required to fully characterize the risk of Cape Carteret's critical built infrastructure to rainfall-driven flood hazards.

## 5.2 Natural Infrastructure

Natural infrastructure provides vital ecosystem services to communities, such as natural flood protection, water quality benefits, recreation opportunities, and ecotourism. Due to limited data on ecosystem services, this assessment does not quantify the values of natural infrastructure assets.

Figure 15. Risk Change for Critical Built Infrastructure



## 6.0 Considerations for Future Assessments

This assessment may serve as a starting point for future analyses and research efforts. The following list summarizes key areas for further refining this assessment and its results:

- **Building Characteristics** – Refine the vulnerability assessment to incorporate more specific building characteristics, such as base floor elevation, or site-specific information, such as the existence of mitigation projects.
- **Natural Infrastructure** – Incorporate complex modeling of impacts to natural infrastructure, including ecosystem service valuation.
- **Rainfall-Driven Flood Hazards** – Conduct a pluvial flood analysis of the Town of Cape Carteret that considers multiple events in varying intensities, durations, and return frequencies to facilitate future exposure, vulnerability, and risk assessments of the region's critical built infrastructure.
- **Climate-Influenced Hazards** – Consider additional climate-influenced hazards included in the 2020 Pamlico Sound Regional Hazard Mitigation Plan, such as extreme heat, and others based on priorities as identified by the Town.

## 7.0 Next Steps

The final Vulnerability and Risk Scores serve as inputs to RCCP Phase 2, through which Cape Carteret plans to select and prioritize resilience projects. These assessment results can support this process by ranking assets by final scores or individual components, such as exposure.

APPENDIX D

# COMMUNITY PROJECT PORTFOLIO

**MAY 2022**

Dewberry

# COMMUNITY PROJECT PORTFOLIO

A critical component of the Resilient Coastal Communities Program is the identification and prioritization of a series of projects that are intended to address community vulnerabilities to coastal hazards. The enclosed list of projects, which includes infrastructure improvements (structural, non-structural, natural or nature-based solutions, or hybrid options), policy and planning efforts, and asset management actions, has been synthesized from previous local and regional planning efforts, input from the Community Action Team, and feedback from the public.

Included in this Appendix is a summary list of the proposed projects, followed by an individual sheet for each project. Each project sheet summarizes the factors that were considered in the project identification and prioritization process, including:

| | |
|---|---|
| **LOCATION** | The geographic location and scope of the project. |
| **HAZARD(S) ADDRESSED** | A summary of the community-specific coastal hazards that impact the project location. This can include flooding, storm surge, wind damage, or other coastal hazards. |
| **TYPE OF SOLUTION** | A description of whether the project represents infrastructure improvements, policy and planning effort, or an asset management/mapping program.<br>A symbol is used to denote whether the project includes a natural or nature-based solution (NNBS) component. |
| **PROJECT ESTIMATED COST** | A qualitative analysis of the total project cost, including initial engineering and construction as well as future maintenance (as available). Project cost is shown symbolically ranging from $ to $$$$. |
| **POTENTIAL FUNDING SOURCES** | Recommendations on potential sources to construct or otherwise implement the project, including the Resilient Coastal Communities Program and other federal and state funding sources. |
| **ESTIMATED PROJECT TIMELINE** | An estimated timeline to complete the project, including notes on any expected delays in the timeline. |
| **PRIORITY RATING** | A qualitative ranking of the project's priority in the context of the entire Project Portfolio. Rankings of **High**, **Medium**, or **Low** are provided for each project. |

Each project sheet includes a proposed map of the project area and photos of potential sites to be addressed, where available.

# Proposed Project Summary

| CAPE CARTERET | RESILIENT COASTAL COMMUNITIES PROGRAM PROJECT PORTFOLIO | | | | | | | | UPDATED MAY 2022 |
|---|---|---|---|---|---|---|---|---|---|
| Project (Priority #) | Project Title | Description | Location | Anticipated Cost | Funding Status | Needs Addressed | NNBS Opportunity | Source Document | Timeline | Notes/ Project Status |
| 1 | Stormwater Facility Improvements | Improve stormwater facilities on multiple Town streets, including Sutton Drive, Ardan Oaks Drive, Anita Forte Drive/Loma Linda Court, Dolphin Street, and Bogue Sound Drive. Specific stormwater improvements (grassy swales) are proposed for Sutton Drive, Ardan Oaks Drive, Anita Forte Drive/Loma Linda Court, Dolphin Street, Neptune Drive, Neptune Court, and Bogue Sound Drive. | Multiple street locations | Varies based on location needs and solution to be implemented. | Project is subject of 2021 BRIC program application; award status TBD. | Stormwater Management, Flooding | Yes | Cape Carteret CAT; included in public survey. | Varies based on location needs and solutions to be implemented. Intended as ongoing program. | Identified as top priority by CAT; project was subject of recent (2021) BRIC application (Flood Mitigation and Resiliency Project). |
| 2 | Stormwater Infrastructure Mapping | Map all stormwater infrastructure within Town limits to determine service gaps and needs. | Townwide | Expected to be low cost, depending upon level of survey effort. | Not currently funded. | Stormwater Management, Flooding | | Cape Carteret CAT; included in public survey. | No proposed timeframe; may take between six months to a year to complete. | A comprehensive survey of stormwater infrastructure has (to date) not been completed. Survey (and condition assessment) needed to determine service needs. |
| 3 | Stormwater Pretreatment | Construct stormwater treatment facilities to minimize water quality impacts to Bogue Sound and Pettiford Creek at multiple locations, including Sutton Drive, Ardan Oaks Drive, Anita Forte Drive, Loma Linda Court, Dolphin Street, Neptune Drive, Neptune Court, and Bogue Sound Drive. | Multiple street locations | Varies based on location needs and solution to be implemented. | Not currently funded. | Stormwater Management, Flooding | Yes | Cape Carteret CAT; included in public survey. | Varies based on location needs and solutions to be implemented. Intended as ongoing program. | Project would build upon the improvements listed in Project #1, with the locations determined in part through the mapping completed in Project #2. |
| 4 | Living Shoreline Construction | Construct an oyster reef or living shoreline along the Bogue Sound and Deer Creek shoreline. | Bogue Sound/ Deer Creek shorelines | Dependent upon location and extent of proposed shoreline. | Not currently funded. | Stormwater Management, Flooding, Disaster Recovery, Climate Change | Yes | Cape Carteret CAT; included in public survey. | No proposed timeframe; construction may take between three and nine months, not including follow-up monitoring. | |
| 5 | Tree Canopy Replacement | Plant young trees to increase overall tree canopy within the Town and replace trees lost during storm events. | Townwide | Dependent upon extent of tree canopy to be replaced. | Not currently funded. | Disaster Recovery | Yes | Cape Carteret CAT; included in public survey. | Intended as ongoing program as funding is available. | |
| 6 | Public Engagement and Education Campaign | Engage and educate Cape Carteret residents and business owners on the impacts of storm events and other coastal hazards. This would be a continuous program to involve Town residents in the decision-making process for determining future resilience actions. | Townwide | Limited cost, primarily staff time and publication/ distribution of materials. | Not currently funded. | Stormwater Management, Flooding, Infrastructure Deficiency or Capacity, Climate Change | | Cape Carteret CAT. | Intended as ongoing program as funding is available. | Build on the Town's existing public engagement efforts that are conducted as part of the NWS StormReady Community program, as well as prior regional hazard mitigation planning efforts. |

| CAPE CARTERET | | RESILIENT COASTAL COMMUNITIES PROGRAM PROJECT PORTFOLIO | | | | | | | | UPDATED MAY 2022 |
|---|---|---|---|---|---|---|---|---|---|---|
| Project (Priority #) | Project Title | Description | Location | Anticipated Cost | Funding Status | Needs Addressed | NNBS Opportunity | Source Document | Timeline | Notes/ Project Status |
| 7 | Low-impact Development Education Campaign | Educate developers, home builders, and the real estate community on low-impact development strategies. | Townwide | Limited cost, primarily staff time and publication/ distribution of materials. | Not currently funded. | Stormwater Management, Flooding, Infrastructure Deficiency or Capacity, Climate Change | | Identified through public feedback (write-in suggestion). | Intended as ongoing program as funding is available. | Cape Carteret is planning to update its stormwater ordinance; education campaign can be conducted in conjunction with this update. |
| 8 | Emergency Shelter Improvements | Work with Carteret County to address shelter needs and on upgrades to existing facilities. | County-wide | Dependent upon the scope of proposed improvements and shelter needs. | Not currently funded. | Infrastructure Deficiency or Capacity | | Cape Carteret CAT; included in public survey. | Dependent upon the scope of the proposed improvements. | Project requires coordination with Carteret County, which is responsible for shelter facilities for the county. |
| 9 | Emergency Operations Center | Establish center for western Carteret County, to be located in a new Town municipal complex proposed at a location outside of the modeled storm surge inundation for a Category 5 storm event. | TBD | To be determined. | Not currently funded. | Infrastructure Deficiency or Capacity, Disaster Recovery | | Cape Carteret 1/25/22 CAT Meeting Discussion; included in public survey. | Dependent upon the scope of the proposed improvements. | Project requires coordination with Carteret County, which is responsible for emergency operations for the county. A new development near existing White Oak Elementary School has been identified as a potential location for a new EOC. |

| 1 | STORMWATER FACILITY IMPROVEMENTS |
|---|---|
| **PROJECT DESCRIPTION** | Improve stormwater facilities on multiple Town streets, including Sutton Drive, Ardan Oaks Drive, Anita Forte Drive/ Loma Linda Court, Dolphin Street, and Bogue Sound Drive. Specific stormwater improvements (grassy swales) are proposed for Sutton Drive, Ardan Oaks Drive, Anita Forte Drive/Loma Linda Court, Dolphin Street, Neptune Drive, Neptune Court, and Bogue Sound Drive. |
| **LOCATION** | Multiple locations within Cape Carteret |
| **HAZARD(S) ADDRESSED BY PROJECT** | Stormwater Management/Flooding. Existing stormwater infrastructure on residential streets is impacted by coastal storm and other rainfall events, causing extensive flooding. |
| **TYPE OF SOLUTION** | Infrastructure improvements. Construction/replacement of stormwater infrastructure at key locations throughout the Town. NNBS options will be implemented as practicable. |
| **PROJECT ESTIMATED COST** | Cost varies based on solution implemented and location needs.<br><br>**Cost Level: $** |
| **POTENTIAL IMPLEMENTATION FUNDING SOURCES** | The Town has applied for funding under the BRIC program (Flood Mitigation and Resiliency Project); the application is under consideration.<br><br>Potential funding sources: Federal sources may include EDA - Investment for Public Works, National Wildlife Federation, and Economic Development Facilities. State sources may include the Rural Grant Programs, EPA – Clean Water State Revolving Fund, NCDEQ American Rescue Plan Act, and Golden Leaf Foundation Flood Mitigation Program. |
| **PROJECT ESTIMATED TIMELINE** | Timeline varies based on solution implemented and location needs. Design and construction timeline expected to vary between 3 months and 1 year per site. This is an ongoing program, to be implemented at individual sites as needs are identified. |
| **PRIORITY RATING** | **High.** The project was identified as top priority by the Resilient Coastal Communities Program CAT. |

## 1 STORMWATER FACILITY IMPROVEMENTS



Dolphin Street

Cape Carteret, NC



Anita Forte Drive

| 2 | STORMWATER INFRASTRUCTURE MAPPING |
|---|---|
| **PROJECT DESCRIPTION** | Map all stormwater infrastructure within Town limits to determine service gaps and needs. A comprehensive survey of stormwater infrastructure has (to date) not been completed. A survey (and condition assessment) is needed to determine service needs. |
| **LOCATION** | Townwide |
| **HAZARD(S) ADDRESSED BY PROJECT** | Stormwater Management/Flooding. The project is intended to identify and address infrastructure deficiency issues and to enable the Town to recover as efficiently as possible from storms and other disaster events. |
| **TYPE OF SOLUTION** | Mapping effort that is intended to lead to future infrastructure improvements. |
| **PROJECT ESTIMATED COST** | Mapping effort is expected to be low cost, depending on the level of survey effort.<br><br>**Cost Level: $** |
| **POTENTIAL IMPLEMENTATION FUNDING SOURCES** | This effort is not currently funded or listed on the Town CIP, but could potentially be added in the future.<br><br>Potential funding sources: Federal sources may include EDA - Investment for Public Works and Economic Development Facilities and FEMA – BRIC. State sources may include the Rural Grant Programs, EPA – Clean Water State Revolving Fund, NCDEQ American Rescue Plan Act, NCDEQ Asset Inventory and Assessment Grant Program, and Golden Leaf Foundation Flood Mitigation Program. |
| **PROJECT ESTIMATED TIMELINE** | There is currently no proposed timeframe for this plan; however, it is considered an urgent need. Depending upon the level of detail to be provided, this mapping effort is expected to take between six months to a year to complete. |
| **PRIORITY RATING** | **High** |

## 2 STORMWATER INFRASTRUCTURE MAPPING


Manatee Street


Neptune Drive


Cape Carteret, NC

| 3 | STORMWATER PRETREATMENT |
|---|---|
| **PROJECT DESCRIPTION** | Construct stormwater treatment facilities to minimize water quality impacts to Bogue Sound and Pettiford Creek at multiple locations, including Sutton Drive, Ardan Oaks Drive, Anita Forte Drive, Loma Linda Court, Dolphin Street, Neptune Drive, Neptune Court, and Bogue Sound Drive. Project would build on the work done by mapping the stormwater system and facility improvements. A survey and condition assessment needed to determine service needs. |
| **LOCATION** | Multiple street locations within Cape Carteret. |
| **HAZARD(S) ADDRESSED BY PROJECT** | Stormwater Management/ Flooding. Existing stormwater treatment infrastructure on residential streets is impacted by coastal storm and other rainfall events. |
| **TYPE OF SOLUTION**  | Infrastructure improvements. Construction/replacement of stormwater treatment infrastructure at key locations throughout the Town. NNBS options will be implemented as practicable. |
| **PROJECT ESTIMATED COST** | Cost varies based on solution implemented and location needs.<br><br>**Cost Level: $** |
| **POTENTIAL IMPLEMENTATION FUNDING SOURCES** | The project is not currently funded in the Town CIP but could be added to the CIP in the future.<br><br>Potential funding sources: Federal sources may include EDA - Investment for Public Works, National Wildlife Federation, and Economic Development Facilities and FEMA – BRIC. State sources may include Rural Grant Programs, EPA – Clean Water State Revolving Fund, NCDEQ American Rescue Plan Act, and Golden Leaf Foundation Flood Mitigation Program |
| **PROJECT ESTIMATED TIMELINE** | Timeline varies based on solution implemented and location needs. Design and construction timeline expected to vary between 3 months and 1 year per site. This is an ongoing program, to be implemented at individual sites as needs are identified. |
| **PRIORITY RATING** | **High** |

## 3 STORMWATER PRETREATMENT

Pettiford Creek



Live Oak Drive

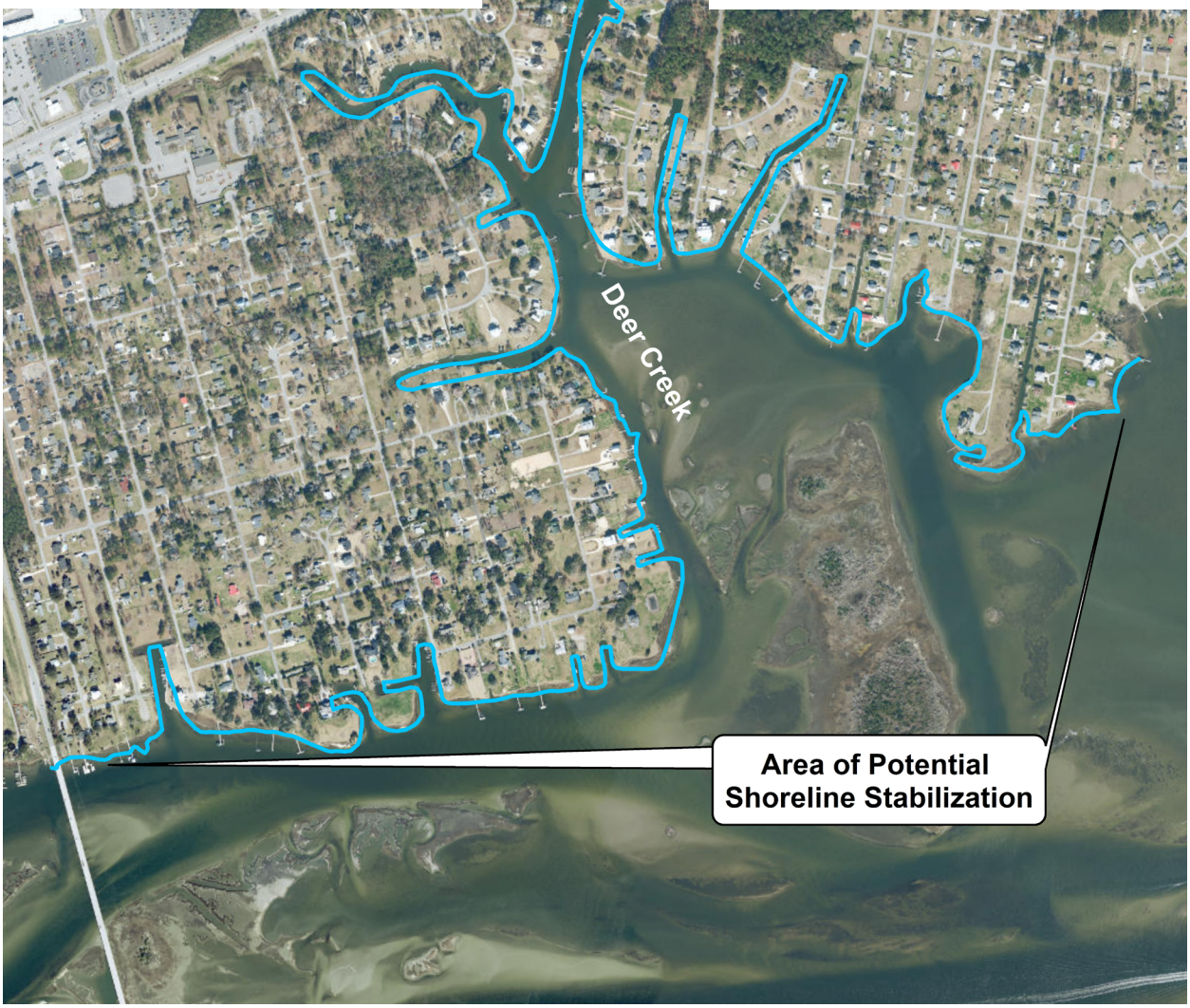
Cape Carteret, NC

| 4 | LIVING SHORELINE CONSTRUCTION |
|---|---|
| **PROJECT DESCRIPTION** | Construct an oyster reef or living shoreline along the Bogue Sound and Deer Creek shoreline. |
| **LOCATION** | Bogue Sound/Deer Creek shorelines |
| **HAZARD(S) ADDRESSED BY PROJECT** | Storm Surge Flooding, Shoreline/Beach Erosion. The program is intended to address flooding due to coastal storm events and storm surge. |
| **TYPE OF SOLUTION**  | Infrastructure improvements |
| **PROJECT ESTIMATED COST** | Project cost dependent upon solution selected for implementation.<br><br>**Cost Level: $$** |
| **POTENTIAL IMPLEMENTATION FUNDING SOURCES** | This effort is not currently funded or listed on the Town CIP. The engineering design and construction of the project is eligible for funding under Phases 3 and 4 of the Resilient Coastal Communities Program.<br><br>Potential funding sources: Federal sources may include NOAA - Coastal & Estuarine Land Conservation Program, NOAA - National Coastal Resilience Fund, National Wildlife Federation, and USFWS – National Coastal Resilience Fund. State sources may include EPA - Clean Water State Revolving Fund, Z. Smith Reynolds Foundation, and NCDWR Water Resources Development Project Grants. |
| **PROJECT ESTIMATED TIMELINE** | There is currently no proposed timeline for the project. Once funded, construction of a living shoreline can take between 3 and 9 months, with follow-up project site monitoring for up to five years following completion. |
| **PRIORITY RATING** | **Medium** |

## 4 LIVING SHORELINE CONSTRUCTION

Boat Launch on Bogue Sound

Boat Ramp & Park Area



| 5 | TREE CANOPY REPLACEMENT |
|---|---|
| **PROJECT DESCRIPTION** | Plant young trees to increase overall tree canopy within the Town and replace trees lost during storm events. |
| **LOCATION** | Townwide |
| **HAZARD(S) ADDRESSED BY PROJECT** | Disaster Recovery. The project is intended to facilitate ecosystem recovery following storm events. |
| **TYPE OF SOLUTION**  | Natural resources restoration program |
| **PROJECT ESTIMATED COST** | Project cost is dependent upon the extent of tree canopy that is being replaced.<br><br>**Cost Level: $** |
| **POTENTIAL IMPLEMENTATION FUNDING SOURCES** | This effort is not currently funded or listed on the Town CIP but could potentially be added in the future.<br><br>Potential funding sources: Funding may be available through state or private grant programs, such as the Golden Leaf Foundation and the NC Urban Forest Council Legacy Tree Fund. North Carolina has also issued grant funding to remove and replace nuisance tree species throughout the state. |
| **PROJECT ESTIMATED TIMELINE** | This is proposed as an ongoing program, focused on replacing trees as they are lost following storm events. |
| **PRIORITY RATING** | **Medium** |

## 5 TREE CANOPY REPLACEMENT

| 6 | PUBLIC ENGAGEMENT AND EDUCATION CAMPAIGN |
|---|---|
| **PROJECT DESCRIPTION** | Engage and educate Cape Carteret residents and business owners on the impacts of storm events and other coastal hazards. This would be a continuous program to involve Town residents in the decision-making process for determining future resilience actions. Build on the Town's existing public engagement efforts that are conducted as part of the NWS *StormReady* Community program, as well as prior regional hazard mitigation planning efforts. |
| **LOCATION** | Townwide |
| **HAZARD(S) ADDRESSED BY PROJECT** | Stormwater Management/Flooding, Climate Change. Project is to educate the community on the impacts of current and future anticipated flooding and the Town's stormwater management needs as well as the impacts of climate change on the community. |
| **TYPE OF SOLUTION**  | Non-regulatory program, specifically an ongoing public engagement and education program for community residents and business owners. |
| **PROJECT ESTIMATED COST** | Primary costs are expected to include staff time for public engagement and events and for the publication/distribution of online and printed education materials.<br><br>**Cost Level: $** |
| **POTENTIAL IMPLEMENTATION FUNDING SOURCES** | This effort is not currently funded or listed on the County CIP but could potentially be added in the future.<br><br>Potential funding sources: Partnerships with non-governmental organizations may provide opportunities to fund the public engagement and education effort. The NC Office of Environmental Education website provides information on potential education grants. |
| **PROJECT ESTIMATED TIMELINE** | There is currently no proposed timeframe for this effort but is recommended to begin in the next year to encourage continued engagement. The program would be an ongoing effort. |
| **PRIORITY RATING** | **Medium** |

## 6 PUBLIC ENGAGEMENT AND EDUCATION CAMPAIGN

| 7 | LOW-IMPACT DEVELOPMENT EDUCATION CAMPAIGN |
|---|---|
| **PROJECT DESCRIPTION** | Educate developers, home builders, and the real estate community on low-impact development strategies. Cape Carteret is planning to update its stormwater ordinance; an education campaign can be conducted in conjunction with this update. |
| **LOCATION** | Townwide |
| **HAZARD(S) ADDRESSED BY PROJECT** | Stormwater Management/Flooding, Climate Change. Project is to educate developers, home builders, and the real estate community on the impacts of current and future anticipated flooding and the role of low-impact development. |
| **TYPE OF SOLUTION** | Non-regulatory program, specifically an ongoing engagement and education program for the real estate and development community. |
| **PROJECT ESTIMATED COST** | Primary costs are expected to include staff time for public engagement and events and for the publication/distribution of online and printed education materials.<br><br>**Cost Level: $** |
| **POTENTIAL IMPLEMENTATION FUNDING SOURCES** | This effort is not currently funded or listed on the County CIP but could potentially be added in the future.<br><br>Potential funding sources: Partnerships with non-governmental organizations may provide opportunities to fund the targeted education effort. The NC Office of Environmental Education website provides information on potential education grants. |
| **PROJECT ESTIMATED TIMELINE** | There is currently no proposed timeframe for this effort but is recommended to begin in the next year to encourage continued engagement. The program would be an ongoing effort. |
| **PRIORITY RATING** | **Low** |

## 7 LOW-IMPACT DEVELOPMENT EDUCATION CAMPAIGN

| 8 | EMERGENCY SHELTER IMPROVEMENTS |
|---|---|
| **PROJECT DESCRIPTION** | Work with Carteret County to address shelter needs and on upgrades to existing facilities. The project requires coordination with Carteret County, which is responsible for shelter facilities for the county. |
| **LOCATION** | County-wide |
| **HAZARD(S) ADDRESSED BY PROJECT** | Infrastructure Deficiency/Capacity, Climate Change. Address sheltering needs during storm events. |
| **TYPE OF SOLUTION** | Infrastructure Improvements |
| **PROJECT ESTIMATED COST** | Projects are not currently included on a Town or County CIP.<br><br>**Cost Level: $$** |
| **POTENTIAL IMPLEMENTATION FUNDING SOURCES** | Shelter improvement projects are not currently funded. This effort could potentially be added to a Town or County CIP in the future.<br><br>Potential funding sources: Shelter facilities would likely qualify for federal hazard mitigation funding. |
| **PROJECT ESTIMATED TIMELINE** | Timeline for implementation dependent on the scope of improvements. |
| **PRIORITY RATING** | **Low** |

## 8 EMERGENCY SHELTER IMPROVEMENTS

| 9 | EMERGENCY OPERATIONS CENTER |
|---|---|
| **PROJECT DESCRIPTION** | Establish center for western Carteret County, to be located in a new Town municipal complex proposed at a location outside of the modeled storm surge inundation for a Category 5 storm event. Project requires coordination with Carteret County, which is responsible for emergency operations for the county. A new development near existing White Oak Elementary School has been identified as a potential location for a new EOC. |
| **LOCATION** | To be determined |
| **HAZARD(S) ADDRESSED BY PROJECT** | Infrastructure Deficiency/Capacity. Address emergency operational continuity during storm events |
| **TYPE OF SOLUTION** | Infrastructure Improvements |
| **PROJECT ESTIMATED COST** | Construction of a new EOC is not currently included on a Town or County CIP.<br><br>**Cost Level: $$** |
| **POTENTIAL IMPLEMENTATION FUNDING SOURCES** | The project is not currently funded but could potentially be added to a Town or County CIP in the future.<br><br>Potential funding sources: Emergency operations facilities would likely qualify for federal hazard mitigation funding. |
| **PROJECT ESTIMATED TIMELINE** | Timeline for implementation dependent on the scope of improvements following site selection and facility design. |
| **PRIORITY RATING** | **Low** |

## 9 EMERGENCY OPERATIONS CENTER