Topsail Island Resilience Strategy

Resilient Coastal Communities Program

May 2022

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List of Acronyms

ACS	American Community Survey
AEC	Area of Environmental Concern
ARPA	American Rescue Plan Act
ATSDR	Agency for Toxic Substances and Disease Registry
CAMA	Coastal Area Management Act
CAT	Community Action Team
CBRA	Coastal Barrier Resource Area
CBRS	Coastal Barrier Resource System
CDC	Centers for Disease Control and Prevention
CIP	Capital Improvement Plan
CRS	Community Rating System
DCM	Division of Coastal Management
EOP	Emergency Operations Plan
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
HMP	Hazard Mitigation Plan
HOA	Homeowners Association
HTF	High Tide Flooding
ID	Identification
KLF	Kleinfelder
NC	North Carolina
NCBIWA	North Carolina Beach Inlet and Waterway Association
NCCF	North Carolina Community Foundation
NCCS	North Carolina Climate Science
NCDEQ	North Carolina Department of Environmental Quality
NCDOT	North Carolina Department of Transportation
NCEI	National Centers for Environmental Information
NFIP	National Flood Insurance Program
NFWF	National Fish and Wildlife Foundation
NOAA	National Oceanic and Atmospheric Administration
NTB	North Topsail Beach
Q&A	Questions and Answers
RCCP	Resilient Coastal Communities Program
SC	Surf City
SE	Southeast
SLR	Sea Level Rise
SVI	Social Vulnerability Index
TBD	To Be Determined
TISPC	Topsail Island Shoreline Protection Commission
TV	Television
USACE	United States Army Corps of Engineers

I. RESILIENT COASTAL COMMUNITIES PROGRAM – PROJECT OVERVIEW

Resilient Coastal Communities Program (RCCP)

The North Carolina Climate Risk Assessment and Resilience Plan (June 2020) called for a statewide North Carolina Resilient Communities Program. The RCCP is a continuation of several years of coastal resiliency work done by the North Carolina Division of Coastal Management. The Program's objectives are to provide financial grants and technical assistance to support a proactive, locally driven, and equitable approach to coastal resilience and project implementation. The RCCP has four goals:

1. Address barriers to coastal resilience in North Carolina at the local level, such as limited capacity, economic constraints, and social inequities.
2. Assist communities with risk and vulnerability assessments and develop a portfolio of well-planned and prioritized projects.
3. Advance coastal resilience projects to a "shovel-ready" status, or ready for implementation
4. Provide funding for project implementation and link to additional funding streams.

This report covers Phase I and Phase II of the Resilient Coastal Communities Program for Topsail Island. Phase I involves Visioning, Community Engagement, and a Risk/Vulnerability Assessment. Phase II involves Planning, Project Identification, and Prioritization. The outcome (this report) is a Resiliency Strategy for Topsail Island that will provide clarity of purpose, attract funding, and provide a more direct path for implementation.

II. VISION & GOALS

As part of the Resilient Coastal Communities Program (RCCP) Phase 1 process, the Community Action Team (CAT) came to a consensus on a long-term vision and set of goals. This exercise enhanced regional coordination and developed shared objectives between the three communities – North Topsail Beach, Surf City, and Topsail Beach – and formed the basis for future collaboration throughout the next Phase of the project.

The RCCP explicitly provided these communities with a much-needed opportunity to take a "long-term" (multi-decade) focus and acknowledge shared risks, hazards, and climate vulnerabilities such as sea level rise, increased sunny day (tidal) flooding, extreme weather events, and water quantity and quality impacts on local commerce and livelihoods. Members of the CAT acknowledged many strengths amongst the three communities regarding resiliency and response

to hazard events. As a barrier island, these communities are acutely aware of the impacts and damages associated with hurricanes, coastal flooding, and erosion, however long-term issues like sea level rise and chronic tidal flooding require more direct focus and inter-town collaboration. A vision statement and accompanying goals created by the communities is important to ensure values and priorities are considered through this project and beyond. Previously adopted vision and goal statements from local and regional planning documents, such as regional Hazard Mitigation Plans, Land Use plans, and Town websites were used as community-specific starting points for the three Topsail Island communities to develop a single shared vision and set of goals for the RCCP.

Regionwide Goals *from* the Southeastern North Carolina Hazard Mitigation Plan (2021)

Goal One: Work to improve existing local government policies and codes to reduce impacts of natural hazards

Goal Two: Design and implement specific mitigation measures to protect vulnerable public and private properties

Goal Three: Increase the protection of critical facilities and infrastructure from hazard threats through retrofit projects for existing facilities and innovative design standards for new facilities

Goal Four: Enhance public education programs to promote community awareness of natural hazards and hazard mitigation techniques available to reduce their impact

Goal Five: Improve stormwater management through enhanced local government programs, policies, and practices

Goal Six: Enhance each county's storm evacuation procedures through increased intergovernmental coordination between the counties, participating municipalities, and State of North Carolina

Goal Seven: Increase the County's emergency management capabilities through sustained system and technology improvements

Goal Eight: Promote volunteer involvement in emergency preparedness and response through increased citizen awareness and training activities

North Topsail Beach Goal Statements *from* the Coastal Area Management Act (CAMA) Land Use Plan (2020)

Goal: Maximize public access to the beaches and the public trust waters of the coastal region

Goal: Ensure that development and use of resources or preservation of land balance protection of natural resources and fragile areas with economic development, avoid risks to public health, safety, and welfare

Goal: Ensure that public infrastructure systems are sized, located, and managed so the quality and productivity of Areas of Environmental Concern (AECs) and other fragile areas are protected or restored

Goal: Conserve and maintain barrier dunes, beaches, floodplains, and other coastal features for their natural storm protection functions and their natural resources giving recognition to public health, safety, and welfare issues

Goal: Maintain, protect, and, where possible, enhance water quality in all coastal wetlands, rivers, streams, and estuaries

Surf City Mission Statement *from* Surf City Department of Emergency Management and Goal Statement *from* the Town of Surf City Land Use Plan (2005)

Mission Statement: "To promote a community that is more resilient, less susceptible, better prepared, and quicker to recover from all hazards, natural and man-made, and to address the needs of the community as a whole, through comprehensive inclusion, effective coordination, and sincere collaboration."

Goal: To maximize public access to the beaches and the public trust waters of Surf City.

Goal: To ensure that development and use of resources or preservation of land minimizes direct and secondary environmental impact, avoids risks to public health, safety and welfare and is consistent with the capability of the land based on considerations of interactions of natural and man-made features.

Goal: To ensure that public infrastructure systems are properly sized, located, and managed, so the quality and productivity of AECs and other fragile areas are protected or restored.

Goal: To conserve and maintain barrier dunes, beaches, flood plains, and other coastal features for their natural storm protection functions and their natural resources giving recognition to public health, safety, and welfare issues.

Goal: To maintain, protect, and enhance water quality in all coastal wetlands, creeks, and estuaries.

Goal: To integrate local concerns with the overall goals of the North Carolina coastal program in the context of land use planning.

Topsail Beach Vision and Goal Statements *from* the Topsail Beach Coastal Area Management Act (CAMA) Core Land Use Plan (2015)

Vision Statement: "The vision is to ensure that Topsail Beach remains a peaceful, family-friendly community to live, work and play while maintaining its natural island beauty."

Goal: To increase and enhance public access opportunity to the ocean and sound waters of Topsail Beach.

Goal: To ensure that development and use of resources or preservation of land minimizes direct and secondary environmental impact, avoids risks to public health, safety and welfare and is consistent with the capability of the land based on considerations of interactions of natural and man-made features.

Goal: To ensure that public infrastructure systems are properly sized, located and managed, to guarantee the quality of service required by a growing Town and to protect designated areas of environmental concern and other fragile areas.

Goal: To conserve and maintain barrier dunes, beaches, flood plains, and other coastal features for their natural storm protection functions and their natural resources giving recognition to public health, safety, and welfare.

Goal: To maintain, protect and where possible enhance water quality in Topsail Sound, coastal wetlands, creeks, streams, and estuaries.

Goal: Topsail Beach will seek to integrate local concerns with the overall goals of the North Carolina coastal program in the context of Land Use Planning.

Community-Driven, Island-Wide Vision and Goals

In October 2021, members of the CAT participated in a workshop focused on developing a unified vision statement and goals for Topsail Island throughout the RCCP. Kleinfelder presented previous vision and goal statements, along with community planning documents, and CAT members used the existing material to formulate a revised vision and list of goals. Additional questionnaires and feedback were collected from the CAT to aid drafting a vision statement and goals. The draft was sent to CAT members in November 2021 for approval. Consensus led to the island-wide vision and goals developed by the three Topsail Island communities for the RCCP:

Topsail Island Resilient Coastal Communities Program Vision Statement:

Address the long-term viability of Topsail Island by preparing infrastructure assets and populations against sea level rise, increased tidal flooding, and more frequent and impactful storm events; minimize chronic flooding and damage from potential disastrous weather; protect residents, seasonal populations, and the natural environment; build more resilient communities; ensure public safety, stability, and prosperity while balancing the needs and unique character of three barrier island communities.

TOPSAIL ISLAND RESILIENT COASTAL COMMUNITIES PROGRAM GOAL STATEMENTS

Minimize damages and losses through island-wide collaboration on longer-range planning for sea level rise and climate change effects on the barrier island
Improve the reliability of built infrastructure and roadway access, allowing continued enjoyment of the community's many amenities while maintaining the unique character of Topsail Island communities
Coordinate and collaborate with neighboring communities to develop policies and programs that benefit the region and maintain Topsail Island's long-term viability as tourism destination and retirement community
Revisit and revise flood elevations (such as base flood elevations derived from the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area (SFHA) that do not consider sea level rise and future storms) and community-specific design standards (e.g., freeboard and structure foundation requirements, building materials, first floor uses, etc.) to incorporate sea level rise projections and other climate hazards
Set and enforce standards for new development and major developments and repairs, integrating stronger standards for fortified roofs and hurricane resistant infrastructure
Conserve and adapt natural infrastructure, including coastal wetland and marsh habitat resources, allowing pathways for adaptation and nature-based solutions
Improve stormwater management (flood mitigation and water quality) and hazard mitigation through enhanced programs, policies, and practices such as stormwater districts

Elevate the dialogue and urgency with state elected officials, government agencies (such as the North Carolina Department of Transportation (NCDOT) for critical path items shared by all three communities, such as road-raising activities at low-lying areas along the Island's primary evacuation routes that are already exposed to coastal flooding and may experience chronic flooding by mid-century due to sea level rise
Hold leaders and government agencies accountable for funding programs that will help mitigate effects of severe weather
Identify and prioritize specific resiliency projects and investments, and promote/pre-position these projects for state, federal, and other funding sources
Retrofit or restore critical infrastructure and public safety facilities to be structurally sound and resistant to extreme weather events of greater intensity
Prepare for potential extreme weather conditions by improving the reach and speed of pre- event communications and warning systems to ensure the safety of all residents, seasonal renters, and other Island visitors when a hazard event is imminent

III. COMMUNITY ACTION TEAM REPORT

A. Developing the Community Action Team (CAT)

The multi-phase nature of the RCCP necessitated a Community Action Team (CAT) stakeholder format. The CAT was envisioned as a group of engaged, informed community stakeholders that can reconvene beyond Phase I and II of the RCCP to provide continuity around resiliency projects on Topsail Island. With support from the three municipalities, a CAT formed consisting of members from diverse backgrounds, capturing the breadth of knowledge and represented the interests and values of the three Topsail Island communities. Members contributed a diverse range of skillsets and levels of past involvement in hazard mitigation, shoreline protection and resiliency projects.

Through workshops and questionnaires, CAT members identified additional stakeholders whose participation would greatly benefit the project. Consideration was given to individuals whose "everyday lives and well-being are directly connected to a resource or issue" (NOAA 2015). Potential stakeholder groups included: elderly populations, sound-side property owners, residents in the Coastal Barrier Resource Area (CBRA) zone, resident and non-resident property owners, political figures, emergency personnel, church leaders, municipal staff, county staff, elected officials, and Homeowners Association (HOA) Presidents. CAT workshops and questionnaires specifically identified vulnerable populations as elderly, low-income, renters, and owners and renters of mobile homes and recreational vehicles (RVs).

Each of the three towns had approximately the same number of representatives on the CAT. Additionally, several members also sit on the Topsail Island Shoreline Protection Commission (TISPC), a collaborative effort by the five entities with governing authority on the island – Board of Commissioners for Pender County and Onslow County, and Towns of North Topsail Beach, Surf City, and Topsail Beach – to advance beach preservation activities (Topsail Island Shoreline Protection Commission, n.d.). For reference North Topsail Beach is located in Onslow County; Surf City spans both Onslow and Pender counties, and Topsail Beach is located in Pender County.

B. Topsail Island CAT Members

North Topsail Beach	
Name	**Title/Affiliation**
Deb Hill	Planning Director, North Topsail Beach
Alice Derian	Town Manager, North Topsail Beach
Marianna Harness	Resident, North Topsail Beach
Michael Pawelko	Resident, North Topsail Beach
Mike Benson	Mayor Pro Tem, TISPC Vice Chair, North Topsail Beach
Surf City	
Name	**Title/Affiliation**
Amy Kimes	Town Planner, Surf City
David Ward	Surf City BRN Committee, TISPC Member
Heather Allen	Resident, Surf City
Kyle Breuer	Town Manager, Surf City
Teresa Batts	Councilwoman, TISPC Member, Surf City
Hiram Williams	Surf City BRN Committee, TISPC Member
Topsail Beach	
Name	**Title/Affiliation**
Christina Burke	Assistant Town Manager, Topsail Beach
Michael Rose	Town Manager, Topsail Beach
Steve Smith	Mayor, Topsail Beach
Ed Broadhurst	Topsail Beach Board of Commissioners

C. Community Action Team Meeting Agendas

CAT Meeting Agendas		
Workshop #1	October 12, 2021	1. Resilient Coastal Communities Program (RCCP) Orientation 2. Background 3. Program Objectives & Goals 4. Program Steps & Deliverables 5. Review Key Project Definitions 6. Project Timeline 7. Next Steps 8. Questionnaires 9. Next workshop: Community Vision Statement
Workshop #2	October 26, 2021	1. Introductions 2. Workshop #1 Recap 3. Questionnaire #1 Responses 4. Share additional feedback from questionnaire #1 (each community) 5. Brainstorm community vision statement and goals 6. Round robin (3-5 minutes) from each community 7. Next steps: questionnaire #2, workshop #3, project timeline
Workshop #3	November 9, 2021	1. Recap weekend events (King Tide Event and Photos) 2. Workshop #2 recap 3. Questionnaire #2 responses 4. Share additional feedback from questionnaire #2 (each community) 5. Finalize vision statement and goals 6. Planning community engagement strategy

CAT Meeting Agendas		
		7. Round robin (3-5 minutes) from each community 8. Next steps
Workshop #4	January 11, 2022	1. Recap of Open House (December 15th, 2021) 2. Vision Statement and main themes 3. Closure of Phase I – Assess Vulnerability, Ranking Assets, and Estimating Risk 4. Transitioning to Phase II 5. Draft List of Portfolio Projects 6. Identify Gaps of Draft Portfolio Projects (projects not already on list) 7. Round robin (2-3 minutes) from each community 8. Next steps 9. Submit questionnaire for additional feedback
Workshop #5	January 25, 2022	1. Review of Assessing Vulnerability (Phase I) 2. Review of Planning, Project Identification, and Prioritization (Phase II) 3. Project overview and expectations update 4. Top selected projects – draft result and findings 5. Bar graph of draft Portfolio Projects 6. Other projects for consideration 7. Round robin (5 minutes) from each community 8. Scheduling Public Open House #2 and Community Engagement Discussion

CAT Meeting Agendas		
		9. Next Steps
Workshop #6	April 7, 2022	1. Project Portfolio Characteristics (Phase II) 2. Project Portfolio Categories 3. Open House Summary 4. Demonstration Boards 5. Project Portfolio Priority Rankings 6. Group discussion about Project Portfolio (5-10 minutes) for each community 7. Phase III Application and general information update 8. Program Timeline 9. Next Steps

IV. STAKEHOLDER ENGAGEMENT STRATEGY

A core tenet of the RCCP is developing an engagement strategy to inform and involve community members with the project. Strong emphasis is placed on the principles of transparency, inclusivity, and equity in developing the strategy, and identifying stakeholders – including vulnerable populations – was an essential step.

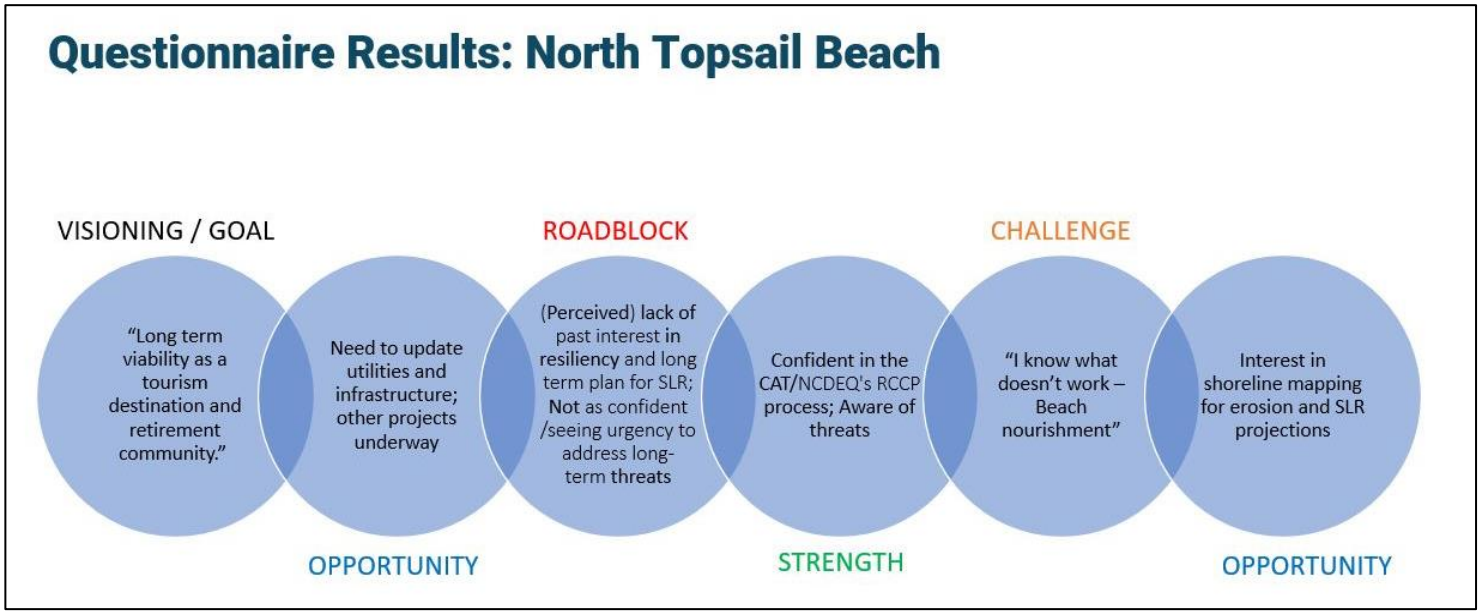
Throughout the duration of the project, several widely accepted participation techniques were employed (NOAA Office for Coastal Management 2015):

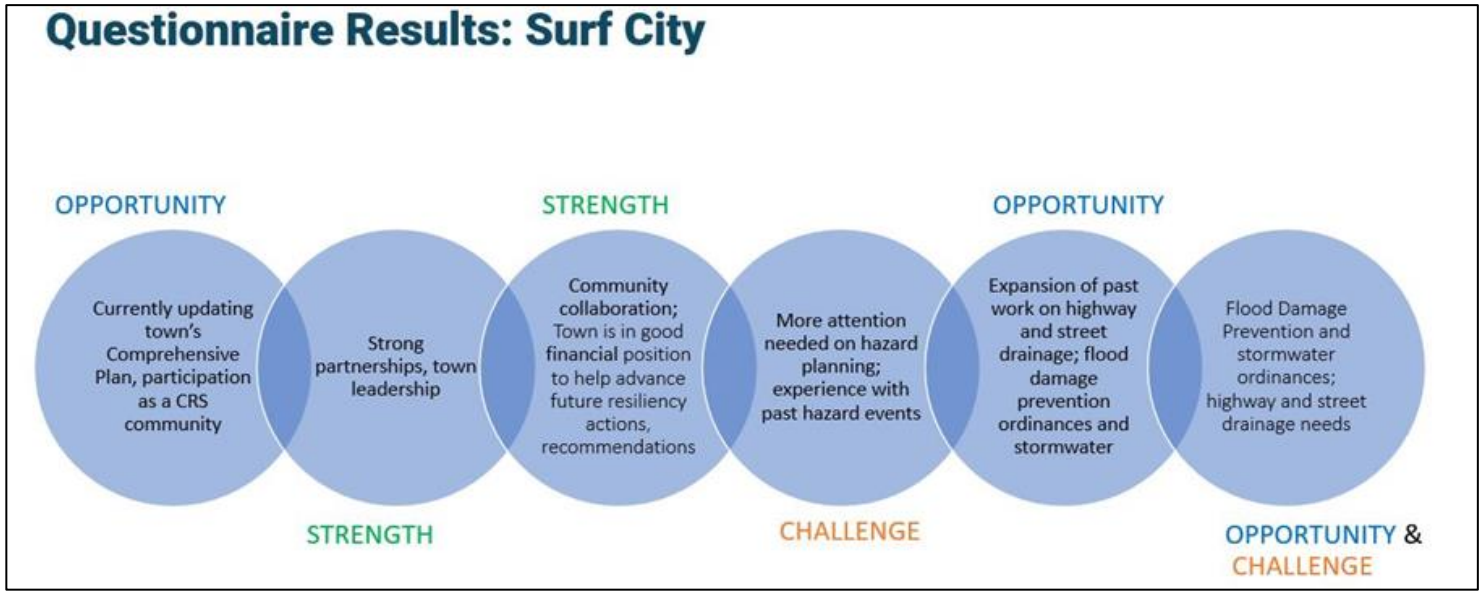
- Advisory group / task force (CAT)
- Internet (project StoryMap, websites, social media, online publications)
- Large / small group meetings
- Open Houses (virtual, in-person, interactivity)
- Poll / survey

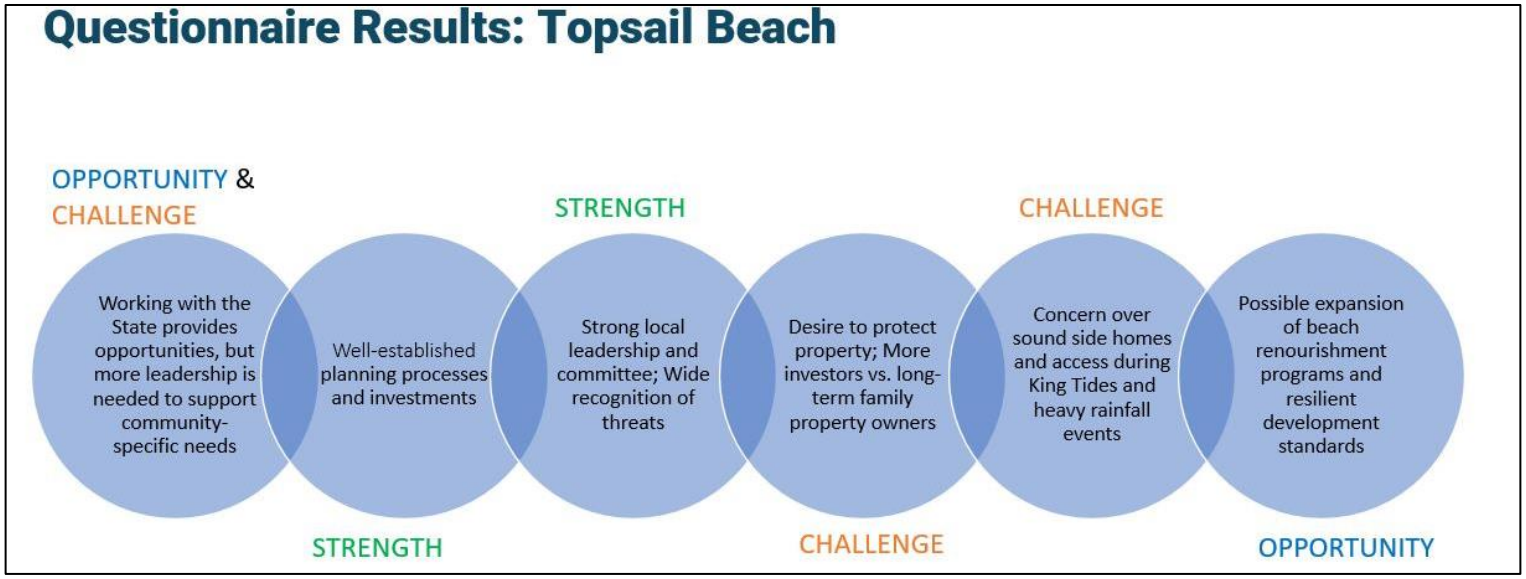
CAT Workshops

Community Action Team workshops were held virtually over the course of six months. The first workshop occurred in October 2021 and the final workshop occurred in April 2022. For each of the six total workshops, the format consisted of a PowerPoint presentation (facilitated by the Kleinfelder Project Manager), open question and answer periods for group discussion and participation, and conversation on the results of previous questionnaires. Kleinfelder periodically dispersed questionnaires to CAT members after workshops to gather feedback and local knowledge. One example asked members for feedback related to communities' "Strengths, Opportunities, Challenges, and Roadblocks" with respect to resiliency (**Figure 4.1**).

FIGURE 4.1 – RESULTS FROM QUESTIONNAIRE BY TOWN







A. StoryMap

One piece of the targeted approach to engage a wide variety of stakeholders was The Topsail Island – Island-Wide Coastal Resiliency (RCCP) Project StoryMap. This interactive, web-based platform informs the public about the status of the project, provides community-specific data via interactive maps, and offers a platform to solicit general feedback. It allowed for asynchronous participation for individuals unable to attend Open Houses or CAT meetings and was updated regularly to keep project information up to date.

The Topsail Island – Island-wide Coastal Resiliency (RCCP) Project

StoryMap is accessible via the TISPC website (https://tispc.org/), and via the direct URL link below:

https://gis.kleinfelder.com/klfportal/apps/storymaps/stories/b5f44c9c12d74cf0b51f6d0419893581

B. Questionnaires

Guided questionnaires were useful tools to gather localized knowledge from CAT members and provided an opportunity for members to offer thoughtful feedback outside of a larger group setting. Following most CAT meetings, members received questionnaires to garner specific input about projects, hazards, and program objectives. During later meetings, anonymous results of the questionnaires were shared with the larger group.

C. Open Houses

An important component of an equitable stakeholder engagement strategy included Open House events with options to attend in-person or virtually. This component was part of a targeted approach for reaching vulnerable populations and inviting greater participation from individuals representing a range of interests and backgrounds. In-person Open Houses facilitate one-on-one interaction amongst stakeholders and agencies and provide opportunities for the local community to attend and provide valuable feedback.

Figure 4.2: First Open House event at Surf City Town Hall (December 2021)

The first Open House was planned for the Risk and Vulnerability assessment stage of the project and was held in December 2021 at the Surf City Town Hall building, a central location accessible to all community members in the evening hours. Participants were informed about the RCCP and how it relates to advancing the resiliency goals of Topsail Island. Flyers with the event information were disseminated through various channels of communication with sufficient notice, and these channels included: Topsail Island StoryMap, TISPC website (https://tispc.org/), town calendars and websites (Topsail Beach Events, n.d.) , social media, and online publications such as the **Coastalreview.org** website (a daily news service from the North Carolina Coastal Federation) (Residents can weigh in on Topsail Island resiliency needs, 2021). For those unable to attend in-person events at the first Open House, a virtual option offered greater flexibility and allowed for participation in the presentation and Question & Answer session. The event was also recorded and posted to the StoryMap for future viewing.

The second Open House was planned for the Project Development stage of the project and held in March 2022 at the Surf City Town Hall building. This event was only offered in-person due to the interactive nature of the event, where participants were asked to rank proposed projects on display boards using stickers. Participants provided input using different media and the results garnered valuable feedback that was integrated into the Project Portfolio. Approximately 30 community members participated in the second Open House.

Figure 4.3: Second Open House event – one of four display boards with stickers (March 2021)

The schedule for the stakeholder engagement strategy aligned with the CAT timeline, shown in **Table 4.1**, to remain consistent throughout the project and allow as many voices as possible to be heard. It was a priority that all participants were given ample notice and clear information on how to engage with the project.

TABLE 4.1 – CAT WORKSHOP TIMELINE

Important Dates & Milestones	
CAT Kickoff Meeting	October 12, 2021
CAT Meeting (Phase I Vision/Goals/Strategy)	October 26, 2021
CAT Meeting (Finalize Vision/Goals & Set Community Engagement Strategy)	November 9, 2021
CAT Meeting (Closure of Phase I)	November 16, 2021
Public Open House – Phase I (In Person)	December 15, 2021
CAT Meeting (Phase II – Strategize Priority Actions)	January 11, 2022
CAT Meeting (Phase II Finalize Priority Actions)	January 25, 2022
Public Open House – Phase II (In Person)	March 16, 2022
Phases 3 Application Period Opens	End of March 2022
CAT Meeting – (Closure of Phase II)	April 7, 2022
Final Deliverables Phase I & II	May 2022
Phases 3 Application Deadline	June 2022

Throughout the project, several articles were published about the Topsail Island RCCP, including announcements about upcoming events and post-event summaries. Summary discussions and progress from these public events were publicized in local media sources, including Dredgewire (Passaretti, Threatened by rising sea level, Topsail Island makes progress in pinpointing coastal resiliency goals, 2022), Port City Daily (Passaretti, Threatened by rising sea level, Topsail Island makes progress in pinpointing coastal resiliency goals, 2021), and RA Forum (Barton, 2021)

V. Review of Existing Local & Regional Efforts

Much work has been done locally and across the southeastern region of North Carolina related to resilience efforts. In an effort to utilize work to date, Kleinfelder completed a review of existing local and regional plans, ordinances, policies, and programs to develop a baseline understanding of critical assets and natural infrastructure, social vulnerability, risk assessments, and resilience-related projects. The following inventory includes the following types of documents, among others:

- Regional and local plans, such as Coastal Area Management Act (CAMA) Land Use Plans, Hazard Mitigation Plans, and hurricane redevelopment plans
- Local ordinances, such as zoning or unified development ordinances
- Non-regulatory programs, such as the FEMA Community Rating System (CRS)

TABLE 5.1 - INVENTORY OF EXISTING DOCUMENTS

Name	Type	Town/County	Year
Onslow County Comprehensive Plan (CAMA Core Land Use Plan)	CAMA / Land Use	Onslow County	2009; amended 2014
Pender County Comprehensive Land Use Plan v1.0 [OLD]	CAMA / Land Use	Pender County	2010
Pender County Comprehensive Land Use Plan v2.0	CAMA / Land Use	Pender County	2018
Town of Topsail Beach CAMA Core Land Use Plan	CAMA / Land Use	Topsail Beach	2015
Town of North Topsail Beach 2009 CAMA Land Use Plan	CAMA / Land Use	North Topsail Beach	2009
Town of North Topsail Beach, NC 2019 CAMA Land Use Plan Update (Draft)	CAMA / Land Use	North Topsail Beach	2020
Town of Surf City Land Use Plan (2005)	CAMA / Land Use	Surf City	2005; update in progress
Town of Topsail Beach CAMA Land Use Plan	CAMA / Land Use	Topsail Beach	2015 (scheduled to be updated)
North Topsail Beach Capital Improvement Plan (CIP)	CIP	North Topsail Beach	under development
Surf City Capital Improvement Plan	CIP	Surf City	2021
FEMA National Flood Insurance Program	CRS / Flooding	Onslow County	Ongoing

Name	Type	Town/County	Year
(NFIP) CRS Program - Onslow County			
FEMA NFIP CRS Program - Pender County	CRS / Flooding	Pender County	Ongoing
FEMA's NFIP CRS program documentation - North Topsail Beach	CRS / Flooding	North Topsail Beach	2021/ Under Development
FEMA's NFIP CRS program documentation - Topsail Beach	CRS / Flooding	Topsail Beach	Ongoing
North Topsail Beach CRS - Program for Public Information	CRS / Flooding	North Topsail Beach	2015
Pender County Flood Damage Prevention Ordinance	CRS / Flooding	Pender County	2019
North Topsail Beach Emergency Operations Plan (EOP)	Emergency Plans	North Topsail Beach	2020
North Topsail Beach Storm Preparedness Plan	Emergency Plans	North Topsail Beach	2019
North Topsail Beach Hazard Mitigation Plan (HMP)	HMP	North Topsail Beach	2015
Onslow County Multi-Jurisdictional Hazard Mitigation Plan	HMP	Onslow County	2015

Name	Type	Town/County	Year
Southeastern North Carolina Regional Hazard Mitigation Plan (2016)	HMP	Pender County	2016
Southeastern North Carolina Regional Hazard Mitigation Plan (2021)	HMP	All	2021
Surf City Hazard Mitigation Plan	HMP	Surf City	2016
Topsail Beach 30 Year Beach Management Plan	HMP	Topsail Beach	2011
Topsail Beach Hazard Mitigation Plan	HMP	Topsail Beach	2016; update in progress
NC Dept of Transportation Comprehensive Transportation Plan Topsail Area	Other	All	2011
North Carolina Department of Environmental Quality (NCDEQ) Inlet Hazard Area guidance	Other	All	2019
Surf City Draft Watershed Protection Plan	Other	Surf City	2021
Topsail Beach Stormwater Feasibility Study	Other	Topsail Beach	2020

Name	Type	Town/County	Year
United States Army Corps of Engineers (USACE) Coastal Storm Damage Reduction Project in Surf City and North Topsail Beach	Other	All	Ongoing; *Note: North Topsail Beach has withdrawn from federal project*
Hurricane Matthew Resilient Redevelopment Plan - Onslow County	Redevelopment	Onslow County	2017
Hurricane Matthew Resilient Redevelopment Plan - Pender County	Redevelopment	Pender County	2017
Hurricane Matthew Resilient Redevelopment Plan - Southeast Region	Redevelopment	All	2017
North Topsail Beach Unified Development Ordinance	Zoning / Ordinances	North Topsail Beach	2011
Surf City Topsail Beach Unified Development Ordinance (Zoning and Subdivision)	Zoning / Ordinances	Surf City	2004
Topsail Beach Unified Development Ordinance	Zoning / Ordinances	Topsail Beach	2019
Unified Development Ordinance Update	Zoning / Ordinances	North Topsail Beach	2015

Name	Type	Town/County	Year
Town of North Topsail Beach Build Out and Non-Conforming Lot Study	Zoning / Ordinances	North Topsail Beach	2010

VI. RISK AND VULNERABILITY ASSESSMENT

A risk and vulnerability assessment evaluates risks to vulnerable populations within a community and risks to critical assets from coastal and climate hazards, such as flooding (rainfall and tidal), storm surge, and sea level rise. The assessment consists of three parts: 1) identify and map the hazards, 2) assess vulnerability, and 3) estimate risk.

A. Hazard Inventory

The first part of the risk and vulnerability assessment is to identify and map the hazards. The following sections take inventory of the relevant hazards and provides background information on past events and future projections.

For Topsail Island, the *Southeastern North Carolina Regional Hazard Mitigation Plan* (ESP Associates, 2021) provides the foundation for the risk and vulnerability assessment. The Plan incorporates hazards that impact Topsail Island communities and the neighboring areas, shown in the table below.

HIGH RISK	Flooding Hurricanes/Coastal Hazards Cyber Tornadoes/Thunderstorms
MODERATE RISK	Severe Winter Weather Radiological Emergency Infectious Disease Hazardous Substances Drought Terrorism Wildfire Geological Hazards (Sinkholes, Coastal Erosion) Rip Currents
LOW RISK	Tsunamis Excessive Heat Earthquake Dam Failure Electromagnetic Pulse

Table 6.1 – Conclusions on Hazard Risk for the Southeastern North Carolina Region, per the *Southeastern North Carolina Regional Hazard Mitigation Plan (ESP Associates, 2021)*

The 2020 North Carolina Climate Risk Assessment and Resilience Plan *(NC Department of Environmental Quality, 2020)* assesses additional hazards (or sub-types of hazards) not listed above. These include heavy precipitation, ecosystem and habitat loss, saltwater intrusion, public health, population growth, and other hazards.

The Topsail Island CAT and additional stakeholders identified the priority hazards specific to communities on the island. These include:

- Coastal flooding from hurricanes and winter storm events
- Sound-side flooding from tidal and precipitation events
- Sea level rise and storm surge
- Coastal erosion associated with each of the above hazards

1. Summary of Priority Hazards to Topsail Island

Hurricanes and Coastal Hazards

Hurricanes, including tropical storms, and coastal hazards include sub-hazards such as nor'easters, storm surge, and rip currents. Topsail Island is no stranger to damaging hurricane winds, coastal flooding, and storm surge. According to the National Hurricane Center historical storm track records (2019), 127 hurricane, tropical storm, or tropical depression tracks have passed within 75 miles of the southeastern NC region since 1850. Clustered events have also occurred within the same decade. During the 1990s, 4 major hurricanes – Bertha, Fran, Bonnie, and Floyd – impacted North Carolina over a 5-year period.

In July 1996, Hurricane Bertha made landfall near Topsail Island and was followed two months later by Hurricane Fran, a Category 3 storm that caused significant damage to the Island. Structures were carried off pilings and more than a half-dozen channels and temporary inlets were cut into Surf City and North Topsail Beach.

The most significant wave of successive hurricanes to hit the area were Hurricanes Joaquin (2015), Matthew (2016), Florence (2018), and Dorian (2019). Matthew, Florence, and Dorian were classified as Category 1 hurricanes, however all brought record level coastal and riverine flooding, heavy rainfall, power outages, road closures, and significant damages and losses. Hurricane Joaquin (2015) also resulted in significant road closures, debris, and major flooding and beach erosion in North Topsail Beach, however it did not result in a disaster declaration. Severe

damages to beach, structures, and infrastructure across the three towns from Florence (2018) were estimated at over $100 million (US Army Corps of Engineers Wilmington District, 2022).

Along with hurricanes and other winter storm events, Topsail Island has experienced significant storm surge associated with storms. Since 1996, the National Centers for Environmental Information (NCEI) has recorded $8 million in damages. Storm surge is a major destructive force of land-falling tropical storms and hurricanes. During Hurricane Fran (1996), storm surge on Topsail Island was as destructive as wind, reaching heights over 12 feet and almost completely over washing the island (Ringer, 2021).

It is likely the entire Topsail Island area will continue to experience damaging hurricanes, larger storm surges, and coastal hazards – independent of, but exacerbated by, future sea level rise.

Coastal Erosion

Southeastern North Carolina is well aware of coastal erosion, which is the process of tidal currents, strong wave action, and wind wearing sand and sediments down. On average, the state

Figure 6.1 – Coastal erosion associated with unnamed 2021 winter storm that occurred during Phase I of the RCCP project, shared by a member of the Topsail Island CAT

is experiencing 1.6 feet of erosion per year based on a study done by the North Carolina Department of Environmental Quality with a focus on multiple locations. Erosion is a natural, dynamic, and continuous process for coastal areas, but it can be exacerbated by shoreline hardening and sea level rise. Beach nourishment and structural shoreline protection lessen the impacts of coastal erosion but are not comprehensive long-term solutions for sea level rise.
It is highly likely the entire Topsail Island area will experience increased coastal erosion in the future, given the increased severity of future storms and non-linear response to sea level rise.

Sea Level Rise, High Tide, and "Sunny Day" (Tidal) Flooding

In addition to coastal flooding, stakeholders provided input about additional types of flooding that impact the area, including sound side and tidal flooding. Coastal flooding is typically caused by storm surge, high tides, wind driven waves, and heavy rainfall associated with hurricanes, tropical storms, and other large coastal storms (Coastal Flood Risk, 2022). The NCEI reports that counties in the southeastern North Carolina region have been affected by 350 flood events since 1997. Topsail Island experiences "high tide flooding" (HTF), which is defined by the National Oceanic and Atmospheric Administration (NOAA) as water levels of 1.6 – 2.1 feet above present Mean High-Water mark. A HTF event occurs when local sea level temporarily rises above an identified threshold height for flooding, in the absence of storm surge or riverine flooding (Coastal Flood Risk, 2022). HTF is also referred to as "sunny day" or "nuisance" flooding that occurs during high tides. Topsail Island also experiences "king tides" which are much higher than normal high tides and occur during new and/or full moons. In addition to natural processes, undersized drainage systems and stormwater infrastructure can exacerbate flooding by failing to evacuate it in a timely or proper manner.

Figure 6.2 – Sound side tidal flooding and inundation is becoming increasingly frequent. The above post features sound side flooding examples shared on social media in November 2021 (photo shared by member of the Topsail Island CAT).

It is highly likely that sunny day and king tide flooding will increase in the future.

According to the 2020 North Carolina Climate Science Report (North Carolina Institute for Climate Studies, 2020), sea level along the North Carolina coast will continue to rise due to expansion of ocean water from warming and melting of ice on land. The report also states that localized sea level rise is "virtually certain." NOAA Intermediate Scenarios are also consistent with projections in North Carolina's *Sea Level Rise Assessment Report*.

With rising sea levels and increasing intensity of coastal storms, coastal flooding caused by storms and storm surge flooding is very likely to increase.

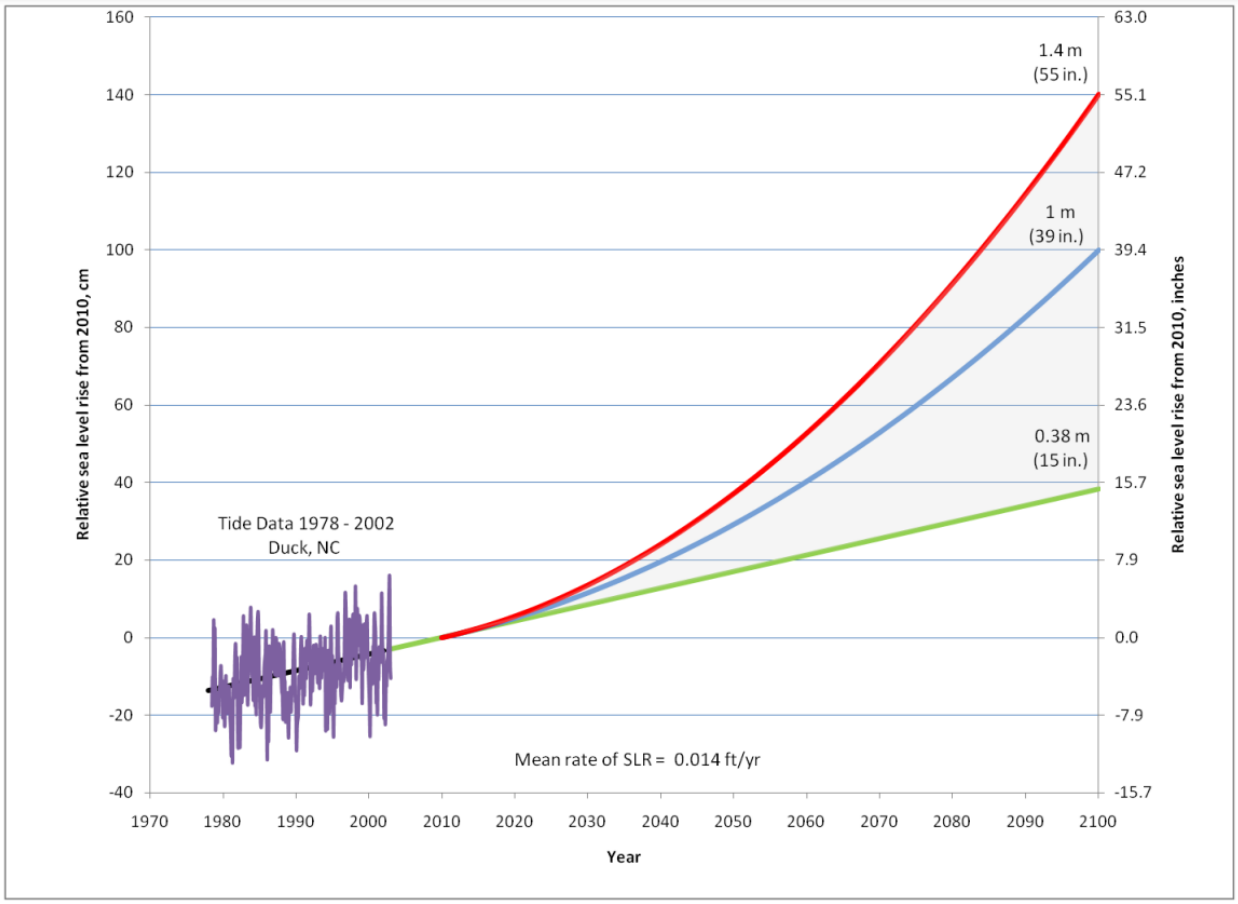


Figure 6.3 – Magnitude of sea level rise from different rates of acceleration – source: *(North Carolina Department of Environment and Natural Resources, 2010)*

Wildfire

The Southeast region of the United States, including North Carolina, experiences the highest average number of wildfires per year. A major threat posed by the changing climate is an extended fire season in North Carolina, characterized by the risk of more frequent and increasingly severe

wildfires (Wildfire Risk to Communities, 2022). The Southeastern North Carolina Regional Hazard Mitigation Plan documents relative wildfire ignition density at the county level, however there is little history of wildfires documented for Topsail Island specifically (ESP Associates, 2021).

However, according to the United States Department of Agriculture, Topsail Island communities are at a greater risk for wildfires than other North Carolina communities – North Topsail Beach and Topsail Beach have 97% greater risk and Surf City has a 98% greater risk.

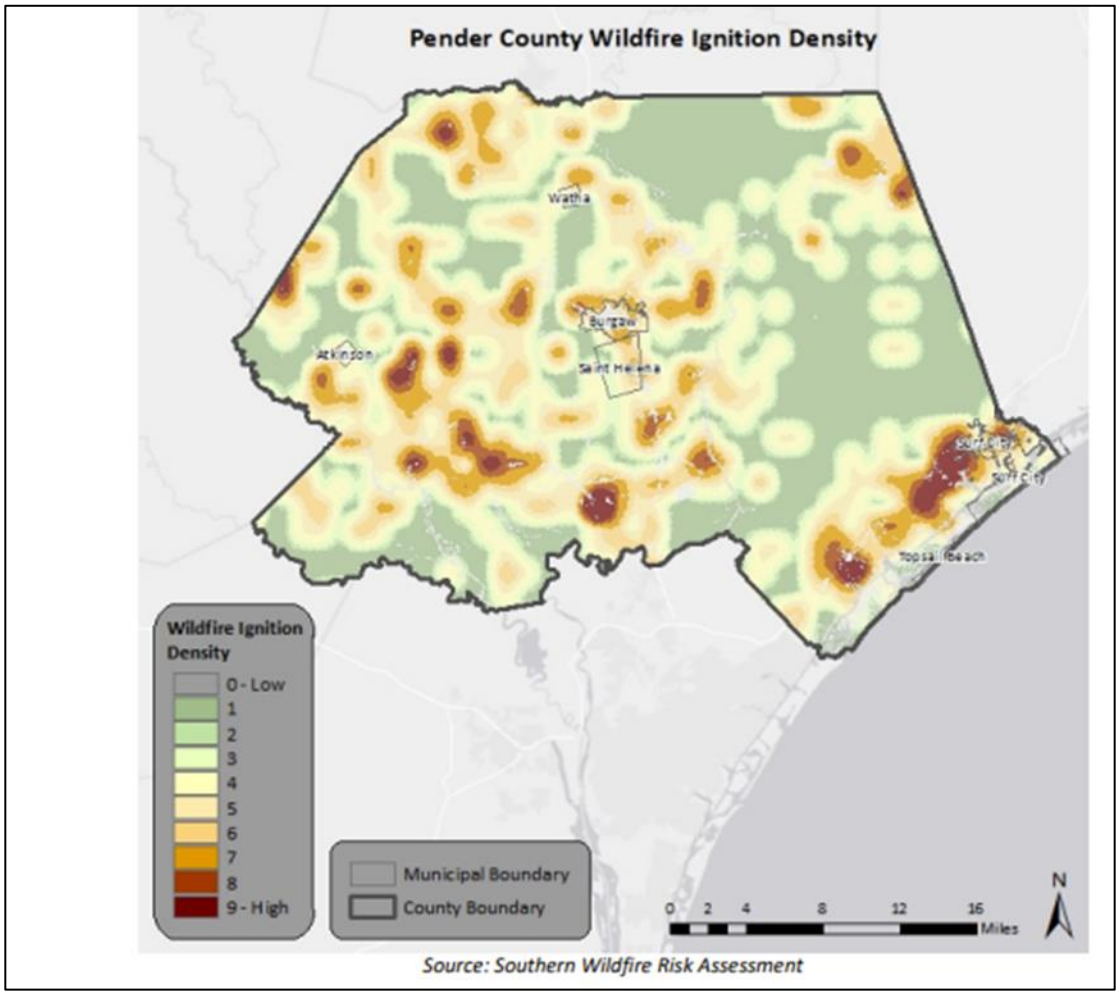


Figure 6.4 – Wildfire ignition density in Pender County source: *(ESP Associates, 2021)*

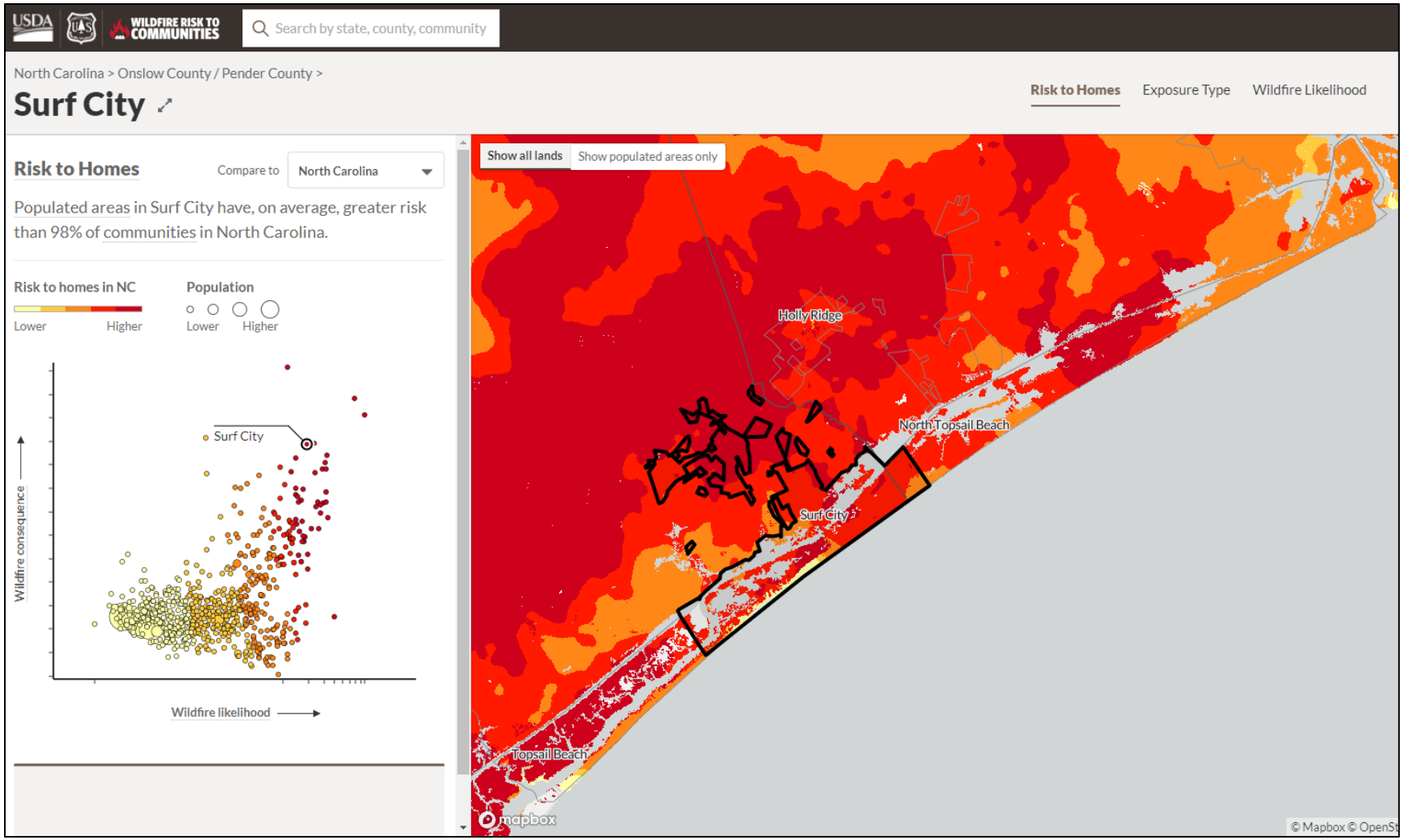


Figure 6.5 – Wildfire risk to homes in Surf City, NC across all lands (source: adapted from US Department of Agriculture and US Forest Service Wildfire Risk to Communities tool)

Excessive Heat

Extreme heat events in southeastern NC are becoming more prevalent and pose a significant risk to socially vulnerable populations. Between 1996 and 2018, Pender and Onslow County experienced a combined nine occurrences of excessive heat (citation). Based on downscaled climate projections, scientists have determined it is likely that this region will experience more intense heat events in the future.

Disaster Declarations

An additional source that provides important insight into hazards that have impacted Topsail Island are disaster declarations. A documented disaster history is a required element of a hazard mitigation plan. Since 1984, the southeastern NC region has reported 19 presidential disaster declarations (Table 6.2). Of the 19 declared disasters, Onslow County experienced 14 and Person County experienced 15. The majority of the disaster occurrences are hurricane related.

Year	Disaster Number	Description	Brunswick County	Onslow County	Pender County	New Hanover County
1984	724	HURRICANE DIANA	X		X	X
1989	844	HURRICANE HUGO	X			
1996	1127	HURRICANE BERTHA	X	X	X	X
1996	1134	HURRICANE FRAN	X	X	X	X
1998	1240	HURRICANE BONNIE	X	X	X	X
1999	1292	HURRICANE FLOYD	X	X	X	X
2003	1490	HURRICANE ISABEL	X	X	X	X
2005	1608	HURRICANE OPHELIA	X	X	X	X
2008	1801	TROPICAL STORM HANNA	X			X
2010	1942	SEVERE STORMS, FLOODING, AND STRAIGHT-LINE WINDS	X	X	X	X
2011	1969	SEVERE STORMS, FLOODING, TORNADOES		X		
2011	4019	HURRICANE IRENE	X	X	X	X
2016	4285	HURRICANE MATTHEW	X	X	X	X
2018	4393	HURRICANE FLORENCE	X	X	X	X
2019	4412	TROPICAL STORM MICHAEL	X			
2019	4465	HURRICANE DORIAN	X	X	X	X
2020	4487	COVID-19 PANDEMIC	X	X	X	X
2020	4543	SEVERE STORMS, TORNADOES, AND FLOODING			X	
2020	4568	HURRICANE ISAIAS	X	X	X	X

Table 6.2 – Disaster declaration history in the southeastern North Carolina region (source: *(ESP Associates, 2021)*

B. Assess Vulnerability

The second part of the assessment investigates the vulnerability of critical assets, natural infrastructure, residential/rental/commercial property, social vulnerability, and other vulnerabilities unique to Topsail Island. Vulnerability of critical assets and natural infrastructure to a hazard is a function of the exposure, sensitivity, and adaptive capacity. Exposure refers to the probability of physical contact between an asset and a hazard. Sensitivity is the degree to which an asset is impacted by a hazard. And adaptive capacity is the ability of an asset to change its characteristics or behavior in response to a hazard.

Vulnerability of Critical Infrastructure Assets

Topsail Island is familiar with the impact intense coastal storms have on the island and seasoned residents are accustomed to the cycles of storm-related damages, power and water outages, accessibility issues, and post-storm clearing, rebuilding, and rehabilitation. For island residents and property owners, the “fundamentals” at the forefront of any resiliency planning effort are “accessible evacuation routes and [post-storm] access to running water, heat, and electricity.”

Evacuation Routes, Major Roadways and Bridges

Regardless of whether there is a storm, accessibility is critical for emergency response and access to essential services. There are multiple low-lying areas along Anderson Blvd., Island Drive, and New River Inlet Road, which are designated evacuation routes that lead to the new Surf City Bridge and NC-210 bridge in North Topsail Beach. These areas are projected to be subjected to increased tidal flooding with sea level rise.

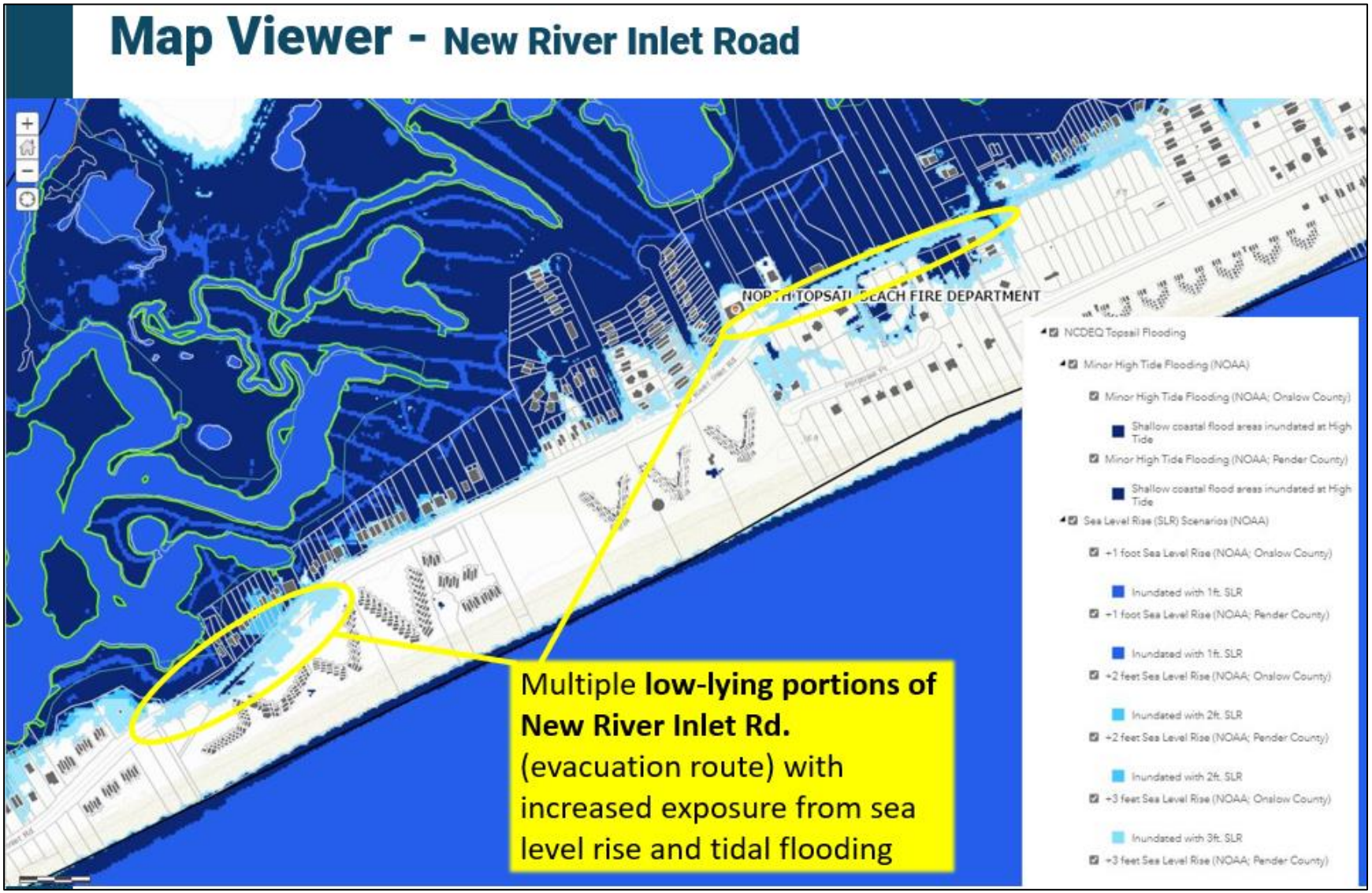


Figure 6.7 – New River Inlet Road future vulnerability to sea level rise and increased tidal flooding, potentially cutting off access to NC-210 bridge, which would isolate areas in North Topsail Beach.

NCDOT recommends that when planning transportation projects, state routes should be planned to be “resilient to a 50-year recurrence interval;” however, evacuation routes should be built to be “resilient to any level of inundation.” At present, there are locations along Topsail Island where roadways designated as coastal evacuation routes are currently subjected to flooding at 10-year or more frequent recurrence. Portions of NC-50 through Topsail Beach are as low in elevation as 2.7’ NAVD88. Over 1.5 miles of NC-50 in Topsail Beach are below elevation 5.0’ NAVD88 and over 5 miles of NC-210 through North Topsail Beach are below the same threshold. Data from the NCDOT Coastal Roadway Inundation Simulator (CRIS) was provided to the project team and is summarized in Table 6.3.

Table 6.3 – NCDOT Coastal Roadway Inundation Simulator modeled water surface elevation and roadway inundation for storm recurrences

Present Day Storm Recurrence	**Water Surface Elevation (NAVD88)**	**CRIS Modeled Roadway Surface Inundation for Evacuation Routes (ft)**	**Reference roadways in Topsail Island**
10-year	3.4 to 5.4	0.1 to 1	NC-50 (Topsail Beach)
25-year	5.5 to 7.0	0.1 to 4.1	NC-50 (Topsail Beach, Surf City), NC-210 (Surf City, North Topsail Beach)
50-year	8.4 to 9.0	0.1 to 6.0	NC-50 (Topsail Beach, Surf City), NC-210 (surf City, North Topsail Beach)
100-year	10.0 to 13.0	0.1 to 9.0	NC-50 (Topsail Beach, Surf City), NC-210 (Surf City, North Topsail Beach)
200- to 500-year	11.1 to 20.0	0.1 to 15.4	NC-50 (Topsail Beach, Surf City), NC-210 (Surf City, North Topsail Beach)

Bridges

Two primary bridges connect Topsail Island with the mainland – one in Surf City and a second in North Topsail Beach.

- The new $53 million Surf City Bridge includes a span that reaches 65-feet high. The bridge includes a 39-foot roadway width, carrying the bicycle and travel lanes, and allowing for an alternative evacuation configuration for emergencies or hurricanes (i.e., two lanes off the island, one lane onto the island) (North Carolina Department of Transportation, 2020).
- The NC-210 Fixed Bridge over the Intracoastal Waterway was built in 1968. While the bridge span is elevated over 20 feet, there is a low-lying approach on the barrier island side from the south along Island Drive (see **Figure 6.8**).

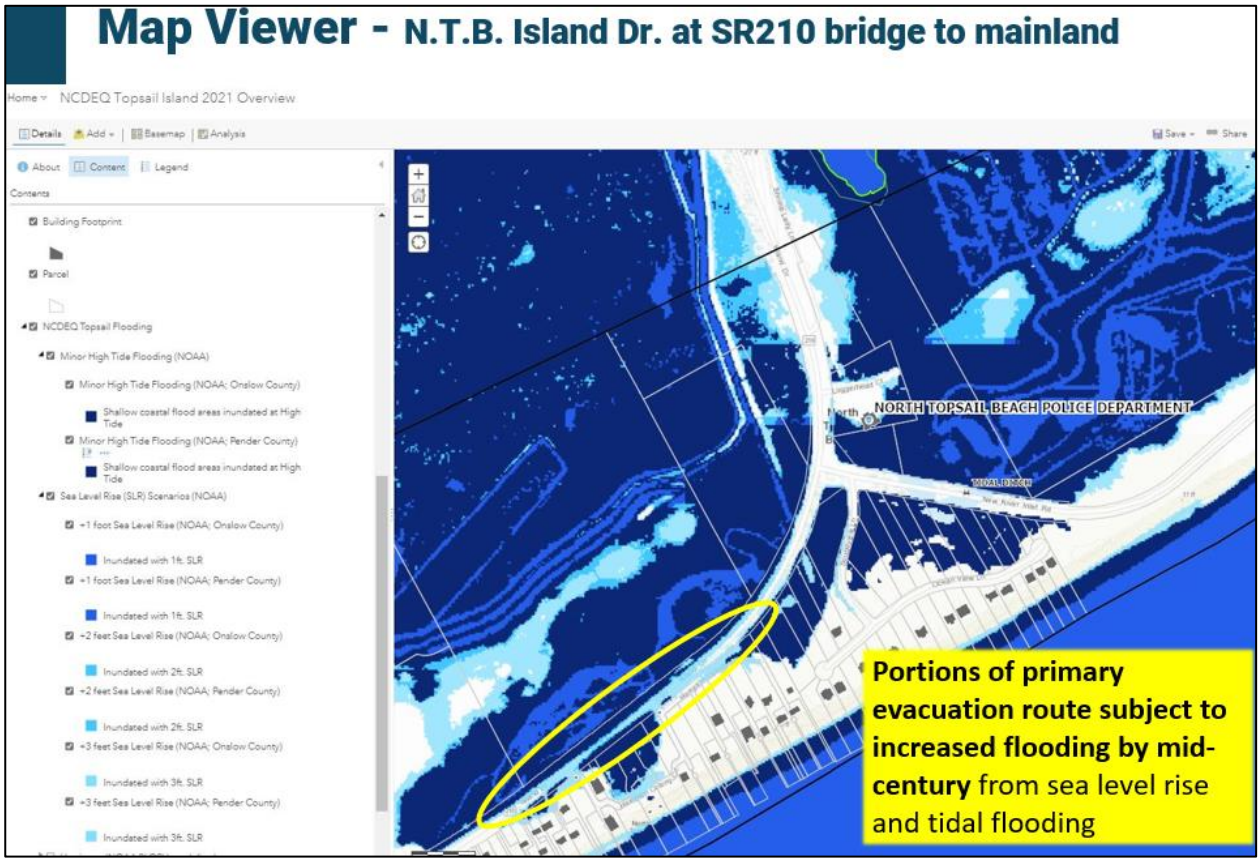


Figure 6.8 – Island Drive future vulnerability to sea level rise and increased tidal flooding, approaching the NC-210 bridge in North Topsail Beach

While the spans of the two high-rise bridges (Surf City and North Topsail Beach) are elevated well above the Intracoastal Waterway, the low-lying approaches on both sides of each bridge are

highly vulnerable to future sea level rise and future high tide flooding. For instance, the island-side eastbound approach to the NC-210 bridge in North Topsail Beach is vulnerable to sea level rise and future tidal flooding. On the mainland side of this bridge, a long stretch of low-lying roadway between the bridge and NC-172/Sneads Ferry is mostly lower than 12 feet (above mean sea level), with smaller segments below 9 feet (above mean sea level).

Electrical Substation and Power Lines

The electrical substation in Topsail Beach (located at Sidbury Ave. and N. Anderson Blvd) is at high risk of future storm and tidal flooding.

Past flooding has typically filled low-lying areas behind the street and houses instead of flooding the substation. However, with additional sea level rise, this area – and the substation equipment – is becoming more vulnerable. While critical equipment is raised slightly above ground surface, this area is subject to more frequent storm flooding, which future projects show may be subject to more than a foot of flooding on a 5% or 20-year storm or more recurrence. A detailed assessment of flood risk at this location can be found in Appendix B (refer to Figures B.6, B7, B8).

Figure 6.9 – Electrical substation in Topsail Beach near Sidbury Ave. and N. Anderson Blvd. (Bing Maps, 2022)

The CAT additionally noted the vulnerability of overhead wires being subjected to hurricane wind damage and raised potential interest in burying overhead utilities where feasible. Following major storm events in the past, structures have been without power for 3-4 months at a time, which the CAT noted was beyond the time required to condemn these structures.

Emergency and Backup Generators and Lift (Pump) Stations

The CAT identified emergency and backup generators as well as lift/pump stations as critical infrastructure of particular importance during coastal flood and other hazard events. Of the 40 sewer lift stations on the barrier island, 30 are within the spatial extent of +3 feet of sea level rise inundation.

Figure 6.10 – Example of a backup generator elevated to FEMA's Base Flood

Estimation of Critical Asset Vulnerability

The following table provides estimates of vulnerability for identified critical assets on Topsail Island.

TABLE 6.4 – ESTIMATION OF CRITICAL ASSET VULNERABILITY

Asset	Exposure score 0-3	Sensitivity Score 0-3	Adaptive Capacity 0-3	Vulnerability Score (E+S-AC)	Estimated Vulnerability (0-2 Low; 3-4 Medium; 5-6 High)	Notes on Critical Asset Vulnerability
Topsail Beach Fire Department (816 S. Anderson Blvd.)	3	3	0	6	High	Structure FFE is >6 feet below existing FEMA BFE.
Topsail Beach Police Department (812 S. Anderson Blvd.)	3	3	0	6	High	Structure FFE is >6.5 feet below existing FEMA BFE.
Topsail Beach Town Hall (820 S. Anderson Blvd.)	3	3	0	6	High	Structure FFE is >5 feet below existing FEMA BFE. The Town hall replaced a gas station. The facility across the street (at similar elevation) was destroyed by Hurricane Hazel in 1954.
Pender Volunteer Emergency Medical Services and Rescue - Station 4 (801 S. Anderson Blvd. / Flake Ave.)	3	3	0	6	High	Structure FFE is >5 feet below existing FEMA BFE.

Asset	Exposure score 0-3	Sensitivity Score 0-3	Adaptive Capacity 0-3	Vulnerability Score (E+S-AC)	Estimated Vulnerability (0-2 Low; 3-4 Medium; 5-6 High)	Notes on Critical Asset Vulnerability
North Topsail Beach Fire Station - South End (2049 New River Inlet Rd.)	3	3	0	6	High	Structure FFE is ~2 feet below existing FEMA BFE. Structural concerns have been previously documented (Federal Storm Damage Mitigation Project History and Summary, 2021).
South Beach electrical substation (~500 N. Anderson Blvd., near Sidbury Ave.)	2	3	0	5	High	High risk of increased tidal flooding and subject to more frequent storm flooding on 20-year or more recurrent basis; more than a foot of flooding during Hurricane Florence and some flooding during Matthew
Assembly Hall and Missiles and More Museum, Topsail Beach (720 Channel Blvd.)	3	2	0	5	High	Structure FFE is >1.5 feet below existing FEMA BFE, and subject to increasing tidal and sound side flooding. Designated National Register of Historic Places site in 1993.

Asset	Exposure score 0-3	Sensitivity Score 0-3	Adaptive Capacity 0-3	Vulnerability Score (E+S-AC)	Estimated Vulnerability (0-2 Low; 3-4 Medium; 5-6 High)	Notes on Critical Asset Vulnerability
Wade H. Chestnut Memorial Church, North Topsail Beach (2649 Island Dr.)	3	2	0	5	High	Structure FFE is >1.5 feet below existing FEMA BFE.
North Topsail Beach Fire Station - North End	3	3	1	5	Medium	Structure FFE is >3.5 feet below existing FEMA BFE.
North Topsail Beach Police Department / Town Hall	3	3	2	4	Medium	Structure is above FEMA BFE, but without additional freeboard. Subject to high wind hazards and roof was destroyed during recent storm event. FEMA funds have been used for repairs, which were still ongoing into 2022.
North Topsail bridge (Island Drive approach to bridge)	2	3	1	4	Medium	Bridge is elevated, but low-lying approach along Island Dr. is highly exposed to increased tidal and sound side flooding with sea level rise.

Asset	Exposure score 0-3	Sensitivity Score 0-3	Adaptive Capacity 0-3	Vulnerability Score (E+S-AC)	Estimated Vulnerability (0-2 Low; 3-4 Medium; 5-6 High)	Notes on Critical Asset Vulnerability
All Saints Catholic Church Surf City	2	2	0	4	Medium	Structure FFE is >2.5 feet below existing FEMA BFE.
North Topsail Beach Public Works Building	2	2	0	4	Medium	Structure FFE is >4.5 feet below existing FEMA BFE.
Surf City Fire Department-Station #23	2	3	2	3	Medium	Structure is >1.5 feet above FEMA BFE; no additional local freeboard requirement
Rogers Bay RV Park (a travel trailer park)	3	1	1	3	Medium	Highly exposed part of community, with ~400 semi-permanent and permanent structures. RV/mobile assets provided flexibility (adaptative capacity) to move as tidal/sound side flooding increase with sea level rise.
Soundside Park	3	1	1	3	Medium	High potential for adaptation of public asset, but vulnerable to increased tidal and sound side flooding in the next several decades

Asset	Exposure score 0-3	Sensitivity Score 0-3	Adaptive Capacity 0-3	Vulnerability Score (E+S-AC)	Estimated Vulnerability (0-2 Low; 3-4 Medium; 5-6 High)	Notes on Critical Asset Vulnerability
Chapel Bay Church Surf City	2	2	1	3	Medium	Structure is above FEMA BFE, but without additional freeboard
Emma Anderson Memorial Chapel	3	2	2	3	Medium	Structure is above FEMA BFE, but without additional freeboard
New Surf City bridge	1	3	2	2	Low	The bridge was upgraded to a wider roadway with 3 lanes for island evacuation purposes.
Surf City Fire Department-Station #25	0	3	1	2	Low	On the mainland, within minimal flood hazard area
Surf City Town Hall and Police Department (Municipal Complex)	0	3	1	2	Low	Facilities were relocated in 2020 the mainland, within minimal flood hazard area, leveraging FEMA Public Assistance and GoldenLEAF funds.
Surf City Urgent Care and Family Medicine	0	2	1	1	Low	On the mainland, within minimal flood hazard area

Vulnerability of Natural Infrastructure Assets

Natural infrastructure is critically important to the three Topsail Island communities in terms of coastal protection, livelihoods, and commerce, along with history and culture of the Island. For example, the name “Topsail” Island is an homage to the mast topsails of pirate vessels that would hide out behind the culturally significant maritime forests along this stretch of coastline.

While there is significant development of the barrier island, it is important to note that most of the infrastructure elements and most vulnerable assets are natural infrastructure. For example, natural features in Pender County (Topsail Beach and Surf City) represent nearly 98% of all features inundated by 2 feet of sea level rise (as measured by area).

There was broad consensus amongst the towns and Topsail Island CAT that water quality needs – tied to improved stormwater management – are integrated into the future resiliency of ecosystems and local commerce. All three communities acknowledged the need for island-wide collaboration, and the link between improved stormwater management and resiliency of natural infrastructure should be made clear.

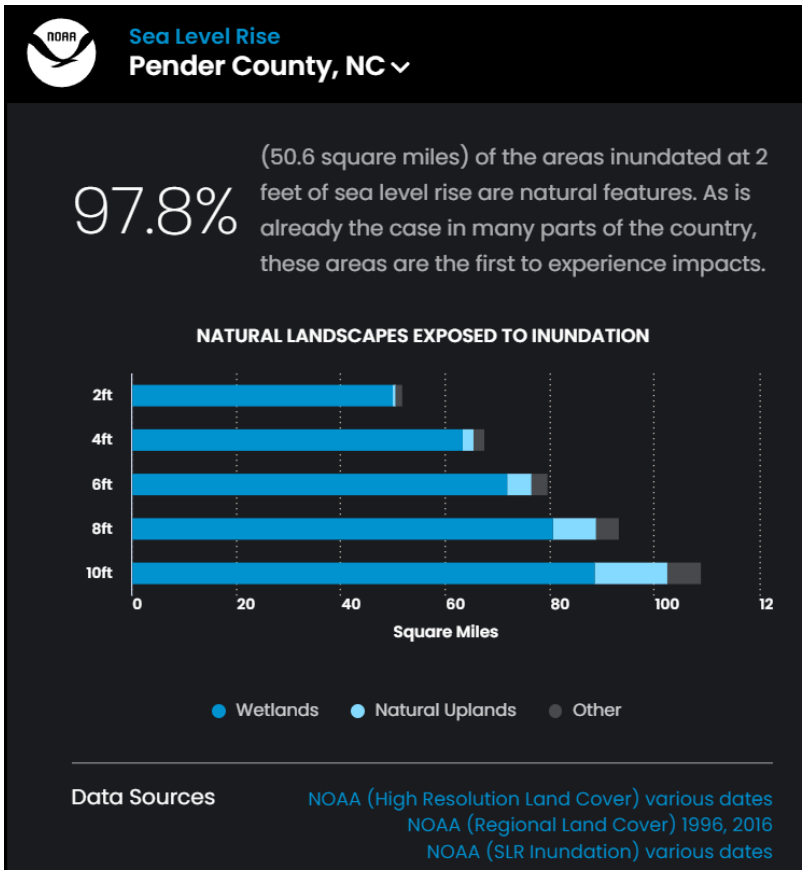


Figure 6.11 – Pender County Coastal Snapshot *(NOAA, 2022)*

Topsail Sound, Stump Sound, Everett Bay, and Chadwick Bay lagoon areas between Sneads Ferry and North Topsail Beach, along with other sound side marshes and coastal wetlands, are home to highly successful and historically renown fisheries, shellfish- and oyster production. NCDEQ has previously designated the sound as an Outstanding Water Resource, which protects the historic uses of the area.

Sound side marshes along Topsail Island provide important nursery habitat for many species of estuarine-dependent fish and offer significant habitat value in the form of refuge for other organisms. Shallow water unvegetated habitats, such as unconsolidated shore and tidal flat areas, lack macrophytes but are very productive environments for benthic microalgal communities and are an important component of estuarine food webs. They also offer refuge for juvenile fish and crustaceans. As highlighted in a 2016 OurState article, "*Oysters are the Beauty Within Stump Sound*," "the burgeoning demand for Stumps over other oysters … [people] drive 100 miles to buy them" (Rice, 2016). Oysters in the shallow, turbid waters in Stump Sound are often hand-gathered using giant tongs and are known for their saltiness, derived from their unique habitat and conditions of North Carolina's diverse estuaries. Fresh rain dilutes the salt content of the water and warmer waters equate to skimpier and more bland oysters (Rice, 2016).

Given the high sensitivity of these ecosystems to rainfall-runoff relationships, it is anticipated that the added stressors of climate change will make future survivability and adaptation of these resources much more challenging. While living shorelines are increasingly supported as a long-term adaptation strategy for sound side flooding and sea level rise, these existing stressors for aquatic and tidal vegetation provide significant upfront challenges during the vegetation establishment period of living shorelines. Species of plantings are highly sensitive to water depth, salinity, temperature, excess nutrient, and other pollutants associated with impervious surfaces and "flashy" runoff patterns from non-point source pollution.

Sea level rise, saltwater intrusion, and increased erosion are already stressing these vital ecosystems and natural resources, and uncontrolled runoff from impervious surfaces are exacerbating water quality issues in the sound side bays. For example, it is well-documented that the vital fish nursery habitats and renown oyster industry in Stump Sound and Permuda Island Reserve are facing repeated closures due to overland runoff (Darrough, 2019). The number of temporary closures has increased in Stump Sound, as seen in a real-time shellfish closure map provided by NCDEQ.

While stormwater management solutions such as dune and subsurface infiltration measures, bioswales, permeable pavement, rainwater harvesting, and other green infrastructure will not themselves be a long-term solution for sea level rise flooding, these strategies are needed as a bridge and/or combination with other strategies (e.g., living shorelines, oyster reefs and

breakwaters, wetland and salt marsh restoration, assisted marsh migration, and thin layer placement of dredged material) in order for critical vegetation to survive.

Figure 6.12 – NCDEQ Shellfish Sanitation Closure Public Viewing Tool (May 26, 2022)

Topsail Island sound side environments are already highly sensitive to only an inch or two or rainfall. Different shellfish growing areas (Topsail Sound and Stump Sound) have different levels of resiliency to runoff and thresholds that cause closures. In Topsail Sound, 2.5 inches of rain in a 24-hour period elicits a closure, whereas in Stump Sound, that threshold is 1.5 inches in the same period.

Refer to **Appendix A** for community-specific maps of marsh migration and coastal ecosystem change with sea level rise (i.e., +1 ft., +1.5 feet, and +3 feet of sea level rise by 2050, 2070, and 2090 timeframes, respectively).

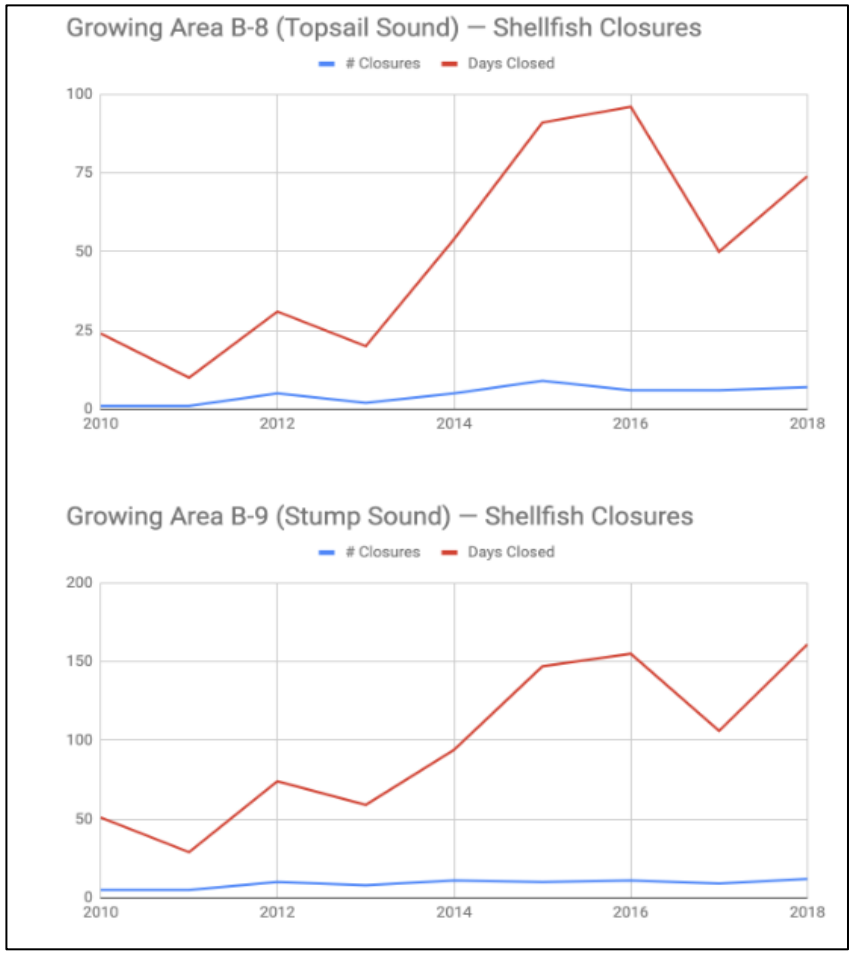


FIGURE 6.13 – INCREASING SHELLFISH CLOSURES WITHIN TOPSAIL SOUND AND STUMP SOUND

Due to sea level rise, shoreline hardening, and channel deepening, there are significant vulnerabilities for natural infrastructure that will require adaptive strategies in the coming decades. Without intervention, the rate of sea level rise may outpace the natural adaptability of many of these ecosystems. In some cases, NOAA's Sea Level Rise Viewer and marsh migration tools project significant vegetation regime change occurring by 2050. An example set of maps for Surf City showing marsh migration and ecosystem shifts with sea level rise between present day and 2070, with 1.5 to 2 feet of sea level rise, are provided in Figures 6.14 and 6.15.

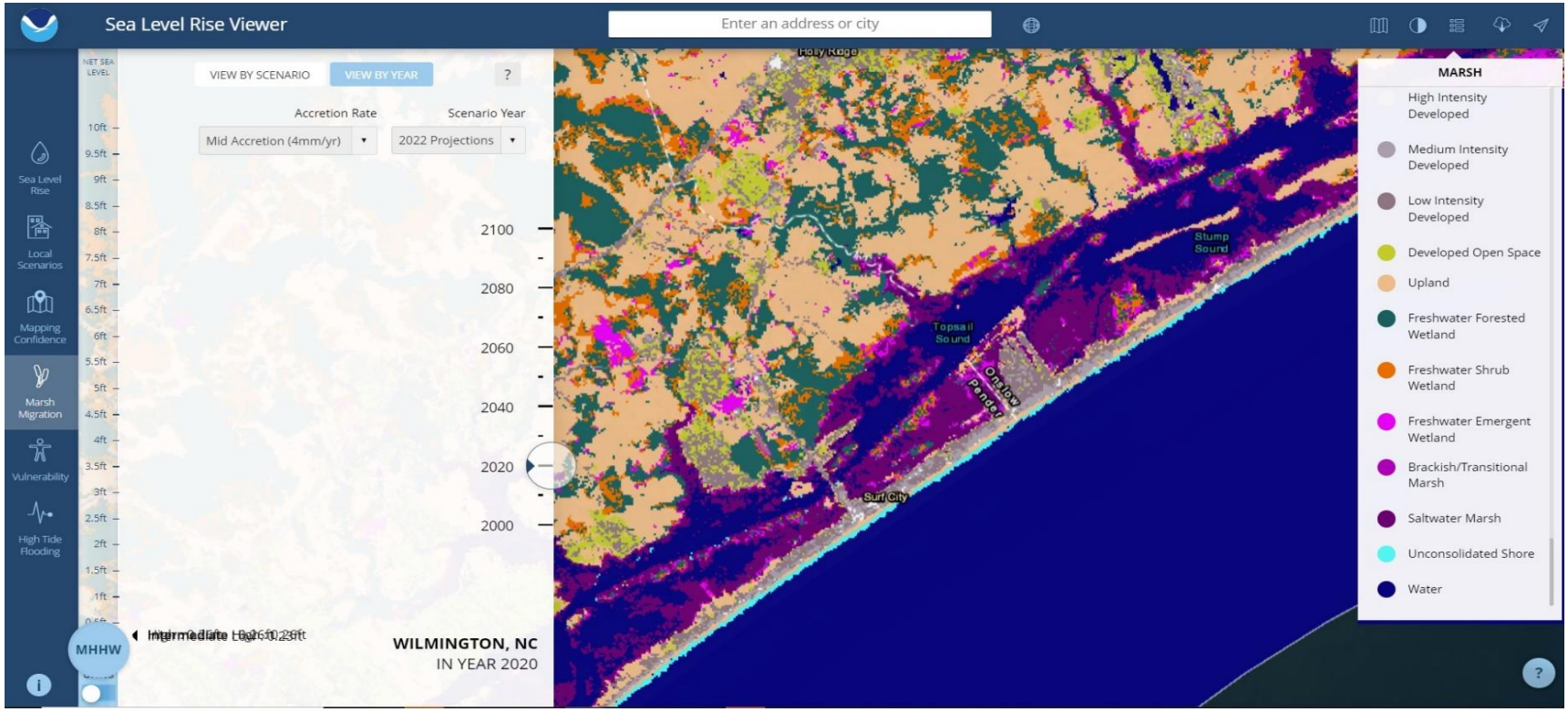


FIGURE 6.14 – Surf City, Present Day (2020) Coastal Marsh & Ecosystem Conditions (source: NOAA Sea Level Rise Viewer, https://bit.ly/3FDcEP2). At present, sound side areas in Surf City have a mix of Fresh Forested Wetlands and Freshwater Emergent Wetlands with particularly large Saltwater Marsh and Brackish/Transitional Marsh areas.

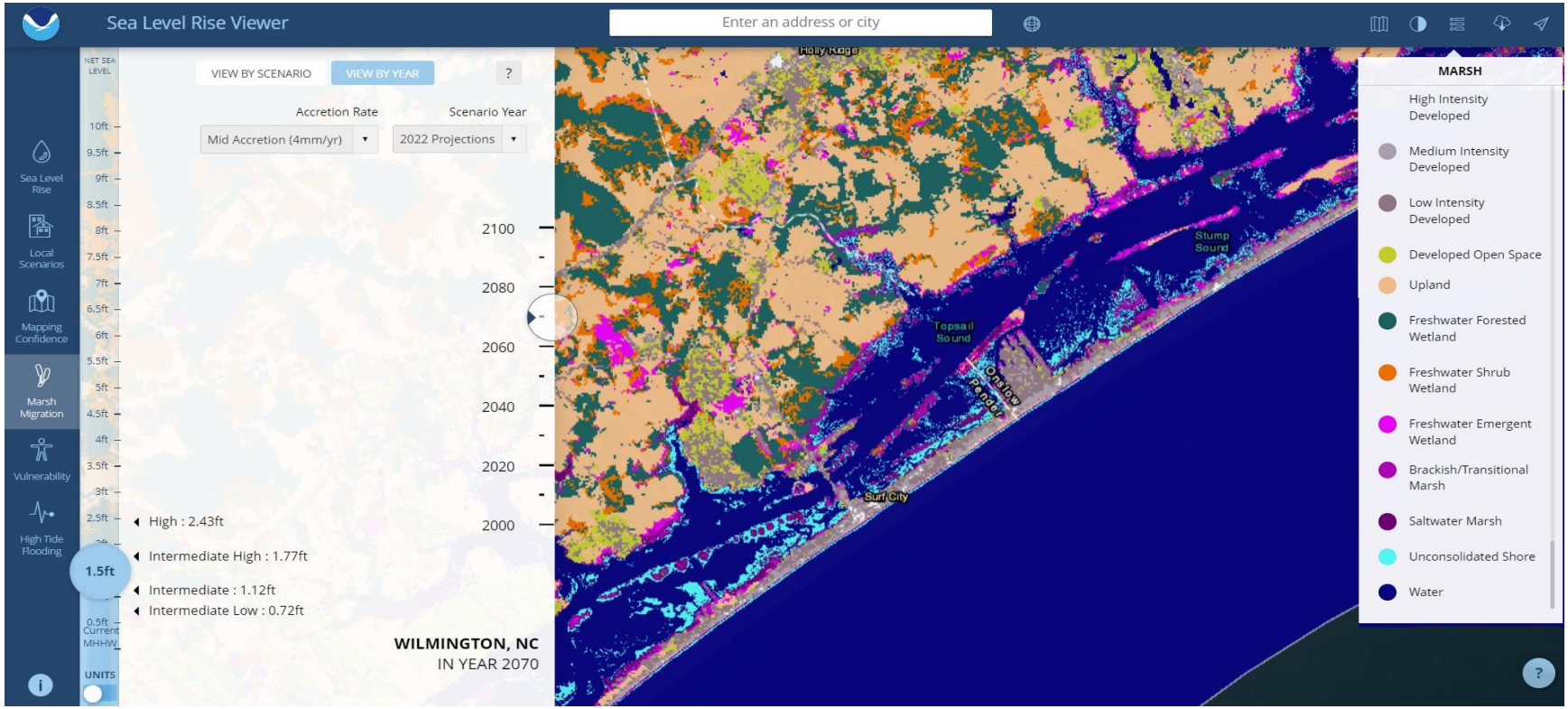


FIGURE 6.15 – Surf City, projected coastal marsh migration and ecosystem change by ~2070 with +1.5-foot sea level rise (source: NOAA Sea Level Rise Viewer, https://bit.ly/3yGQ86v). By 2070, projections of 1.5 to 2 feet of sea level rise result in large losses of Brackish/Transitional Marsh, Freshwater Emergent Wetlands, and Saltwater Marsh areas within Stump Sound and south of Permuda Island Reserve. This is accompanied by an expansion of areas with deeper Open Water.

Owing to natural forces like lunar cycles, a NASA study (Rasmussen, 2021) currently also projects a temporary upward tick in tidal flooding starting in the mid-2030s, which – similar to king tide flooding today – may offer a lens into conditions these ecosystems may face in future decades with additional sea level rise. Such conditions may further stress fragile coastal ecosystems but also present an opportunity for trialing the efficacy of nature-based solutions and innovative adaptation strategies like thin-layer placement and assisted marsh migration.

Among other nature-based strategies, the Town of Topsail Beach has previously contracted with the North Carolina Coastal Federation to oversee the selection, design, and installation of four demonstration living shoreline projects along Banks Channel (Topsail Beach Living Shoreline, n.d.). These include projects at:

- Haywood Avenue
- Ward Road
- Near the sound side public access at Rocky Mount Avenue

Vulnerability of Private Residences, Rental, and Commercial Property

The long-term vulnerabilities to sea level rise, increased nuisance and tidal storm flooding, coastal erosion, and potential loss of protective natural infrastructure are key drivers of increased flood risk to more than 8,000 structures across the Topsail Island communities and low-lying mainland areas in Surf City.

Despite many private properties elevating structures on piles in accordance with local floodplain ordinance requirements, part of FEMA-funded repairs, or proactively on their own accord, the past record of FEMA National Flood Insurance Program (NFIP) claims payments in the three towns has exceeded $50 million in flood damages (Table 6.5).

NFIP claims within North Topsail Beach only tell part of the overall flood risk story, as two thirds of the Town is in a CBRA Zone and a majority cannot access NFIP, relying instead on private flood insurance.

TABLE 6.5 – Summary of Insured Flood Losses (table adapted from *2021 Southeastern NC Regional Hazard Mitigation Plan* – Table 5.27)

Location	Policies	Claims	Claims Payments
Onslow County			
North Topsail Beach	1,217	1,503	$20,581,302
Pender County			
Surf City	1,775	1,739	$14,811,148
Topsail Beach	948	2,183	$23,213,045
Source: FEMA NFIP (data as of February 2021)			

Additionally, there is history of repetitive loss properties, particularly within North Topsail Beach, which is where development is happening the fastest on the barrier island. As of 2021, North Topsail Beach had 60+ buildings under construction. While it was noted that North Topsail Beach enforces strong building code standards ("the Town has an Insurance Services Office, Inc. (ISO) rating of 5"), there are high vulnerabilities to coastal and sound side flooding, erosion, and hurricane winds.

TABLE 6.6 – Summary of Repetitive Loss Properties (table adapted from 2021 Southeastern NC Regional Hazard Mitigation Plan – Table 5.28)

Location	Number of Properties	Non-Residential Properties	Residential Properties
Onslow County			
North Topsail Beach	266	1	225
Pender County			
Surf City	8	0	8
Topsail Beach	2	0	2
Source: National Flood Insurance Program			

Almost the entirety of Topsail Island is presently located within FEMA AE or VE zones and within the 100-year Special Flood Hazard Area. Nearly 8% of structures on the barrier island pre-date the first FEMA FIRM maps in this area (Table 6.7).

TABLE 6.7 – Summary of Flood Risk (table adapted from *2021 Southeastern NC Regional Hazard Mitigation Plan* – Tables 6.16 and 6.17)

Location	Pre- Flood Insurance Rate Map (FIRM) Buildings at Risk[1]	within FEMA 100 Year (1% Annual Chance) Special Flood Hazard Area (SFHA)			within FEMA 500 Year (0.2% Annual Chance of Flooding)		
		Approx. Number of Parcels	Approx. Number of Buildings[2]	Approx. Value of Buildings[3]	Approx. Number of Parcels	Approx. Number of Buildings[2]	Approx. Value of Buildings[3]
North Topsail Beach	172	3,666	2,653	$464,623,395	3,666	2,653	$464,623,395
Surf City	172	4,141	3,378	$479,330,751	4,437	3,570	$516,792,223
Topsail Beach	242	1,850	1,504	$254,855,021	1,852	1,505	$255,021,882

Notes

[1] The initial FIRM maps for Topsail Island were distributed by FEMA in 1974. Base flood elevations (BFEs) were added for specific Special Flood Hazard Area (SFHAs) in FIRM updates in 1984. "Pre-FIRM Buildings at Risk" include structures constructed before 1974, for which local floodplain development ordinances would not have stipulated any freeboard requirements (typically referenced in relation to a FEMA BFE).

[2] "Buildings" includes Improved Structures (per local communities Assessors data).

[3] "Value of Buildings" is the value of Improved Structures (per local communities Assessors data).

The vulnerability of the island-wide building stock varies by building material and foundation types, as well as the Finished Floor Elevation. Table 6.8 summarizes the stock for all three Topsail Island communities.

TABLE 6.8 – FINISHED FIRST FLOOR ELEVATION FOR TOPSAIL ISLAND

Municipality	Building Foundation Type[2]	Finished Floor Elevation (FFE) range[2]	# of Buildings in FEMA 100-year SFHA on barrier island
North Topsail Beach	Basement or Crawl Space	below 6' NAVD88	16
		between 6' and 9' NAVD88	47
		between 9' and 12' NAVD88	23
		between 12' and 15' NAVD88	6
		above 15' NAVD88	8
	Basement or Crawl Space Total		*100*
	Pile Foundation	below 6' NAVD88	1
		between 6' and 9' NAVD88	5
		between 9' and 12' NAVD88	80
		between 12' and 15' NAVD88	291
		above 15' NAVD88	541
	Pile Foundation Total		*918*
	Slab on Grade	below 6' NAVD88	202
		between 6' and 9' NAVD88	175
		between 9' and 12' NAVD88	47
		between 12' and 15' NAVD88	19
		above 15' NAVD88	7
	Slab on Grade Total		*450*

Municipality	Building Foundation Type[2]	Finished Floor Elevation (FFE) range[2]	# of Buildings in FEMA 100-year SFHA on barrier island
	Unverified / Low Confidence	below 6' NAVD88	128
		between 6' and 9' NAVD88	409
		between 9' and 12' NAVD88	244
		between 12' and 15' NAVD88	347
		above 15' NAVD88	428
	Unverified / Low Confidence Total		*1,556*
North Topsail Beach Total			3,024
Surf City[1]	Basement or Crawl Space	below 6' NAVD88	11
		between 6' and 9' NAVD88	55
		between 9' and 12' NAVD88	204
		between 12' and 15' NAVD88	12
		above 15' NAVD88	5
	Basement or Crawl Space Total		*287*
	Pile Foundation	below 6' NAVD88	5
		between 6' and 9' NAVD88	16
		between 9' and 12' NAVD88	289
		between 12' and 15' NAVD88	241
		above 15' NAVD88	687
	Pile Foundation Total		*1,238*
	Slab on Grade	below 6' NAVD88	78
		between 6' and 9' NAVD88	65

Municipality	Building Foundation Type[2]	Finished Floor Elevation (FFE) range[2]	# of Buildings in FEMA 100-year SFHA on barrier island
		between 9’ and 12’ NAVD88	218
		between 12’ and 15’ NAVD88	20
		above 15’ NAVD88	16
	Slab on Grade Total		*397*
	Unverified / Low Confidence	below 6’ NAVD88	284
		between 6’ and 9’ NAVD88	169
		between 9’ and 12’ NAVD88	753
		between 12’ and 15’ NAVD88	86
		above 15’ NAVD88	93
	Unverified / Low Confidence Total		*1,385*
Surf City Total			3,307
Topsail Beach	Basement or Crawl Space	below 6’ NAVD88	5
		between 6’ and 9’ NAVD88	11
		between 9’ and 12’ NAVD88	4
		between 12’ and 15’ NAVD88	3
	Basement or Crawl Space Total		*23*
	Pile Foundation	below 6’ NAVD88	6
		between 6’ and 9’ NAVD88	13
		between 9’ and 12’ NAVD88	123
		between 12’ and 15’ NAVD88	368
		above 15’ NAVD88	261

Municipality	Building Foundation Type[2]	Finished Floor Elevation (FFE) range[2]	# of Buildings in FEMA 100-year SFHA on barrier island
	Pile Foundation Total		*771*
	Slab on Grade	below 6' NAVD88	135
		between 6' and 9' NAVD88	53
		between 9' and 12' NAVD88	32
		between 12' and 15' NAVD88	13
		above 15' NAVD88	5
	Slab on Grade Total		*238*
	Unverified / Low Confidence	below 6' NAVD88	58
		between 6' and 9' NAVD88	57
		between 9' and 12' NAVD88	30
		between 12' and 15' NAVD88	76
		above 15' NAVD88	62
	Unverified / Low Confidence Total		*283*
	Topsail Beach Total		1,315

Notes:

[1] Surf City building data and sub-totals reflect only structures on the barrier island, and do not include buildings on the mainland.

[2] Based on NCEM Building Footprints layer, with FEMA Hazus inventory reference tables.

For reference purposes, the NAVD88 elevations provided in this table can be compared to NCDOT and NCEM modeled water surface elevations (WSEs) for coastal flood events at major roadways (i.e., NC-50 and NC-200):

Present Day 10% annual chance ("10-year") storm WSE: approximately 5 to 5.5 feet NAVD88

Municipality	Building Foundation Type[2]	Finished Floor Elevation (FFE) range[2]	# of Buildings in FEMA 100-year SFHA on barrier island
Present Day 4% annual chance ("25-year") storm WSE: approximately 6 to 7 feet NAVD88 Present Day 2% annual chance ("50-year") storm WSE: approximately 8 to 9 feet NAVD88 Present Day 1% annual chance ("100-year") storm WSE: approximately 10 to 14 feet NAVD88 Present Day 0.2% annual chance ("500-year") storm WSE: approximately up to 19 feet NAVD88			

With future sea level rise and increasing frequency and intensity of storm events, the recurrence of storm events is anticipated to shift in a stepwise fashion. For example, the present day 4% annual change flood event (i.e., "25-year storm") may look similar to the future 10% annual chance flood event (i.e., "10-year storm") by 2070.

There are limitations with respect to communicating the risks to property owners when simplifying the "percent annual chance" probabilities. It is also important for property owners to understand the implications of *cumulative risk* over time. When a particular property that is vulnerable to the 1% annual chance flood (i.e., 100-year storm event) appears low any given year, the cumulative (risk) probability of that property flooding over a 30-year period (i.e., a typical mortgage cycle) is ~26%.

10-year" event ➔ 10% annual chance (in any given year)

"100-year" event ➔ 1% annual chance (in any given year)

However, this does not translate into once every 10 or 100 years, respectively.

The cumulative probability, P, of a "100-year" event occurring *at least once* over a 30-year period:

$$\boldsymbol{P = 1 - (1 - 0.01)^{30}} \approx 26\%$$

Social Vulnerability

Social vulnerability refers to the resilience – the ability to survive and thrive – of communities when confronted by external stresses on human health, such as natural or human-caused disasters, or disease outbreaks (citation). Socially vulnerable populations include those who have special needs, people without vehicles, disabled persons, elderly persons, low-income persons, and persons with limited English proficiency, among many others. These populations are acutely at-risk during disasters as they have fewer resources to respond. Reducing social vulnerability can decrease both human suffering and economic stress. It is key for planners to meet the needs of socially vulnerable people in emergency response and recovery efforts.

The first step is to identify and map where socially vulnerable populations are located. One tool is the CDC/ATSDR (Centers for Disease Control and Prevention/Agency for Toxic Substances and Disease Registry) Social Vulnerability Index (SVIA) 2018. The SVI ranks each census tract on 15 social factors and groups theme into four related themes: 1) Socioeconomic Status, 2) Household Composition and Disability, 3) Minority Status and Language, and 4) Housing Type and Transportation (Figure 6.16). Each tract receives a separate ranking for each of the four themes in addition to an overall ranking. Data sources used by the CDC/ATSDR include the US Census and the American Community Survey (ACS) 5-year data.

CAT members determined that for Topsail Island communities, elderly persons, low-income persons, RV and trailer park/campground users, and mobile homeowners were especially vulnerable to natural hazards. The project team created social vulnerability maps for each of the three Topsail Island towns (Appendix A).

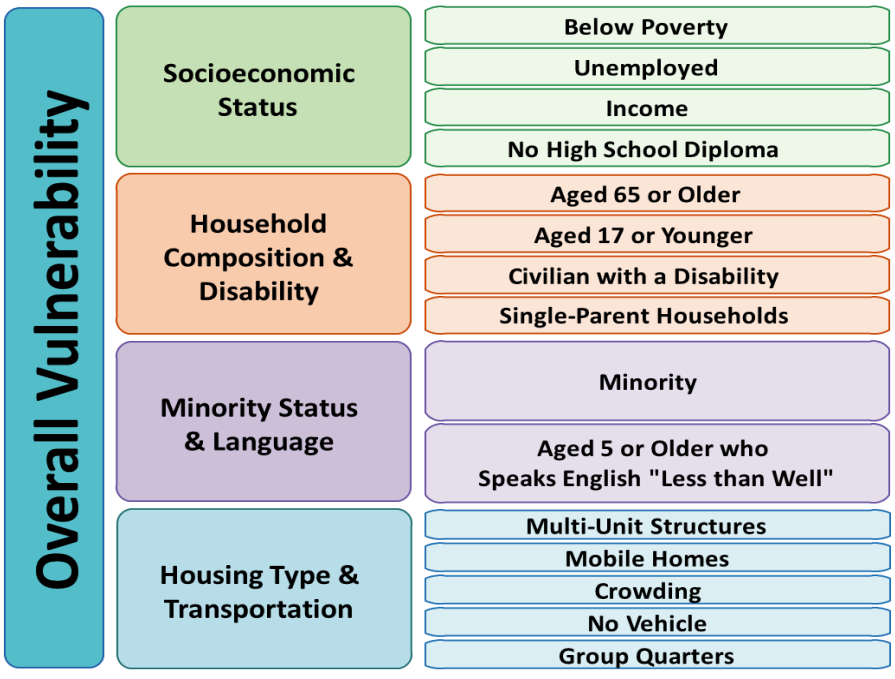


FIGURE 6.16 – SVI INFOGRAPHIC (SOURCE: CDC/ATSDR)

Composite CDC Social Vulnerability Index Scores by Town

Four census tracts lie within Topsail Island – one for Topsail Beach, two for Surf City, and one for North Topsail Beach. On average, Topsail Island has a low vulnerability level across its four census tracts. Upon close look into the four themes that contribute to the overall vulnerability level, Topsail Beach and Surf City have elevated vulnerability levels (moderate to high) for the Household Composition and Disability theme. This theme includes metrics for age (elderly and youth), disability status, and single-parent households.

The SVI composite scoring generally aligns with comments expressed by CAT members at multiple workshops and in project-specific questionnaire responses. For example, a primary concern is about elderly populations that are particularly vulnerable to flood hazard events and those in assisted living facilities that may have to shelter in place when there are no beds available to relocate to during a major storm event. Low- and moderate-income persons who rely on rental properties (AirBnB or other seasonal arrangements) as supplemental income were also identified as vulnerable.

Topsail Beach

The town of Topsail Beach consists of one census tract (9201.01). It has a low level of vulnerability with an overall SVI Score of 0.1023. Possible scores range from 0 (lowest vulnerability) to 1 (highest vulnerability). Three of the four themes that make up the Overall SVI also have a 'low' level of vulnerability (minority and language, housing and transportation, and household composition and disability theme). The remaining theme, socioeconomic status, has a 'low of moderate' level of vulnerability with a score of 0.3691.

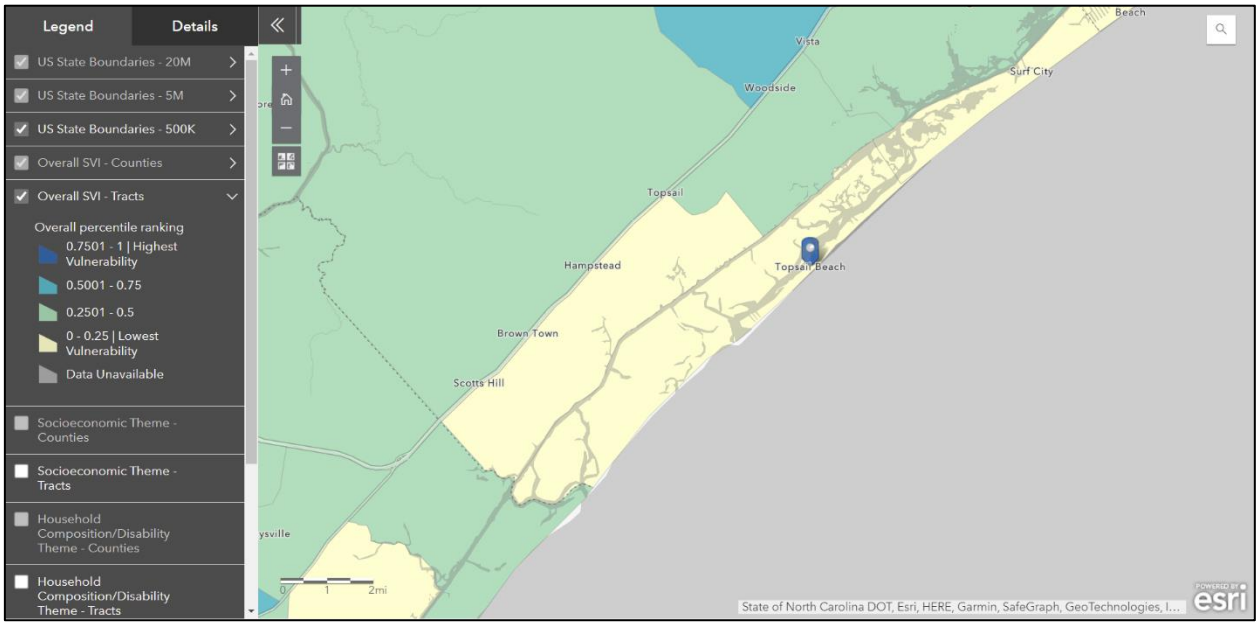


FIGURE 6.17 – CDC SVI COMPOSITE SCORING FOR TOPSAIL BEACH, NC

Surf City

Surf City consists of two census tracts – one on the barrier island itself (tract 9201.02) and the second on the mainland (tract 9201.03) shown in green on the map (Figure 6.18).

In Census Tract 9201.02, there is a 'low' level of vulnerability (score of 0.1846) overall. Three of the four themes that make up the overall score also have 'low' levels of vulnerability: socioeconomic (0.2268), minority and language (0.2021), and household composition and disability (0.2223). The remaining theme, housing and transportation, scores as 'low to moderate' (0.3602). Possible scores range from 0 (lowest vulnerability) to 1 (highest vulnerability).

Census tract 9201.03 has a 'low to moderate' level of vulnerability, given its overall SVI score (0.3819). Three of the four themes that make up the composite SVI score are as follows: socioeconomic status is 'low to moderate' (0.439), housing and transportation is 'low to

moderate' (0.346), and minority and language is 'low' (0.2002). The remaining theme, household composition and disability, is 'moderate to high' vulnerability level with a score of 0.6844. The two main contributing factors here are disability (percentile ranking 0.7158) and age 17 years old or younger (percentile ranking 0.6954).

*<u>*Note*</u>: The mainland portion of Surf City has unusual, jagged town boundary lines where small portions of adjacent towns also lie in tract 9201.03. Very small portions of Surf City itself lie in an adjacent Census tract.

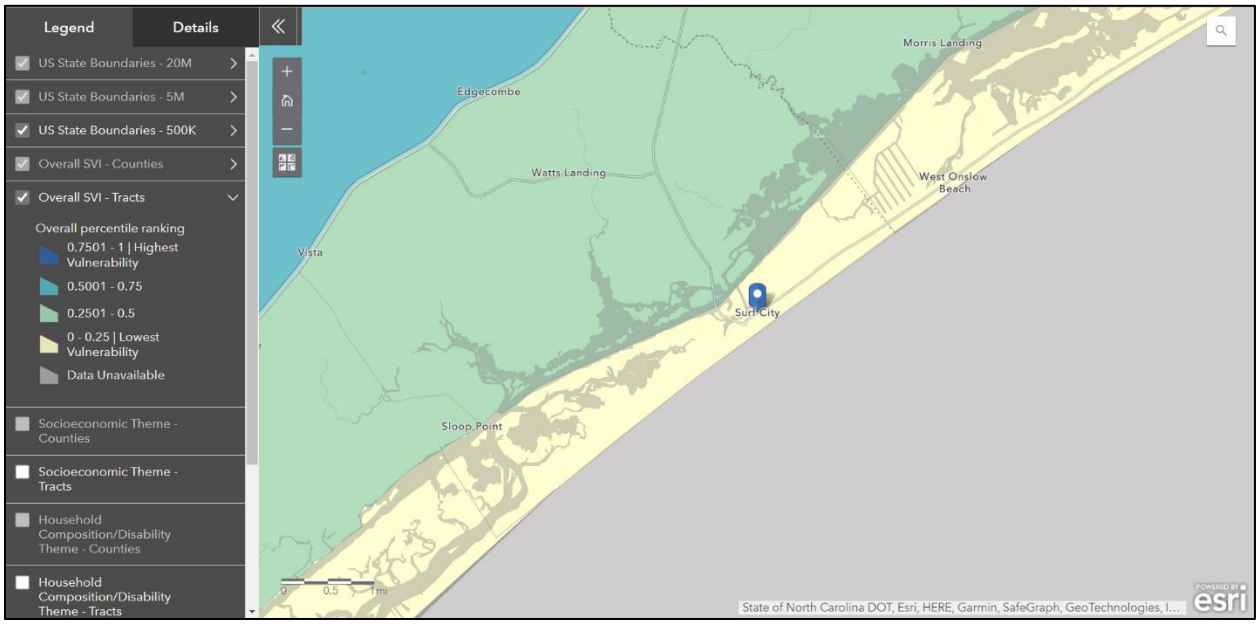


FIGURE 6.18 – CDC SVI COMPOSITE SCORING FOR SURF CITY, NC

North Topsail Beach

North Topsail Beach consists of one Census Tract (tract 4.03). The overall SVI score is 0.234. Possible scores range from 0 (lowest vulnerability) to 1 (highest vulnerability). A score of 0.234 indicates a 'low' level of vulnerability.

Although the overall SVI score is considered 'low,' Household Composition and Disability is a 'moderate to high' level of vulnerability with a score of 0.5465. The two main contributing factors are its Aged 65 or Older (percentile ranking 0.9478) and Disability (percentile ranking 0.8491).

For the remaining three themes, Housing and Transportation is a 'low to moderate' level of vulnerability (0.286), Minority and Language is 'low' level of vulnerability (0.0677), and socioeconomic status is 'low to moderate' level of vulnerability with a score of 0.3328.

Beyond vulnerabilities explicitly factored within SVI Index, the CAT identified mobile home residents as socially vulnerable populations on Topsail Island. American Community Survey census data – such as those highlighted in the Headwater Economics' *Neighborhoods at Risk Tool* (Headwaters Economics, n.d.) also show slightly elevated vulnerability levels for the household and transportation theme ('low to moderate' for three of the four tracts) and the socioeconomic status theme ('low to moderate' for three of the four tracts). The scores for all census tracts for the minority and language theme is 'low' due to the demographic makeup and majority of English language speakers in the area.

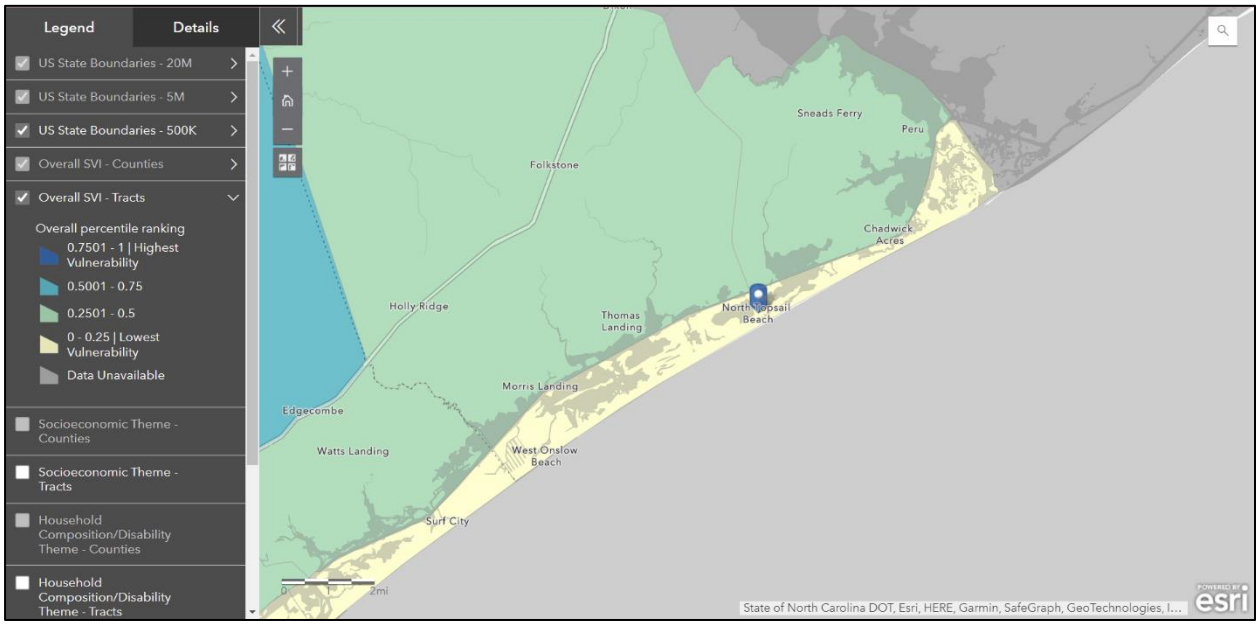


FIGURE 6.19 – CDC SVI COMPOSITE SCORING FOR NORTH TOPSAIL BEACH, NC

Surf City and other communities on Topsail Island have a high percentage of rental properties and elder residents, two demographics that are not captured well by the CDC SVI.

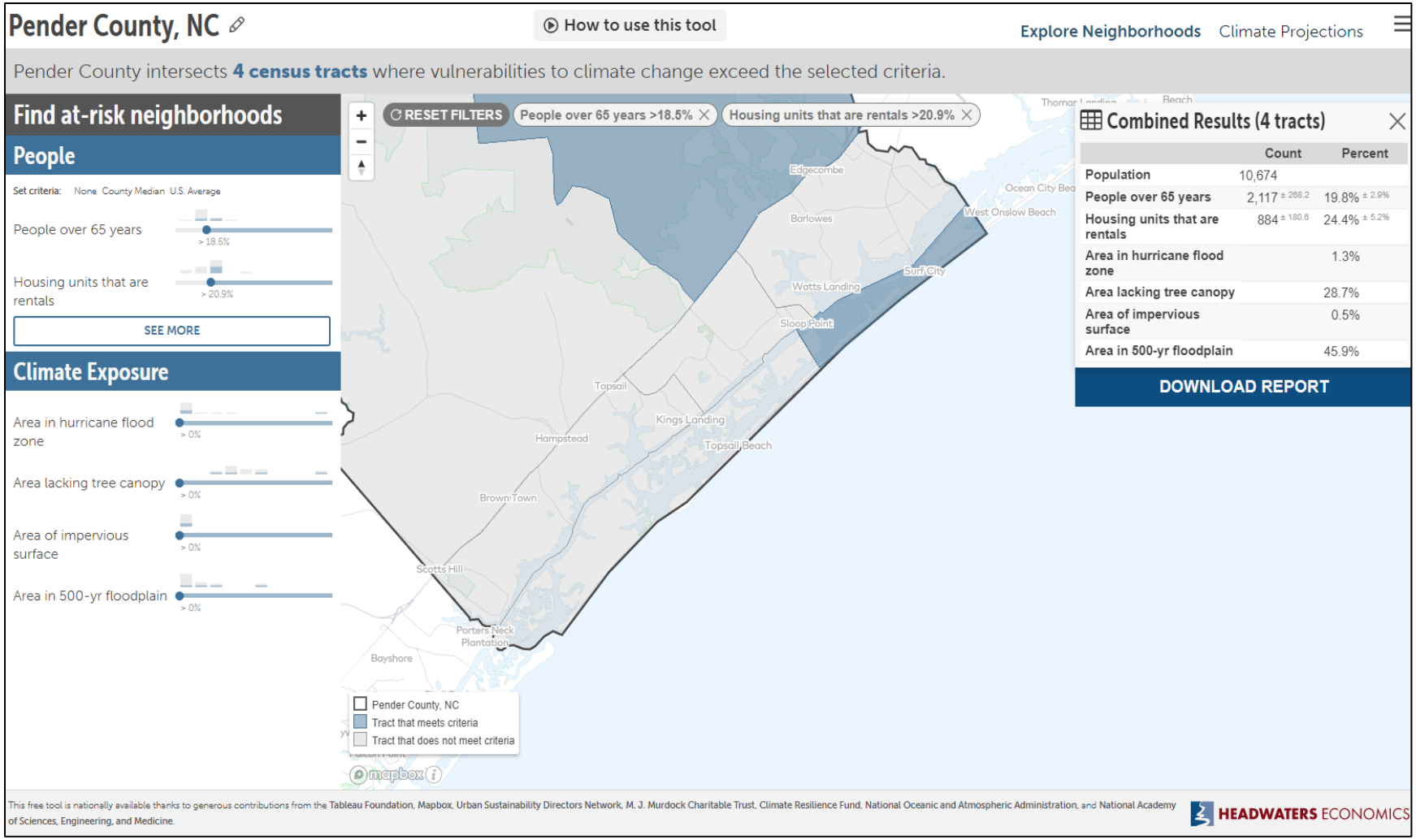


FIGURE 6.20 – HEADWATERS ECONOMICS' NEIGHBORHOODS AT RISK TOOL FOR PENDER COUNTY, NC

Additional Vulnerabilities Unique to Topsail Island

The CAT identified additional vulnerabilities that are unique to barrier island communities.

- **Frontal Dune Systems:** There is a lack of established frontal dunes in North Topsail Beach. While most dunes have been renourished at some point, most of the area is barely above sea level. There is also a lack of established frontal dunes in the northern part of Surf City. Such areas can be exposed to lunar tidal flooding even without significant storm events.
- **Pile foundations at higher elevations exposed to erosion / sea level rise:** Whereas structures built in relatively low elevation areas (such as in North Topsail Beach or northern portions of Surf City) have been built with longer structural pile foundations, this is contrasted by structures built at relatively higher elevations, such as within southern oceanfront areas of Surf City.

  While these areas are higher in elevation (15 or more feet above sea level), the foundations for these structures often utilize designs with shorter piles (8 to 10 feet deep), as anticipation to design for sea level rise is lacking. Such structures face increasing risks of being undermined by continued coastal erosion and undercutting. Past events, such as Hurricane Florence, have resulted in such structures being "on a precipice," within 20 feet of eroding shorelines (Coastal Engineer's Report Post-Florence, 2020).
- **Abandoned Vessels, Storm Debris, and Dock Resiliency**: Storm events and increased coastal erosion have led to numerous structure collapses along the North Carolina coast in recent years. Beyond the resiliency of individual structures to coastal hazards, marine debris (e.g., abandoned vessels, deteriorating docks and structures, and dislodged vessels) can become a significant source of impact loading to adjacent built and natural infrastructure during storm events. It has been noted in the past that storm events with major surge can dislodge boats from their moorings, or even off the top of the pilings. With increasing sea level rise, some dock pilings may require retrofits (i.e., raised higher) to prevent vessels coming loose during future storms.

  Derelict docks themselves can become a source of storm debris, an issue that was noted by the Topsail Island CAT and NC Coastal Federation. Made possible by a new law in 2020, an effort is also currently underway by the North Carolina Wildlife Resources Commission, NC Coastal Federation, and the state Department of Environmental Quality's Division of Coastal Management to help clear more than 80 abandoned vessels along the coast (Allen, Project to Remove Abandoned Boats Begins, 2021), a strategy in line with

the 2020 *North Carolina Marine Debris Action Plan* (North Carolina Marine Debris Action Plan, 2020).

- **Coastal Barrier Resource Act (CBRA) zones and coastal protection:** An additional challenge specific to North Topsail Beach (and portions of Topsail Beach) is that a large portion – as much as 56% of land mass in North Topsail Beach – is within the CBRA zone. While the Town acknowledges the value of CBRA in terms of free market conservation and its success on coasts across the nation, the legislation has significant economic implications for CBRA towns in terms of coastal protection. Significant infrastructure in North Topsail Beach – including homes, roadways, and the high-rise bridge connecting to the mainland – pre-date the 1982 passage of CBRA but were still mapped into the protected zone (Coastal Barrier Resources Act, n.d.). The mapping issue has become a continued point of advocacy in attempting to get areas removed from the zone.

  As this federal legislation deters federal investment within these coastal barrier resource areas for purposes of coastal flood protection, the Town, its residents, and property owners are more limited in terms of eligibility for FEMA pre-hazard mitigation and other grants, cutting off a key resiliency funding source. In addition to restricted access to federal flood insurance within the CBRA zone, the cost for nourishment of public beaches has been driven up as the Town has and continues to self-fund such efforts.

  Limitations on the ability to use sediments from within the CBRA zone can also drive up the costs of beach nourishment. Beyond the immediate limits of the CBRA zone, there has been back-and-forth policy and rule interpretation during the past two presidential administrations about whether projects outside of CBRA units can use federal funds to access sediment from CBRA protected areas (Praats, 2021). Federal projects adjacent to inlets in CBRA units (such as at New River Inlet) may have higher costs if such projects must get sand from further offshore.

  Uncertainty regarding the future of these zones and interpretation of the rules continues in the background of federal beach nourishment projects (previously a joint effort with Surf City and U.S. Army Corps of Engineers), and as a proposed terminal groin project is considered at the New River Inlet (Passaretti, Residents seek de-annexation from North Topsail Beach, 2022).

- **Emergency Communications and Seasonal Rental and Tourist Populations:** Although Topsail Island towns have made significant progress in improving emergency planning and evacuation protocols, the CAT noted that there are still significant issues in reaching and communicating with large populations of seasonal renters and tourists in

advance of a major storm event. Previously, police and fire engines have traveled up and down the island using bullhorn speakers to warn these populations of hazardous conditions. EMS have relayed that rental housing "is so insulted" and seasonal populations are hard to reach. It was noted that a "reverse 911"-type system or other methods should be explored to improve advance warning to these populations.

C. Estimate Risk

Public, private, and natural infrastructure on Topsail Island, as well as low-lying parts of the mainland in Surf City, are highly vulnerable to coastal storms, storm surge, erosion, and hurricane-force winds. The barrier island and sound-side developments face increasing risks of nuisance tidal and winter storm flooding. The Island is already noticing some effects of sea level rise. Future sea level rise projections, including new analysis by NOAA, anticipate an additional foot of sea level rise by 2050, which has significant implications for low-lying infrastructure, public and private properties, and natural infrastructure.

By sheer quantity and exposed value, most of the developed assets on the barrier island that are at heightened risk of hurricanes and coastal flooding, increased erosion, and nuisance/chronic tidal flooding with sea level rise are residential and rental properties. There are very few commercial properties and structures on the barrier island. Aside from essential services (fire, law enforcement, and emergency services), many of the public assets, such as schools, are on the mainland in Surf City, or in adjacent communities (e.g., Hampstead, Holly Ride, Sneads Ferry).

However, there are significant critical infrastructure and essential services facilities and infrastructure on barrier island that are at high risk of hazards at present and in the future.

Table 6.9 provides a summary overview and estimation (by primary sector/asset types) of assets at high risk of present day and future hazards.

A more detailed version of Table 6.9, "Estimation of Critical Asset Vulnerability" is provided in **Appendix B (**refer to **Table B.2 - Critical Asset Vulnerability**). This detailed table is inclusive of estimated asset values, year constructed, and notes pertaining to vulnerability of specific assets.

TABLE 6.9 – OVERVIEW OF ASSET RISKS

Sector / Asset Type	Risk Summary (High Risk Assets and Value Estimates)
Residential and rental properties	Nearly the entirety of the barrier island is presently located with FEMA AE or VE zones- which are subject to coastal storm events, hurricanes, and storm surge. There is over $1.2 billion in total building value (i.e., building replacement value) on the barrier island and within Surf City mainland areas located in the FEMA NFHL. This total is not inclusive of any building contents. While many properties have elevated their finished/first floor elevation (FFE) and contents above FEMA BFE, there is also over $500 million in land value (separate from building value) exposed to +3 feet of sea level rise (i.e., projected SLR by 2100). With increased nuisance tidal flooding and erosion, these lands are increasing at risk absent significant interventions (such as to elevate land or adaptations to maintain access to public services such as roadways and utilities).
Evacuation routes, low-lying roadway segments, and bridges	Low-lying portions of NC-50 and NC-210 are at high risk of nuisance and chronic tidal flooding with sea level rise. Each of these routes serve as the barrier island's evacuation routes, and are the most trafficked routes spanning the length of the narrow barrier island. As Topsail Island has become a more known draw for regional and out-of-state tourists ("we are now on the map," per one of the Topsail Island CAT members), the Island has seen large increases in vehicle traffic. For instance, per North Topsail Beach's 2021 update to the CAMA Land Use Plan, the annual average daily traffic count (AADT) reported by NCDOT in 2017 along NC Highway 210 was 5,300 just north of the North Topsail Beach-Surf City corporate limit line, and 4,800

Sector / Asset Type	Risk Summary (High Risk Assets and Value Estimates)
	just north of North Topsail Beach Town Hall. These figures represent a greater than 40% increase from those reported in the 2009 Land Use Plan (citation). While the spans of the two high-rise bridges (Surf City and North Topsail Beach) are elevated well above the Intracoastal Waterway, the low-lying approaches on both sides of the bridges are highly vulnerable to future sea level rise and future high tide flooding. For instance, the island-side eastbound approach to the NC-210 bridge in North Topsail Beach is vulnerable to sea level rise and future tidal flooding. On the mainland side of this bridge, a long stretch of low-lying roadway between the bridge and NC-172/Sneads Ferry is mostly lower than 12 feet (above MSL), with smaller segments below 9 feet (above MSL). While these low-lying roadways are already at risk of flooding during major storm events, future sea level rise and tidal flooding may make these bridge approach segments less accessible more frequently (and for longer durations) in future decades.

Sector / Asset Type	Risk Summary (High Risk Assets and Value Estimates)
Beaches, Dunes, and Coastal Recreation	Individual communities have long recognized and prioritized the protective value of nature-based strategies. For instance, Topsail Island has a FEMA engineered beach, as well as local 30-year Beach Nourishment Plan. Aside from local beach nourishment efforts, Surf City is moving forward with a Coastal Storm Risk Management project that was originally authorized for construction in 2014 (originally with North Topsail Beach). The estimated net benefits of a Surf City-only project were over $19M per year, per a USACE congressional fact sheet in April 2022 (citation). North Topsail Beach has identified an alternative path to finance beach nourishment activities via Special Obligation Bonds. The Island-wide TISPC has been active in coordinating efforts restoring and maintain the Island's sandy beaches, storm protection dunes through beach nourishment for all of Topsail Island's oceanfront.
Other Natural Infrastructure	Projected increases in the rate of sea level risk put coastal wetlands, salt marshes, and other sound-side natural resource areas (such as Stump Sound Outstanding Resource Waters, open shellfish waters, and primary nursery areas) are at high risk of ecosystem vegetation shifts and long-term survivability. Even with levels of natural sediment accretion, salt marsh ecosystems will be stressed to maintain pace with sea level rise beyond 2050.
Essential services, Public Safety	Essential services and public safety-related assets that this study identified as having high risk of future hazards include: Topsail Beach Fire and Police Stations, Topsail Beach Town Hall, Pender County Volunteer Emergency Medical Services and Rescue, North Topsail Beach – South End Fire Station.

Sector / Asset Type	Risk Summary (High Risk Assets and Value Estimates)
	Other essential services and public safety-related assets that this study identified as having medium risk of future hazards include: Surf City Police Department, North Topsail Beach – North End Fire Station, North Topsail Beach Police Department / Town Hall, Surf City Fire Department- Station #23 and the North Topsail Beach Public Works Building.
Electric substation, power and communication lines, and emergency power generators	With additional sea level rise, the electrical substation in Topsail Beach (near S Anderson Blvd. and Sidbury Ave.) is at high future risk of coastal flooding. While flooding at the site was not significantly impactful during Hurricanes Florence (2018) and Matthew (2016), projected flooding in 2050 and beyond put critical substation infrastructure at risk of inundation. Island-wide power line and communications infrastructure remains at high risk of hurricane force winds. While several facilities for essential services have emergency power generators, there are others that do not have generators.
Community assets and cultural/historic resources	The Topsail Beach Assembly Hall, which is located on the Topsail Sound front, is a registered historic property dating back to the Island's site for missile testing operations (Operation Bumblebee) in 1946. The Assembly Hall has been renovated and today hosts receptions and weddings with capacity for 250 people. Along with the Missiles and More Museum, this significant cultural resource is at risk of increased coastal storm and tidal flooding due to sea level rise. Other historic/cultural resources that this study identified as having elevated risk of future hazards include (but are not limited to): All Saints Catholic Church (Surf City), Chapel Bay Church

Sector / Asset Type	Risk Summary (High Risk Assets and Value Estimates)
	(Surf City), Wade H. Chestnut Memorial Church (North Topsail Beach) and Emma Anderson Memorial Chapel (Topsail Beach).

VII. PROJECT PORTFOLIO

The second major piece of the RCCP is a Project Portfolio comprised of projects that can be taken into next steps and implemented to address the resilience of Topsail Island. Through dialogue with Town Staff and CAT members, projects emerged early on, and further review of hazard mitigation plans, and flood studies identified additional existing, planned, or proposed projects. The following section documents context for ongoing and planned projects within each town.

Topsail Beach

For more than ten years, the Town of Topsail Beach has dedicated significant resources towards shoreline protection and beach nourishment activities and has a 30-year Beach and Inlet Management Plan. The Town has been proactive in apportioning local taxpayer revenue from both residents' property tax (ad valorem) and rental property (occupancy) taxes – well above and beyond what is required – towards shoreline protection and beach nourishment. Topsail Beach continually dedicates 12 cents per $100 value (over 1/3rd of its local taxes) – towards these efforts. The Town has also leveraged Federal (FEMA) and State funds – such as the Shallow Draft Inlet Fund - to move beyond beach sand maintenance activities into more proactive storm mitigation.

Federally funded beach nourishment projects have been completed in Topsail Beach over the last decade, and the Town has a FEMA "engineered beach" (Walsh, 2019), which helps keep costs down for regular cycle-based renourishment. The Town strives to get into a 5- or 6-year cycle to complete these activities while reducing more frequent disruption to natural infrastructure and ecosystems.

Topsail Beach has recently made it a priority to implement nature-based project solutions to combat ongoing climate hazards with long term resiliency. For example, the town is partnering with the North Carolina Coastal Foundation (NCCF) to install four living shoreline demonstration projects to reduce sound side erosion and maintain fisheries habitats. The first living shoreline project was constructed in the Spring of 2021 along Banks Channel, near the sound-side public access location at Rocky Mount Avenue with the second project completed in Fall of 2021 along Banks Channel at the end of Haywood Ave. The Town has also performed stormwater planning efforts that have been recently completed, such as the Stormwater Feasibility Study Report (LDSI, 2020). The report identified improvements for water quality measures within the town; to date, none of the actions/projects identified have been implemented.

In terms of critical infrastructure asset resilience, Topsail Beach recently completed a project to support critical assets and ensure they remain online during energy grid failures. This effort has been recently implemented with the addition of a backup generator at the Emergency Operations Center.

Surf City

Supplemented by State and Federal funds, the town of Surf City has several on-going and planned beach nourishment projects to enhance a portion of the beaches in Surf City. Identifying further beach nourishment projects evolved from these recent successes. The Town is proceeding with a Coastal Storm Risk Management project with the U.S. Army Corps of Engineers and North Topsail Beach, which was authorized in 2014 and funded in 2019 (note: North Topsail Beach withdrew from the project in July 2021).

A recent flood study for South Shore Drive (Topsail Island Shoreline Protection Commission - Regular Meeting Minutes, 2019) determined a need for improvements at nine problematic sites. This study recommended roadway/public right of way infiltration basin projects along South Shore Drive.

Surf City currently relies on NOAA weather data and warnings and will deploy Code Red messages when flooding is expected. While there is a “Caution - High Water” sign for motorists, there are no electronic tools, such as a float switch mechanism, to integrate into a lighted warning sign. Previous attempts to fund this device were unsuccessful through GoldenLEAF.

Soundside Park was identified by Surf City staff early as an asset that could be enhanced with a nature-based engineering solution. Using examples from Battleship Park in Wilmington, NC, the town has recognized the successes from the project and is considering implementing best management practices for stormwater management at Soundside Park. An area north of Surf Condos was also identified early on as a potential location for additional nature-based projects, as the town has considered implementing a stormwater infiltration chamber system.

North Topsail Beach

Since incorporation in 1987, beach nourishment has been an ongoing effort for the North Topsail Beach. Due to catastrophic events, such as Hurricane Fran in 1996 and more recent major weather events, beach nourishment has primarily occurred at the northeast end of the town. North Topsail Beach, which recently withdrew from the federal Coastal Storm Risk Management project

with the U.S. Army Corps of Engineers and Surf City, has identified an alternative path to finance beach nourishment activities via Special Obligation Bonds (Passaretti, North Topsail Beach finds alternative path to finance beach nourishment after withdrawing from federal funding, 2022).

Coastal erosion at the north end of the Town, near New River Inlet, has been well-documented, and remains a challenge in terms of long-term solutions. Since 2002, the town has performed erosion studies and evaluated the feasibility of a hardened terminal groin structure at the New River Inlet. The proposed groin project is still in the permitting and regulatory stages with an ongoing environmental impact statement. In 2012 and 2014, a continuous, geotextile sandbag revetment was implemented along approximately 2,300 feet of shoreline. In April 2021, the Coastal Resources Commission granted a variance (i.e., a 5-year extension of sandbagging efforts) to protect an eight-building condominium complex from accelerated erosion on the town's northeastern end (Allen, Topsail Reef Sandbags OK'd for 5 More Years, 2021). Other case studies have explored the feasibility and economics of targeted acquisitions (Peek, 2019). Open space preservation is also important to North Topsail Beach, which has over 2,000 acres of coastal wetlands. Therefore, considerations of implementing a potential project focused on open space preservation and/or targeted acquisitions have emerged.

At a CAT meeting during the Phase 1 portion of the RCCP, potential projects emerged (discussed later in this section) based on visible awareness of the impacts of sunny day flooding and sea level rise projections. There are concerns that emergency evacuation routes, such as Highway 210 in North Topsail Beach, are deemed impassable based on tidal flood projections, even absent large storm events. The need for consideration of elevated roadways, along with potential elevation of critical asset(s), has emerged for Highway 210 and other areas across the island.

Efforts to Draft a Project Portfolio

In identifying project(s), it has been said before "there is no silver bullet solution to building coastal resilience." Through several meetings with the CAT and town administrations, the three communities vetted a comprehensive list of potential projects that was refined and developed into a project portfolio. Several draft lists were collaborated on by the CAT team from January through May 2022.

An Open House workshop was also held in March 2022 in Surf City to allow for more refinement and feedback on potential projects. The format of the Open House was arranged for interpretive

collaboration and intuitive feedback from attendees. Kleinfelder developed four demonstration boards to showcase preferred projects, and each board was organized by category of project: 1) maintenance, 2) infrastructure, 3) policy/programming, and 4) nature based. Approximately 32 people attended the workshop with 26 community members, 2 NCDEQ/Division of Coastal Management representatives, 2 North Carolina Coastal Federation representatives, and 2 Kleinfelder representatives.

FIGURE 7.1 – OPEN HOUSE WORKSHOP EVENT AT SURF CITY TOWN HALL (MARCH 2022)

Open House attendees could leave feedback by placing color-coded stickers showing favorable support (green sticker) or non-favorable support (red sticker) on each project. Table 7.1 demonstrates the proposed projects presented at the Open House workshop with the results of participant feedback and priority rankings. While the projects presented do not equate to the total number of projects allocated on the comprehensive list, the projects selected for presentation at the workshop were based on the top five projects proposed by each town and two alternate projects per a previous draft list.

A full “long-list” of draft projects considered for inclusion in the Island-wide project portfolio is provided in **Additional Projects Identified - North Topsail Beach**.

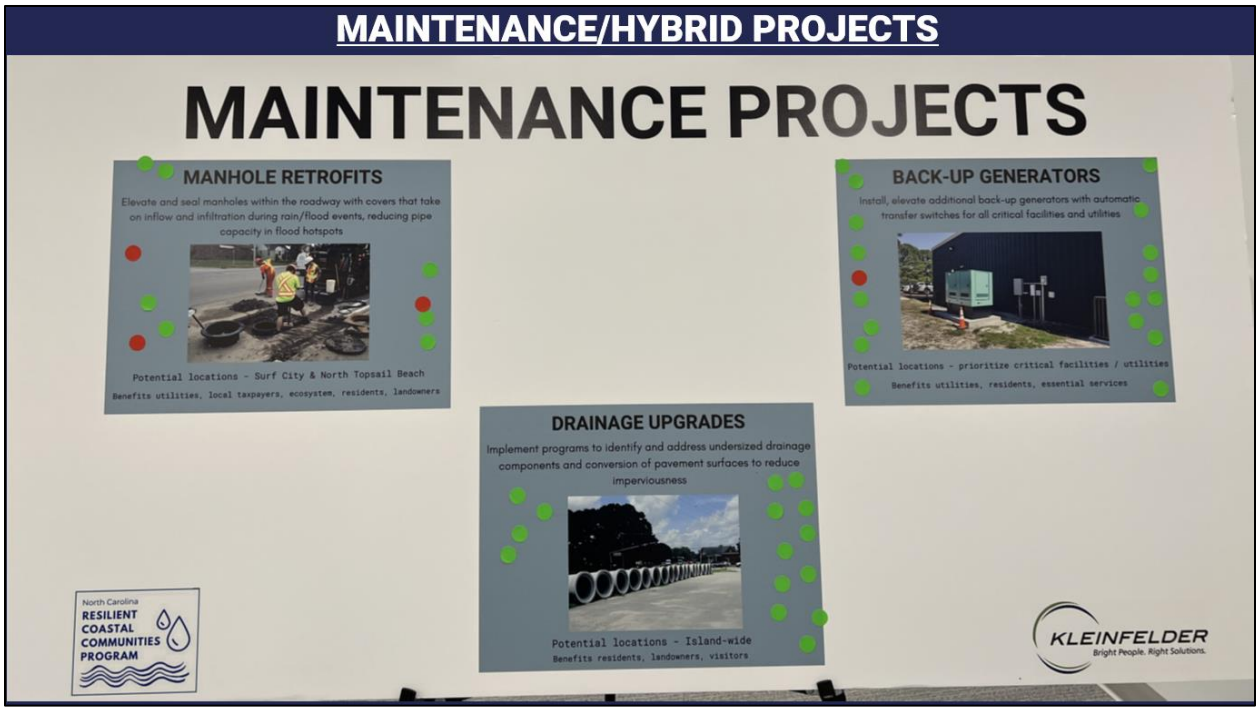


FIGURE 7.2 – MICHAEL HICKS (KLEINFELDER) SHOWCASED THE THREE "HYBRID STRATEGIES" AT THE MAINTENANCE PROJECTS DEMONSTRATION BOARD.

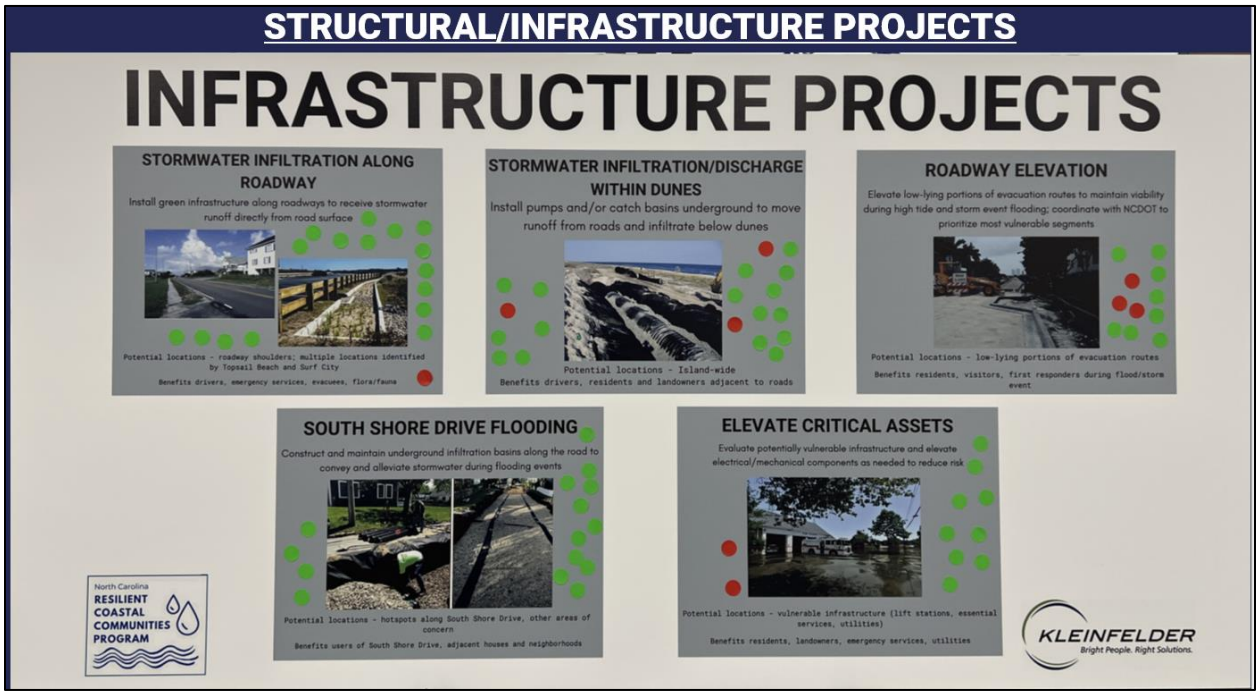


FIGURE 7.3 – DEB HILL (NORTH TOPSAIL BEACH) SHOWCASED THE FIVE "STRUCTURAL STRATEGIES" AT THE INFRASTRUCTURE PROJECTS DEMONSTRATION BOARD.

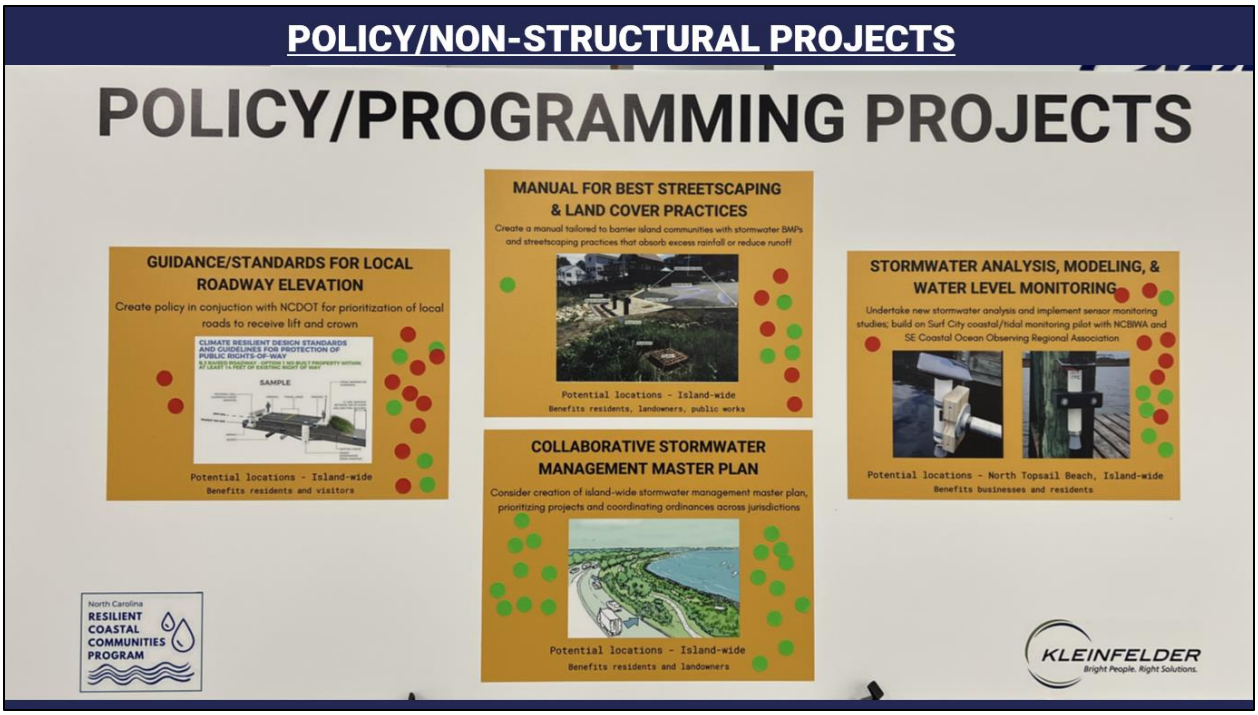


FIGURE 7.4 – CHRISTINA BURKE (TOPSAIL BEACH) SHOWCASED THE FOUR "NON-STRUCTURAL STRATEGIES" AT THE POLICY/PROGRAM PROJECTS DEMONSTRATION BOARD.

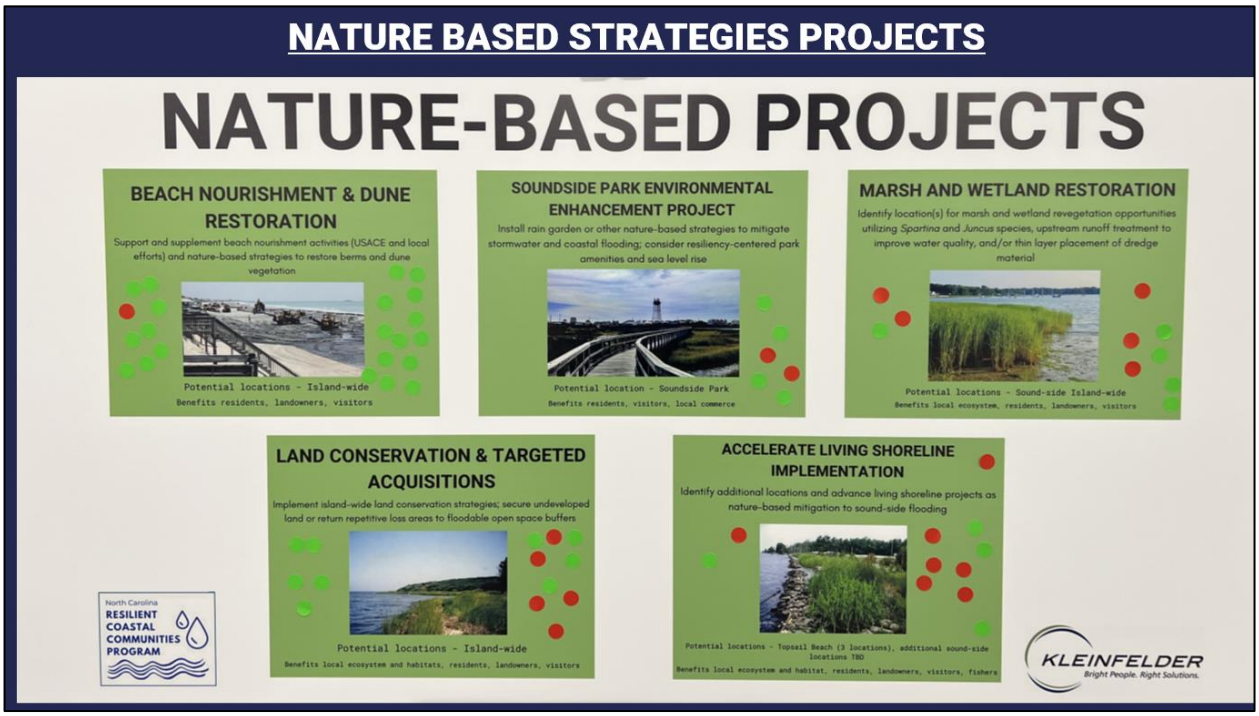


FIGURE 7.5 – KYLE BREUER (SURF CITY) SHOWCASED THE FIVE "NATURE-BASED STRATEGIES" AT THE NATURE-BASED PROJECTS DEMONSTRATION BOARD.

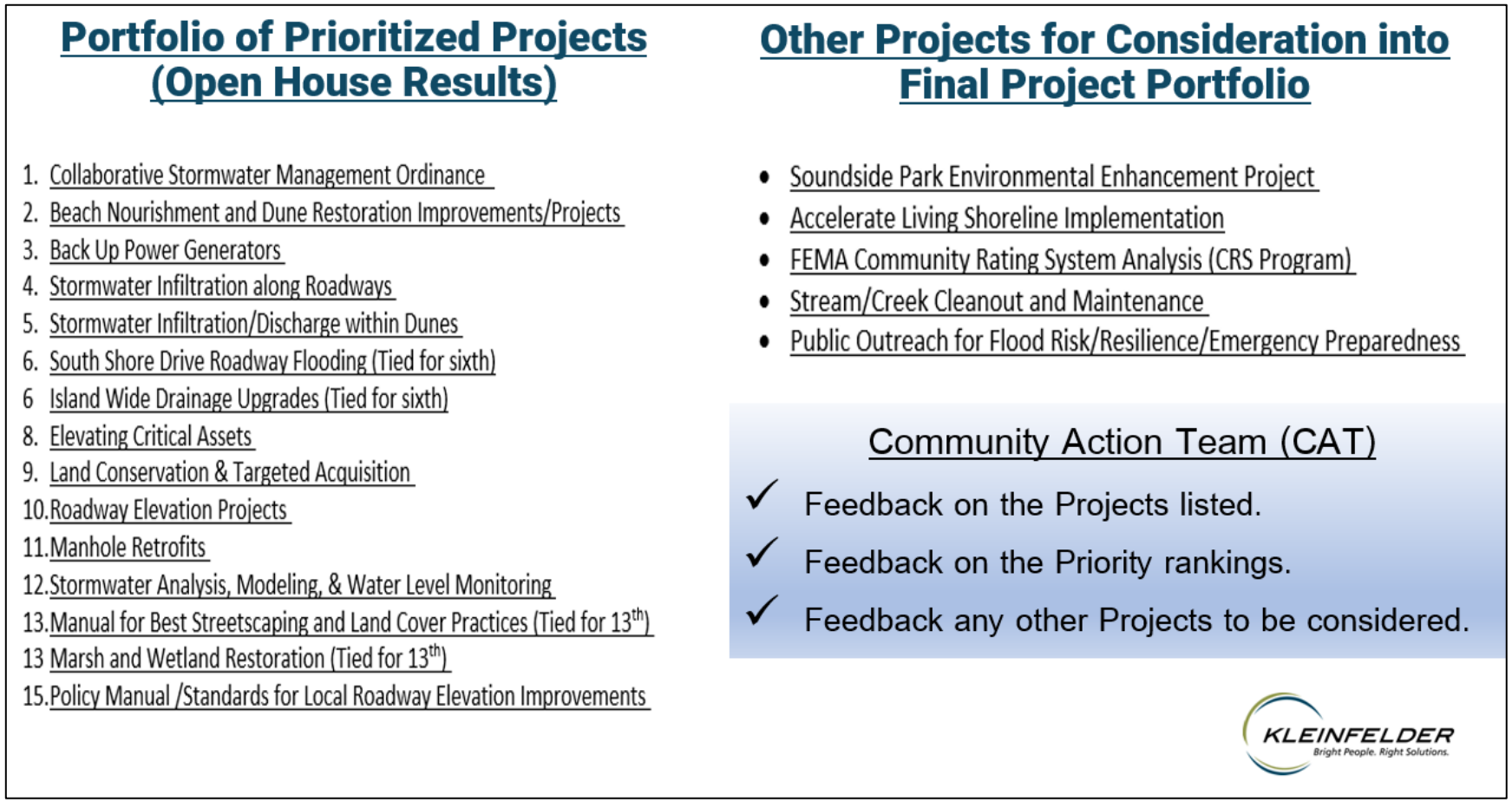
TABLE 7.1 – RESULT OF DRAFT PROJECT PORTFOLIO RANKINGS FROM MARCH 2022 OPEN HOUSE

Project	# Green	# Red	Priority	Location
Collaborative Stormwater Management Ordinance	21	0	Highest (1)	Island Wide
Stormwater Analysis, Modeling, & Water Level Monitoring	6	8	Low (12)	North Topsail Beach & Island Wide
Manual for Best Streetscaping & Land Cover Practices	5	5	Low (13 tied)	Island Wide
Guidance/Standards for Local Roadway Elevation	5	11	Low (15)	Island Wide
Beach Nourishment & Dune Restoration	21	1	Highest (2)	Island Wide
Land Conservation & Targeted Acquisition	9	5	Medium (9)	Island Wide
Marsh & Wetland Restoration	5	5	Low (13 tied)	Island Wide
Soundside Park Environmental Enhancement Project	4	2	Low (16)	Surf City
Accelerate Living Shoreline Implementation	4	7	Low (17)	Topsail Beach
Stormwater Infiltration along Roadways	16	1	High (4)	Island Wide
Stormwater Infiltration/Discharge within Dunes	16	3	High (5)	Island Wide
South Shore Drive Roadway Flooding	15	0	High (6 tied)	Surf City
Elevate Critical Assets	9	2	Medium (8)	Island Wide
Roadway Elevation	8	3	Medium (10)	Island Wide
Back-Up Generators	17	1	High (3)	Island Wide
Drainage Upgrades	15	0	High (6 tied)	Island Wide
Manhole Retrofits	7	3	Medium (11)	Surf City/Topsail Beach

Participant feedback collected at the Open House was integrated into the process of project selection and prioritization. The CAT additionally supplied firsthand knowledge and experience, along with funding strategies and anticipated project costs, which aided in consolidating and prioritizing the projects. Table 7.1 and the itemized list in Figure 7.6 illustrate the results of feedback on proposed projects.

Recognizing that certain projects may need an initial analysis/data collection component prior to engineering and implementation stages, the CAT applied several attributes from the STAPLEE method (FEMA). This approach recognizes factors such as social, environmental, economic, political, administrative, and technical aspects contributing to the decision making of selected or non-selected projects into the final project portfolio. Certain projects were not considered in the final project portfolio based on factors like feasibility, funding, permitting, or duration. For example, the accelerating living shoreline implementation project was not included in the final project portfolio based on factors such as existing funding sources (other means of implementing this project), town staff feedback (“we are a little ‘living-shorelined-out’ after multiple installations and mixed public feedback"), and less public support as other projects (demonstrated at the March Open House workshop).

FIGURE 7.6 – DRAFT PROJECT PORTFOLIO PRIORITIZATION MATERIALS FROM SIDE MEETINGS WITH TOWN STAFF FOLLOWING CAT WORKSHOPS AND THE OPEN HOUSE



The final consensus, Island-wide project portfolio contains a total of fifteen (15) projects with five (5) projects selected by each community. It is the cumulative result of many discussions across CAT workshops, the Open House, and numerous side meetings with representatives from North Topsail Beach, Surf City, and Topsail Beach.

TOPSAIL ISLAND PROJECT PORTFOLIO

A. Final Topsail Island Project Portfolio

LEGEND (for each project below):

Symbol	Estimated Cost Range
$	< $250,000
$$	$250,000 - $500,000
$$$	$500,000 - $1,000,000
$$$$	> $1,000,000

Project Next Steps (color by type)
More analysis / detailed planning needed to identify and/or prioritize specific location(s), suitability, or feasibility
Design- or implementation-ready (project location and type of design already identified)
Other implementation (policy, non-structural, monitoring)

Project #1 –Stormwater Infiltration System Along Roadways

Green infrastructure can be installed along roadways to receive stormwater runoff directly from the road surface. Green infrastructure such as swales, bioswales and rain gardens can provide locations for stormwater retention and enhanced mechanisms of infiltration to allow roads to drain faster and avoid ponding. *Potential island wide project.*

Hazard(s) addressed by the project	Flooding – rainfall, sea level rise, water quality
Type of Solution	Infrastructure
Project Design (Phase 3) Estimated Cost*	$
Project Construction (Phase 4) Estimated Cost*	$$$
Potential Implementation Funding Sources	ARPA/NC Stormwater funding; other state grants; GoldenLEAF Flood Mitigation Program, Clean Water State Revolving Fund, EPA 319 grants
Projected Estimated Timeline	3 years
Priority Rating	High
Project location(s)	Some locations already identified by Topsail Beach and Surf City; can be applied on roadway shoulders Island-wide. In Topsail Beach, the Rocky Mount area (among others) has been identified as top priority for nuisance flooding/stormwater improvements. Surf City has been looking into an area north of Surf Condos to implement a chamber infiltration project

Project #2 – Collaborative (Island-Wide) Stormwater Management Ordinance

Compose an island wide stormwater management ordinance as current stormwater management policies vary across the three communities. Allow for flexibility within existing ordinances to "improve land area to hold and retain water to offset water table height increases and reducing runoff." *Potential island wide project.*

Hazard(s) addressed by the project	Flooding – rainfall, tidal, sea level rise, water quality
Type of Solution	Policy/programming
Project Design (Phase 3) Estimated Cost*	$
Project Construction (Phase 4) Estimated Cost*	N/A
Potential Implementation Funding Sources	Local municipal funds, RCCP Phase III
Projected Estimated Timeline	1 year
Priority Rating	High
Project location(s)	Island-wide

Project #3 – Beach Nourishment and Dune Restoration

Continue on-going projects to maintain both a healthy dune system and beach for protection from hurricanes, nor'easters, etc. A nature-based strategy to restore dune vegetation and berms for flood protection. *Potential island wide project.*

Hazard(s) addressed by the project	Storm surge
Type of Solution	Nature-based
Project Design (Phase 3) Estimated Cost*	$-$$
Project Construction (Phase 4) Estimated Cost*	$$$$
Potential Implementation Funding Sources	USACE; FEMA/federal
Projected Estimated Timeline	1-5 years
Priority Rating	High
Project location(s)	Island-wide

Project #4 – Stormwater Infiltration within Existing Dunes

An infiltration system can be installed within the dune systems to receive stormwater runoff from roadways. The system will provide additional storage for runoff and improved conditions for faster infiltration, which will in turn allow roads to drain faster. Pumps and/or catch basins can be installed to move stormwater runoff from roadways into the dune infiltration system. *Potential island wide project.*

Hazard(s) addressed by the project	Flooding – rainfall
Type of Solution	Hybrid Infrastructure-Nature-based
Project Design (Phase 3) Estimated Cost*	$
Project Construction (Phase 4) Estimated Cost*	$$$-$$$$
Potential Implementation Funding Sources	ARPA/NC stormwater funding, RCCP Phase III, GoldenLEAF Flood Mitigation Program, Clean Water State Revolving Fund, EPA 219 grants
Projected Estimated Timeline	2-4 Years
Priority Rating	High
Project location(s)	Multiple locations identified; some prioritization needed for specific “hot spots.”

Project #5 – Consultant Study to Obtain Credit Points for FEMA's Community Rating System (CRS)

Act with consultant to obtain credit points to increase rating class to reduce flood insurance premiums for property owners by determining what credits are in place and further credits that are needed to improve CRS rating. Note: NTB is currently a class 5 community which provides a 25% discount for Special Flood Hazard Area (SFHA) and a 10% discount for non-SFHA. *Project identified by the towns of Topsail Beach and North Topsail Beach.*

Hazard(s) addressed by the project	Flooding
Type of Solution	Programming/Policy
Project Design (Phase 3) Estimated Cost*	$
Project Construction (Phase 4) Estimated Cost*	$-$$
Potential Implementation Funding Sources	ARPA/NC stormwater funding; FEMA/federal
Projected Estimated Timeline	1+ year
Priority Rating	High
Project location(s)	Topsail Beach and North Topsail Beach

Project #6 – South Shore Drive Drainage Project

The Town of Surf City conducted feasibility analysis to divert stormwater from high frequency rain events to areas of underground infiltration. Project could be several forms of engineering approaches such as a system to include pumps, piping, or other mechanisms that would connect to infiltration basins. *Project locations on S. Shore Drive in Surf City.*

Hazard(s) addressed by the project	Flooding – rainfall, sea level rise
Type of Solution	Infrastructure
Project Design (Phase 3) Estimated Cost*	$
Project Construction (Phase 4) Estimated Cost*	$$$
Potential Implementation Funding Sources	ARPA/NC stormwater funding, GoldenLEAF Flood Mitigation Program, Clean Water State Revolving Fund, EPA 319 Grants, NCEM Transportation Infrastructure Resiliency Fund Grants, NCDOT
Projected Estimated Timeline	Need to verify scope from existing study/analysis
Priority Rating	High
Project location(s)	Nine (9) locations identified through from an analysis done along South Shore Dr. in Surf City, including some that place infiltration basins on adjacent properties that the Town owns. Consultant WK Dickson has completed a study that is in final review with NCDOT.

Project #7 – Analysis to Evaluate Vulnerable and Critical Infrastructure for Elevation

Evaluate vulnerable/critical infrastructure locations such as lift stations, fire stations, and emergency facilities and determine if electrical or mechanical components need to be elevated. *Potential island wide project.*

Hazard(s) addressed by the project	Flooding – rainfall, tidal, sea level rise
Type of Solution	Infrastructure
Project Design (Phase 3) Estimated Cost*	$
Project Construction (Phase 4) Estimated Cost*	$$
Potential Implementation Funding Sources	ARPA/NC stormwater funding; FEMA/federal grants
Projected Estimated Timeline	2+ years
Priority Rating	Medium
Project location(s)	Critical facilities (fire, police, utilities)

Project #8 – Manhole Retrofits

Retrofitting manhole covers that take on inflow and infiltration (I & I). Combination of elevating manholes that do not impede traffic and sealing manholes that are within the roadway with sensible access for maintenance and cleanout. *Project location within towns of Surf City and NTB.*

Hazard(s) addressed by the project	Flooding
Type of Solution	Maintenance
Project Design (Phase 3) Estimated Cost*	$-$$
Project Construction (Phase 4) Estimated Cost*	$$
Potential Implementation Funding Sources	Local municipal funds; ARPA/NC stormwater grants
Projected Estimated Timeline	1 year+
Priority Rating	Medium
Project location(s)	Surf City and North Topsail Beach

Project #9 – Land Conservation and Targeted Acquisitions

A nature-based solution/strategy to preserve interconnected systems of natural areas and open space. Land conservation projects begin by prioritizing areas of land for acquisition. Secure lots through either acquisition, grant-funded purchase, or donation. These lots may be secured as open space easements in perpetuity. Special attention will be given to acquire properties that have been deemed unbuildable due to either state or local development regulations. *Potential island wide project.*

Hazard(s) addressed by the project	Flooding – rainfall, tidal, sea level rise
Type of Solution	Nature-based
Project Design (Phase 3) Estimated Cost*	$
Project Construction (Phase 4) Estimated Cost*	$$-$$$$
Potential Implementation Funding Sources	Local municipality funds, NC Land and Water Fund, Wildlife Conservation Society Climate Adaptation Fund, NOAA Coastal and Estuarine Land Conservation Program
Projected Estimated Timeline	2+ years
Priority Rating	Medium
Project location(s)	Island-wide

Project #10 – Develop Policy for Roadway Elevations (lift and crown) with Stormwater BMPs

Create a policy manual to dictate roadway elevation standards and other drainage solutions that convey roadway flooding such as stormwater infiltration systems and other best management practices coupled with elements of streetscaping/landscaping improvements to also enhance the public rights-of-way. In addition, policy would prioritize local and State roads to receive lift and crown improvements. *Potential island wide project.*

Hazard(s) addressed by the project	Flooding - rainfall
Type of Solution	Policy/programming
Project Design (Phase 3) Estimated Cost*	$
Project Construction (Phase 4) Estimated Cost*	N/A
Potential Implementation Funding Sources	Local municipal funds
Projected Estimated Timeline	2+ years
Priority Rating	Low
Project location(s)	Island-wide

Project #11 – Conduct Engineering Studies for Hydrology and Stormwater Management

The Town of North Topsail Beach will review its stormwater control policies and include regulatory updates for water detention and/or retention facilities in new developments as per new state and federal policy requirements. This will include analysis of reducing the Town's current maximum lot coverage requirements and other land use/development mechanisms which relate to stormwater management. *Project identified by North Topsail Beach but has potential for implementation of an island wide project.*

Hazard(s) addressed by the project	Water quality, flooding
Type of Solution	Policy/programming
Project Design (Phase 3) Estimated Cost*	$
Project Construction (Phase 4) Estimated Cost*	$-$$
Potential Implementation Funding Sources	ARPA/NC Stormwater funding; NC Coastal Federation
Projected Estimated Timeline	2-3 years
Priority Rating	Low
Project location(s)	North Topsail Beach

Project #12 – Drainage Maintenance Program & Infrastructure Upgrades

Conduct analysis for drainage infrastructure maintenance and upgrades by implementing programs coupled with data collection/monitoring to identify locations for drainage infrastructure upgrades. *Potential island wide project.*

Hazard(s) addressed by the project	Flooding
Type of Solution	Policy/programming/research
Project Design (Phase 3) Estimated Cost*	$
Project Construction (Phase 4) Estimated Cost*	$$
Potential Implementation Funding Sources	ARPA/NC stormwater funding; state grants; university research partnership
Projected Estimated Timeline	2+ years
Priority Rating	Low
Project location(s)	Island-wide

Project #13 – Locate/Design/Construct a Living Shoreline Demonstration Project

The community would determine the location of the living shoreline project. Once location is determined, engineering and design would be performed, and project would be further implemented by permitting and construction. *Project identified by North Topsail Beach.*

Hazard(s) addressed by the project	Flooding – tidal, sea level rise
Type of Solution	Nature-based
Project Design (Phase 3) Estimated Cost*	$
Project Construction (Phase 4) Estimated Cost*	$-$$
Potential Implementation Funding Sources	NC Coastal Federation and other state appropriated funding, NCDEQ grants, National Fish and Wildlife Federation (NFWF) and NOAA Coastal Resilience grants, Wildlife Conservation Society Climate Adaptation Fund
Projected Estimated Timeline	2 years
Priority Rating	Low
Project location(s)	3 locations on Topsail Beach, other locations to be determined and prioritized based on suitability and other factors

Project #14 – Soundside Park Environmental Enhancement Project

Implement a suite of best management practices (BMP) such as a rain garden or other nature-based solutions to control stormwater runoff and water quality and to improve drainage conditions. An additional educational component will describe the project and encourage similar projects to be implemented potentially elsewhere across Topsail Island. *Project location Soundside Park in Surf City.*

Hazard(s) addressed by the project	Flooding – rainfall, tidal, sea level rise
Type of Solution	Nature-based
Project Design (Phase 3) Estimated Cost*	$-$$
Project Construction (Phase 4) Estimated Cost*	$$$-$$$$
Potential Implementation Funding Sources	NC Coastal Federation, other state grants, NFWF Coastal Resilience, NC Land and Water Fund
Projected Estimated Timeline	6 months
Priority Rating	Low
Project location(s)	Surf City - Soundside Park

Project #15 – Stream/Creek Cleanout and Maintenance

Remove debris from and perform maintenance on various streams/creeks that feed into the tidal area and intracoastal waterway on the mainland portion of Surf City. Priority emphasis on stream/creek cleanout on portions that cross major travel ways (i.e., NC 210 and NC 50). *Project location mainland Surf City.*

Hazard(s) addressed by the project	Flooding – rainfall
Type of Solution	Maintenance
Project Design (Phase 3) Estimated Cost*	$
Project Construction (Phase 4) Estimated Cost*	$$-$$$
Potential Implementation Funding Sources	Local municipality funds; ARPA/NC Stormwater funding
Projected Estimated Timeline	Routinely every 2 years
Priority Rating	Low
Project location(s)	Mainland Surf City

ADDITIONAL PROJECTS IDENTIFIED – NORTH TOPSAIL BEACH

Project Description
The Town supports implementation of the Cape Fear and White Oak River Basin Water Quality Management Plans. ***New River*** watershed (03030001020040) projects that improve estuarine water quality, shellfish habitat and fish nursery habitat are priorities for this Hydrologic Units (HU). (Ref: White Oak River Basin Restoration Priorities 2010, link here).
The Town supports implementation of the Cape Fear and White Oak River Basin Water Quality Management Plans. ***Turkey Creek*** watershed priorities for the HU include buffer projects, stormwater BMPs, and agricultural BMPs (ref: White Oak River Basin Restoration Priorities 2010).
The Town supports implementation of the Cape Fear and White Oak River Basin Water Quality Management Plans**.** ***Topsail Beach*** watershed (est. 2010) stormwater management projects that reduce impacts from runoff are highest priority here. (Ref: White Oak River Basin Restoration Priorities 2010). *Potential island wide project also listed above.*
Implement stream, wetland and riparian buffer restoration projects within watersheds that drain directly into class SA waters (e.g., tidal creeks). *Potential for island wide project.*
Support local public education/outreach efforts to increase public awareness of the sources and controls of pathogens in local streams, rivers, bays, and sounds. *Potential for island wide project*
Existing pervious pavement parking lot in front of Town Hall, Fire Stations, Public Works.
Electric vehicle charging stations. *Potential for island wide project.*
Critical facilities flood protection.
Flooding of tidal pond.
Stormwater erosion and ponding.
Hazard mitigation through elevation and acquisition. Pursue the acquisition of properties in flood prone areas when they are substantially damaged and meet the benefit-cost analysis (BCA) requirements for acquisition. A re-use plan will be identified during the scoping process. Deed restrictions should be placed on properties that are acquired to prevent development.

ADDITIONAL PROJECTS IDENTIFIED – NORTH TOPSAIL BEACH

Project Description
Retrofit critical facilities and town owned facilities for improved resilience to all hazards with the use new technology. This could include but is not limited to wind retrofits, low water consumption fixtures, leak detectors, backup generators, ignition-resistant materials, 320 or 361 compliant safe rooms, lightning protection, hail resistant roofing, anchoring fixed building equipment.
Support activities in the development of Army Corps of Engineers Federal Shoreline Protection Project.
The Town supports ongoing planning and capital improvement efforts to address the drainage problems associated with flooding. Perform assessment town wide of ditches to ensure proper grading. Coordinate with NCDOT for repairs to ensure proper drainage.
Work with Onslow County to ensure implementation of a viable public education and outreach program for mitigation, preparedness, response, and recovery.
Install backup generators with automatic transfer switches for mobile generators on all critical facilities and critical utilities.
Reduce *plastic marine* debris. The Town supports commercial and recreational fishing in its waters and will cooperate with other local governments and state and federal agencies to control pollution of these waters to improve conditions so that commercial and recreational fisheries will not be depleted. It also supports the preservation of primary nursery and habitat areas.
Salt marsh and wetland preservation. Consider opportunities for planting *Spartina alterniflora* (smooth cordgrass), *Spartina patens* (salt meadow hay) and *Juncus roemerianus* (black needle rush) to restore marshes and provide shoreline protection.
Protect shellfish harvesting waters.
Conduct a build out analysis to assist with policy development related to resilience.
Habitat protection.
Construct LEEDs certified fire station(s) (critical facility).
The Town will secure land through property acquisition. The Town may aim to secure lots through either acquisition, grant-funded purchase, or donation, in an effort to protect the eco-friendly environment that they have established. These lots may be secured as open space easements in perpetuity. Special attention will be given to acquire properties that have been deemed unbuildable due to either state or local development regulations.

ADDITIONAL PROJECTS IDENTIFIED – NORTH TOPSAIL BEACH

Project Description
The Town will establish a land trust that will serve to secure undeveloped land through either acquisition or donation as open space easements in perpetuity. This effort will help realize the Town's vision to maintain an eco-friendly environment. The Town will work with the Conservation Trust of North Carolina throughout this effort to ensure that all land secured is properly protected.
Shoreline Protection. The Town supports the US Army Corps of Engineers policy on dredging the New River Inlet; however, the Town would like to work with the Corps to establish a dredging process that will provide sand to the Town. This will help the Town in their efforts to establish a long-term solution to beach nourishment.
High Water Mark Initiative. Provide information on past floods by posting high water markers in public places, along with maps and photographs of past floods on the Town's website.
Build oyster reefs to protect the emergency service buildings from sound side flooding. The State of North Carolina owns all land below the mean high-water line, except provided for by NCGS 113-205 and -206. Lines extending beyond the MHW will require proof from chain of title to a recorded declaration of submerged land, pursuant to NCGS 113-205 and -206.
Reduce impacts from runoff. Review recommendations found in the Cape Fear and White Oak River Basin Water Quality Management Plans. The ***Topsail Beach*** watershed (est. 2010) stormwater management projects that reduce impacts from runoff are highest priority. (Ref: White Oak River Basin Restoration Priorities, 2010, link here). Potential for island wide project, proposed by NTB.

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IX. APPENDIX A – MAPPING PRODUCTS

The following maps provide additional information regarding hazards, exposure, and specific locations in the Topsail Island area.

In addition, an interactive web-mapping dashboard tool

– "**Resilient Coastal Communities Program – Topsail Island**" –

has been developed specifically for this project and is accessible via the link below:

https://gis.kleinfelder.com/klfportal/apps/opsdashboard/index.html#/29bda8afaa49430d9b7354fc6be842e6

This dashboard aggregates pertinent Geographic Information Systems (GIS) data layers from hazard events, critical infrastructure, natural infrastructure and coastal ecosystems, and other resiliency-related data layers from many sources into a single web viewer for future use by Topsail Island and others. Data is displayed on the dashboard tool in two tabs: **Island-wide Flood Exposure/Critical Infrastructure** and **Natural Infrastructure**.

A. Hazard-Specific Maps

1. Sea Level Rise and High Tide Flooding

FIGURE A.1 – SEA LEVEL RISE (+1, +2, +3 FEET) AND PRESENT-DAY HIGH TIDE FLOODING IN TOPSAIL BEACH, SOUTH OF DARDEN AVE.

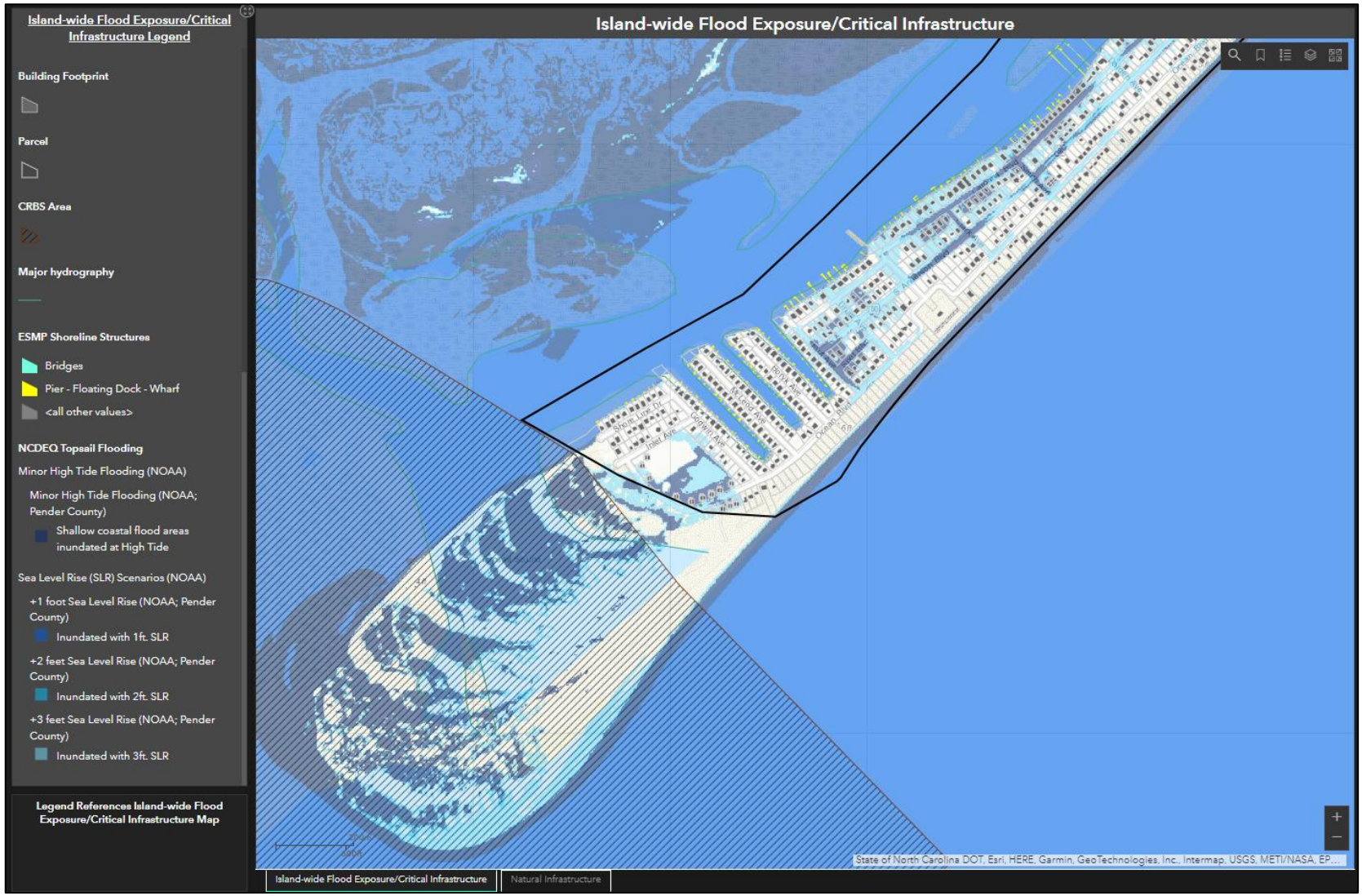


FIGURE A.2 – SEA LEVEL RISE (+1, +2, +3 FEET) AND PRESENT-DAY HIGH TIDE FLOODING IN TOPSAIL BEACH, BETWEEN DARDEN AVE. AND MONROE LANE

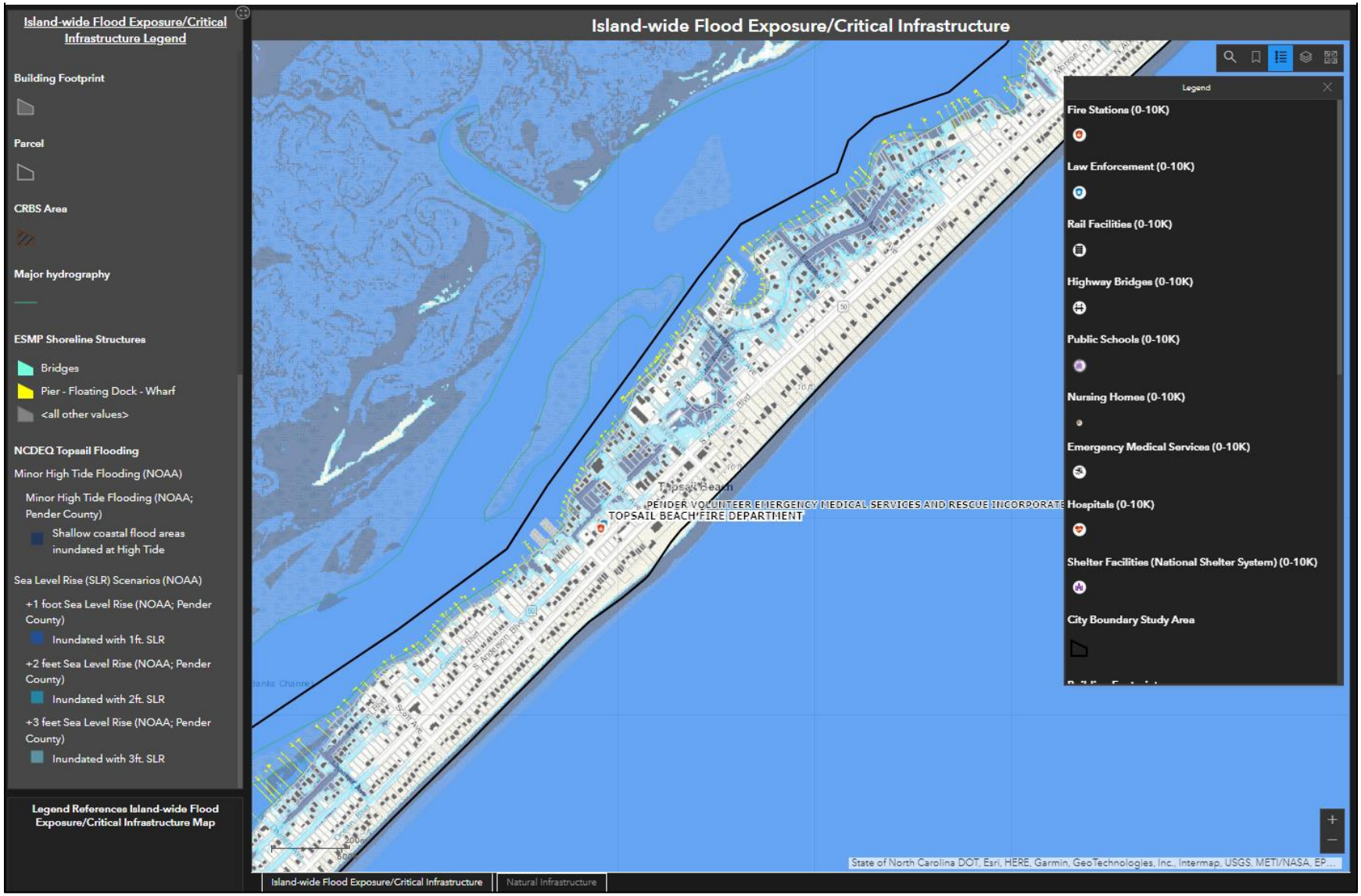


FIGURE A.3 – SEA LEVEL RISE (+1, +2, +3 FEET) AND PRESENT-DAY HIGH TIDE FLOODING IN TOPSAIL BEACH, BETWEEN MONROE LANE AND SURF CITY BOUNDARY

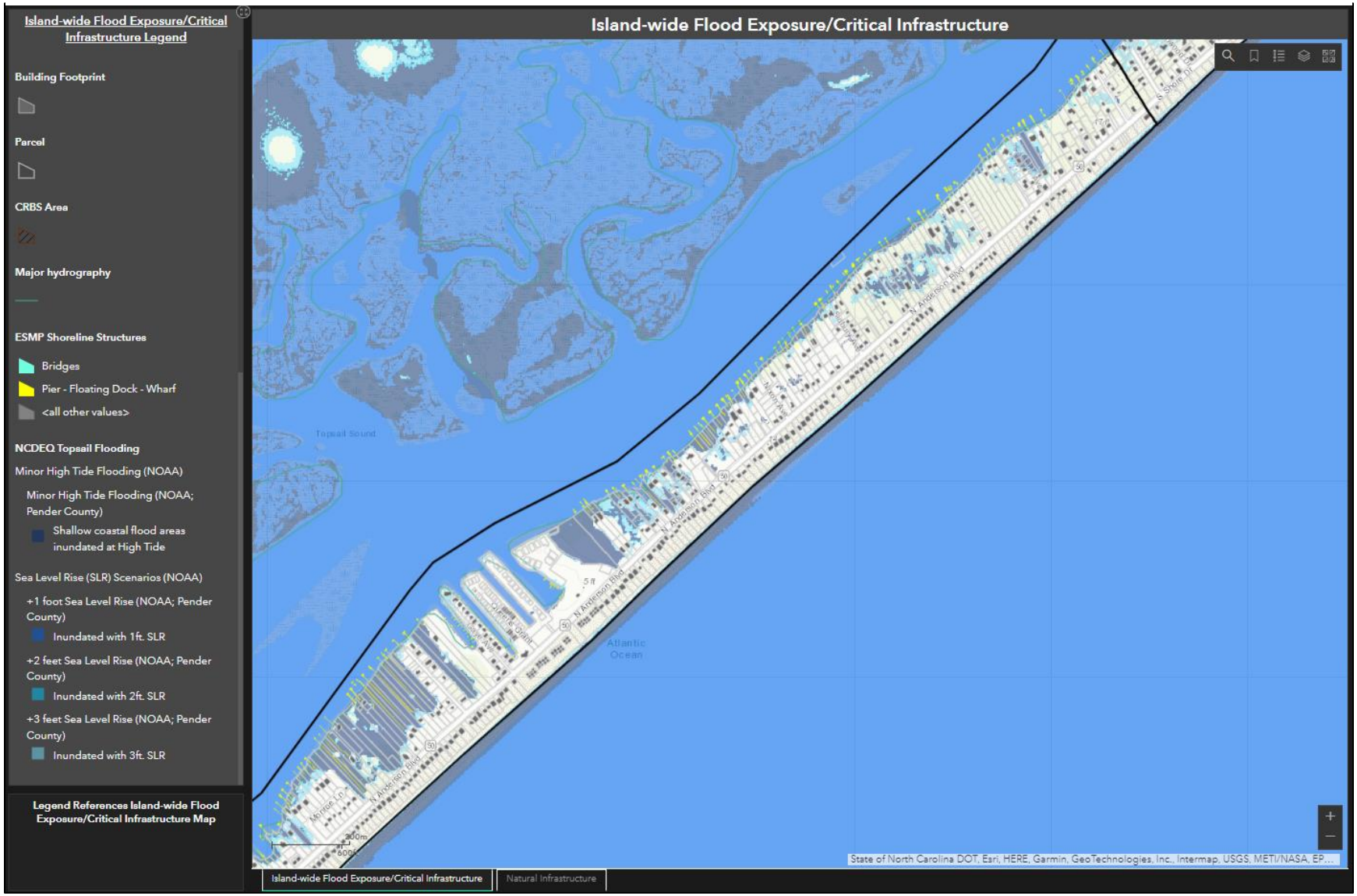


FIGURE A.4 – SEA LEVEL RISE (+1, +2, +3 FEET) AND PRESENT-DAY HIGH TIDE FLOODING IN SURF CITY, SOUTH OF SANDY LANE

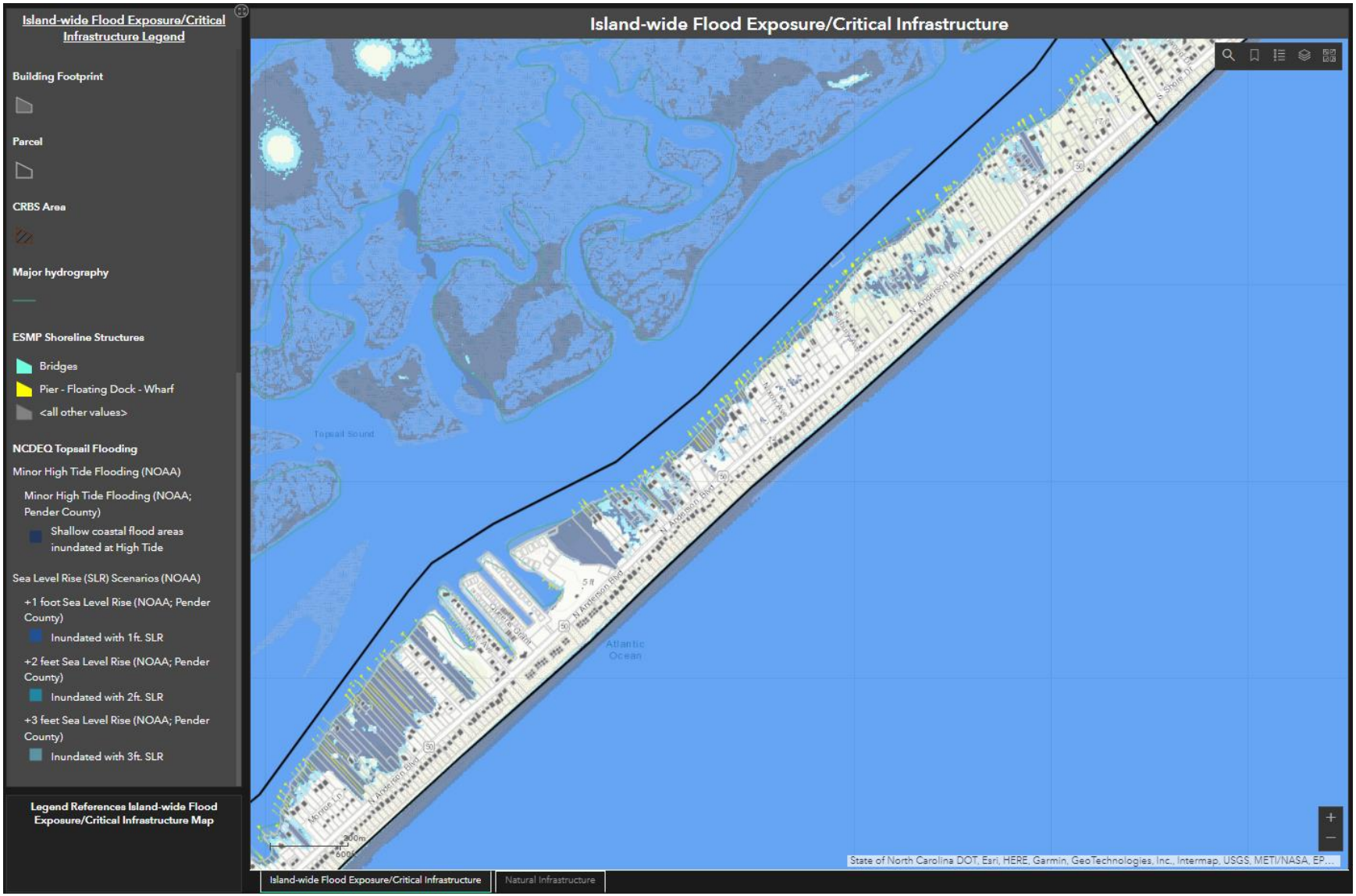


FIGURE A.5 – SEA LEVEL RISE (+1, +2, +3 FEET) AND PRESENT-DAY HIGH TIDE FLOODING IN SURF CITY, BETWEEN SANDY LANE AND NC-210/ROLAND AVE.

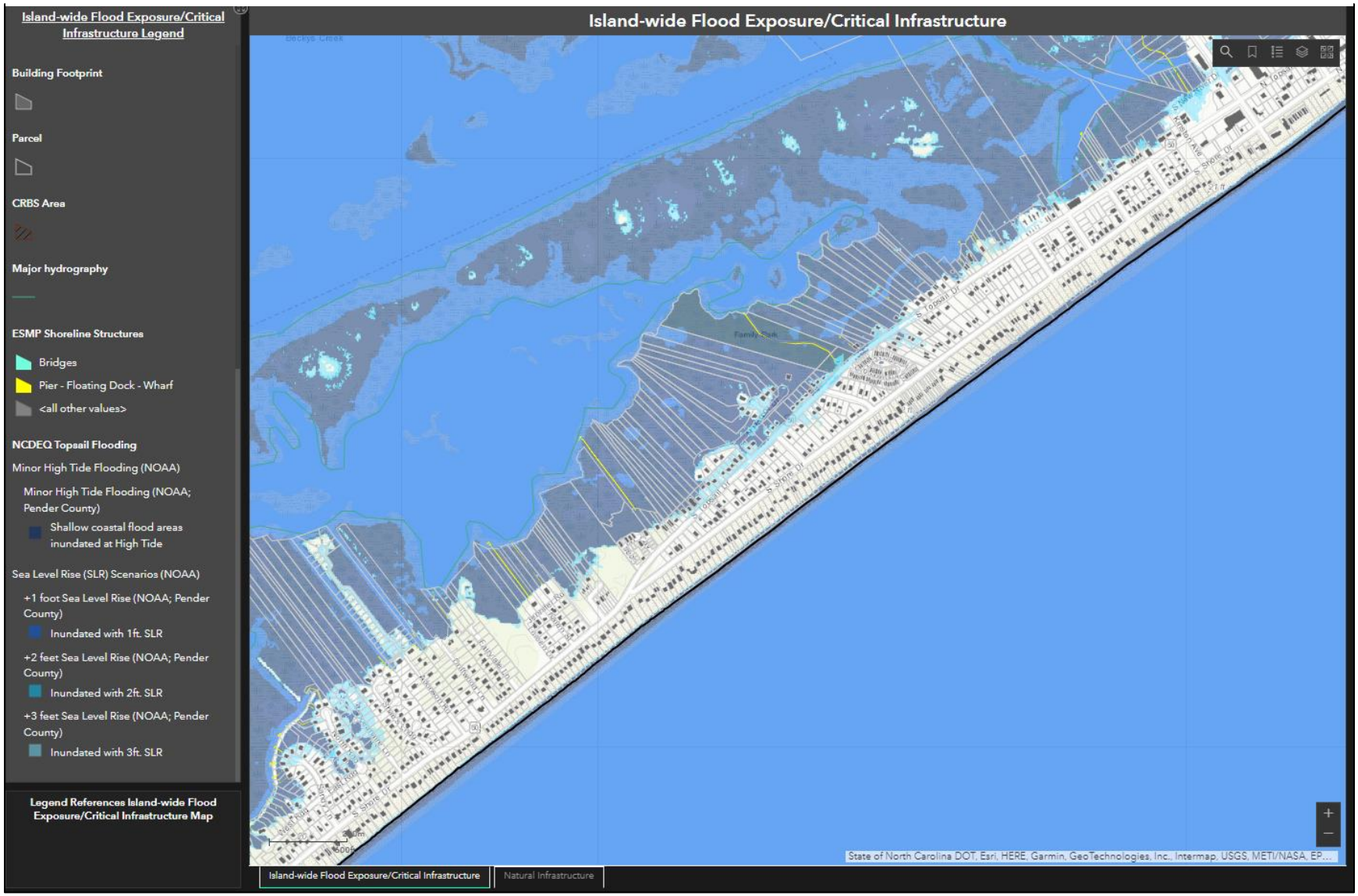


FIGURE A.6 – SEA LEVEL RISE (+1, +2, +3 FEET) AND PRESENT-DAY HIGH TIDE FLOODING IN SURF CITY, NEAR NC-210 AND LENOIR AVE.

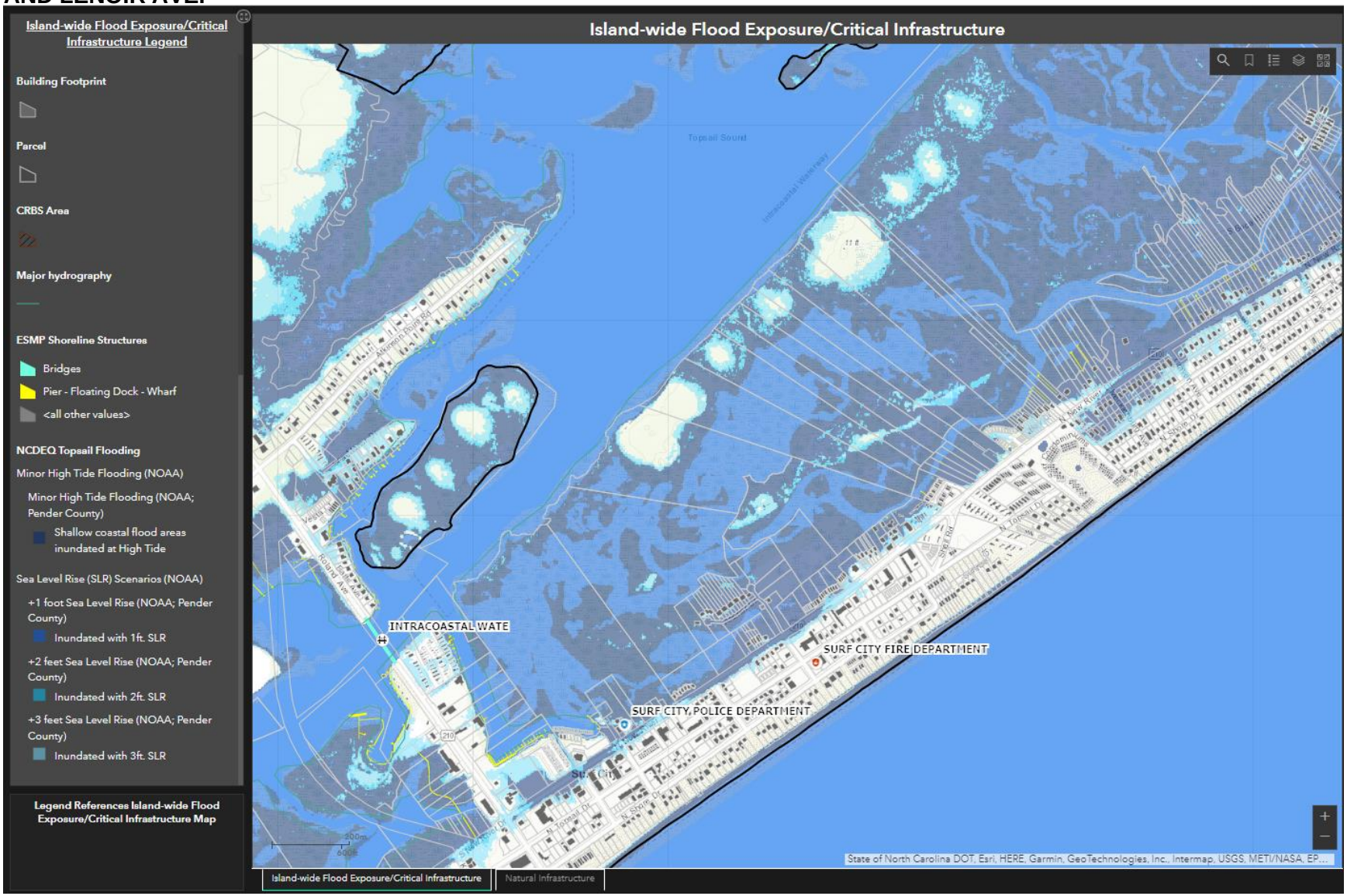


FIGURE A.7 – SEA LEVEL RISE (+1, +2, +3 FEET) AND PRESENT-DAY HIGH TIDE FLOODING IN SURF CITY, BETWEEN LENOIR AVE. AND NORTH TOPSAIL BEACH, NEAR THE PENDER/ONSLOW COUNTY LINE

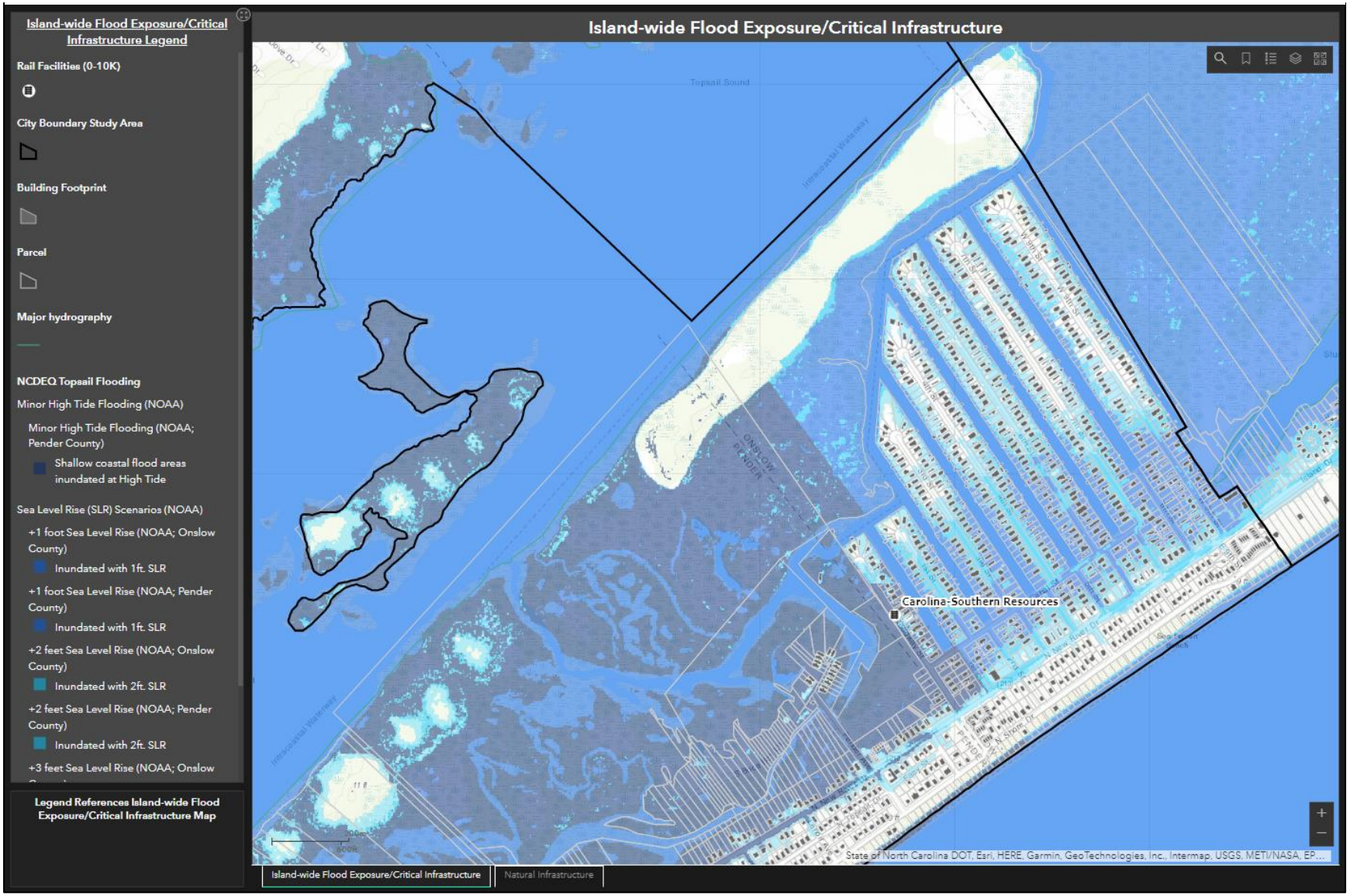


FIGURE A.8 – SEA LEVEL RISE (+1, +2, +3 FEET) AND PRESENT-DAY HIGH TIDE FLOODING IN NORTH TOPSAIL BEACH, BETWEEN SURF CITY/COUNTY LINE AND PORTA VISTA DRIVE

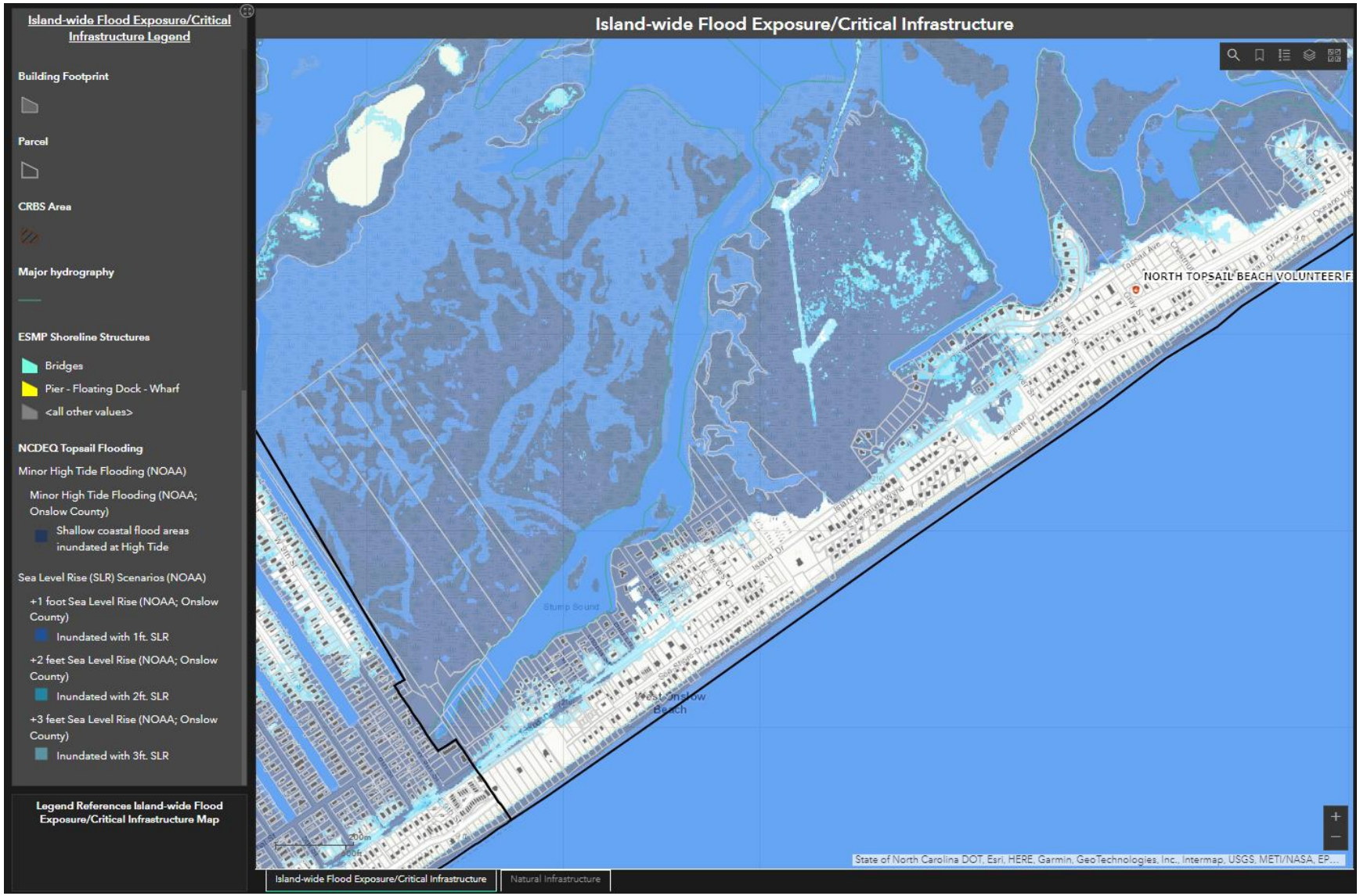


FIGURE A.9 – SEA LEVEL RISE (+1, +2, +3 FEET) AND PRESENT-DAY HIGH TIDE FLOODING IN NORTH TOPSAIL BEACH, NORTH OF CALINDA CAY COURT NEAR ROGERS BAY FAMILY CAMPWAY AND RV PARK

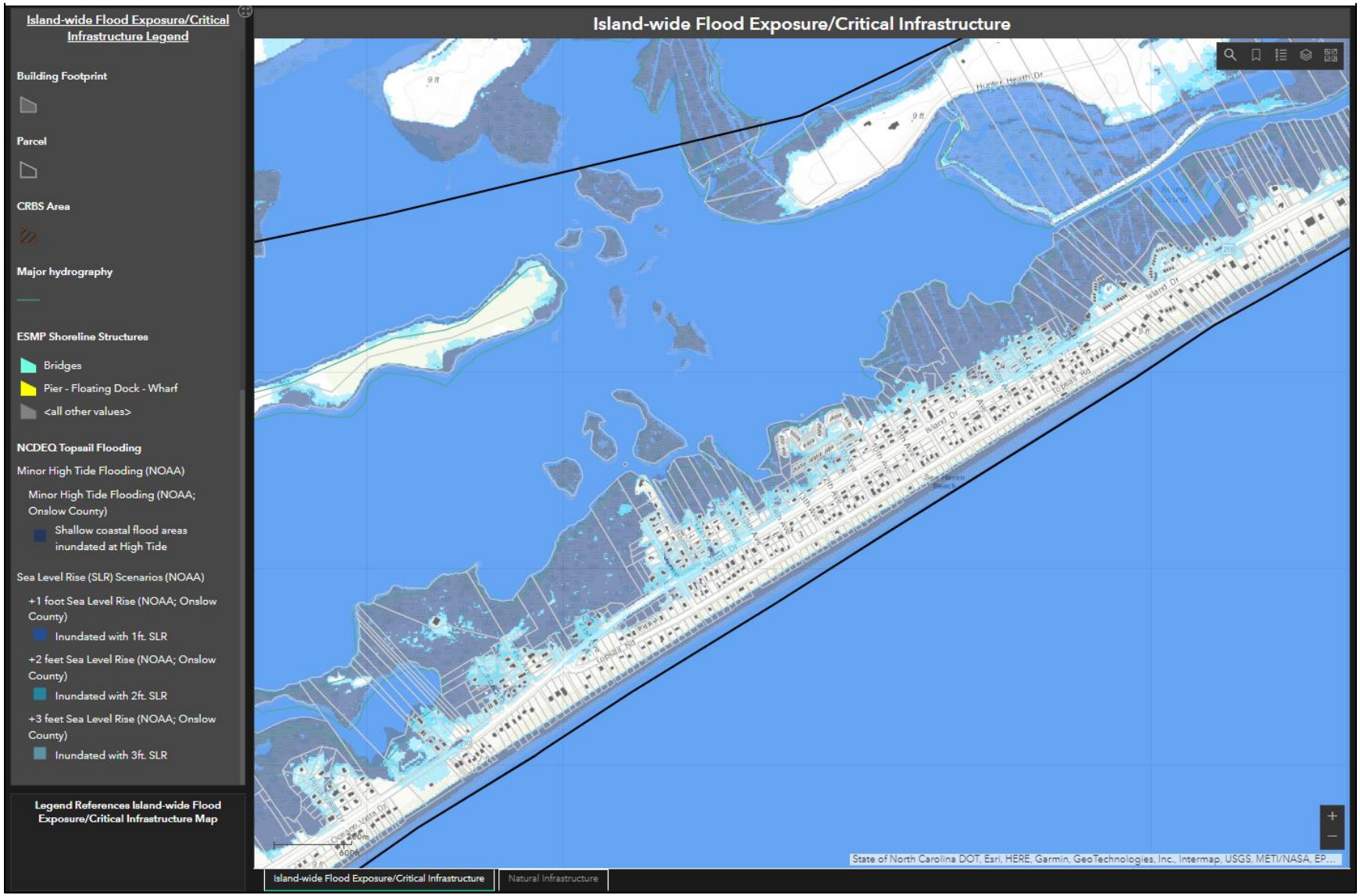


FIGURE A.10 – SEA LEVEL RISE (+1, +2, +3 FEET) AND PRESENT-DAY HIGH TIDE FLOODING IN NORTH TOPSAIL BEACH, ALONG ISLAND DRIVE SOUTH OF NC-210 BRIDGE

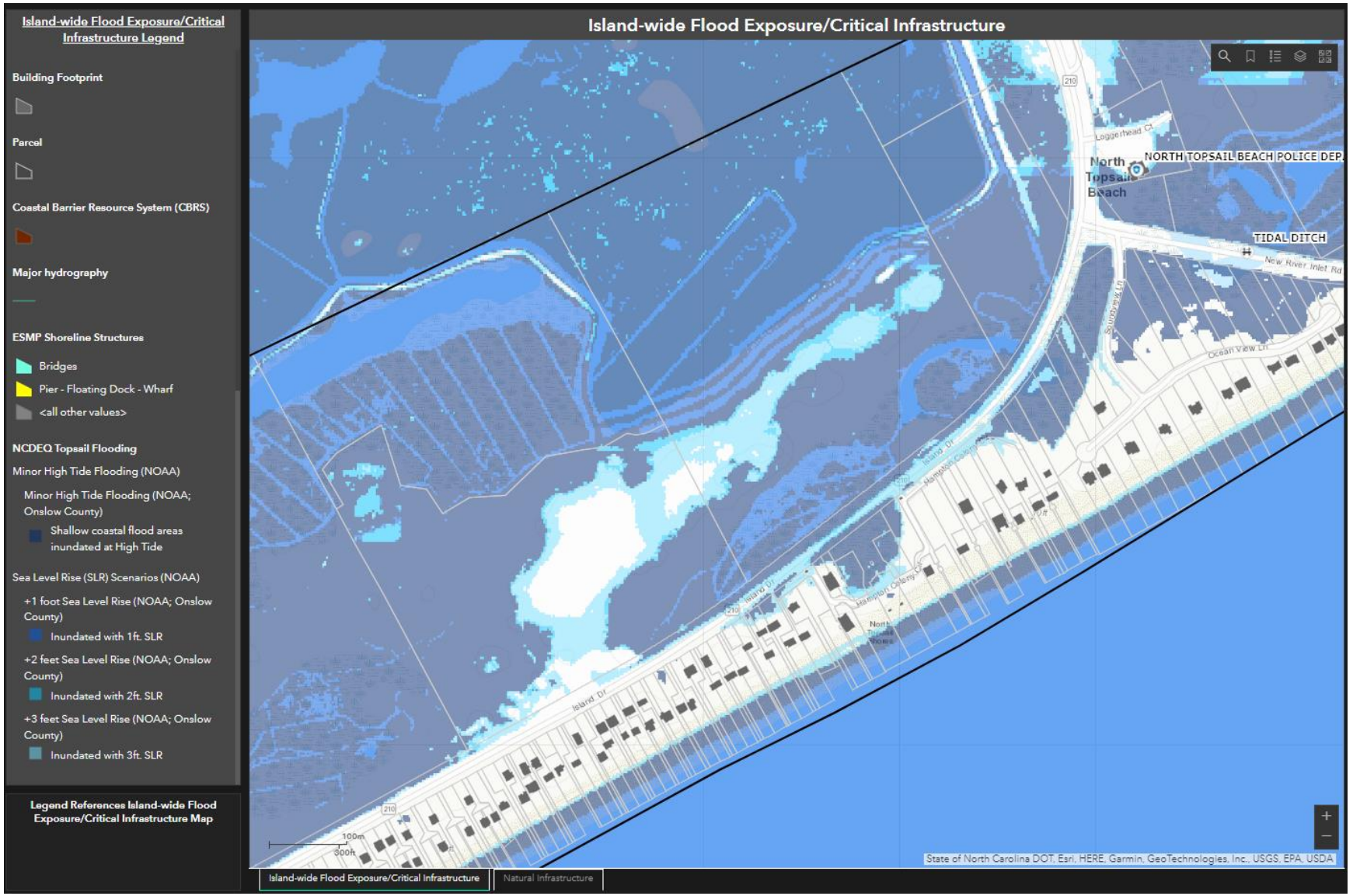


FIGURE A.11 – SEA LEVEL RISE (+1, +2, +3 FEET) AND PRESENT-DAY HIGH TIDE FLOODING IN NORTH TOPSAIL BEACH, NORTH OF NC-210 BRIDGE TO CAPE LANE

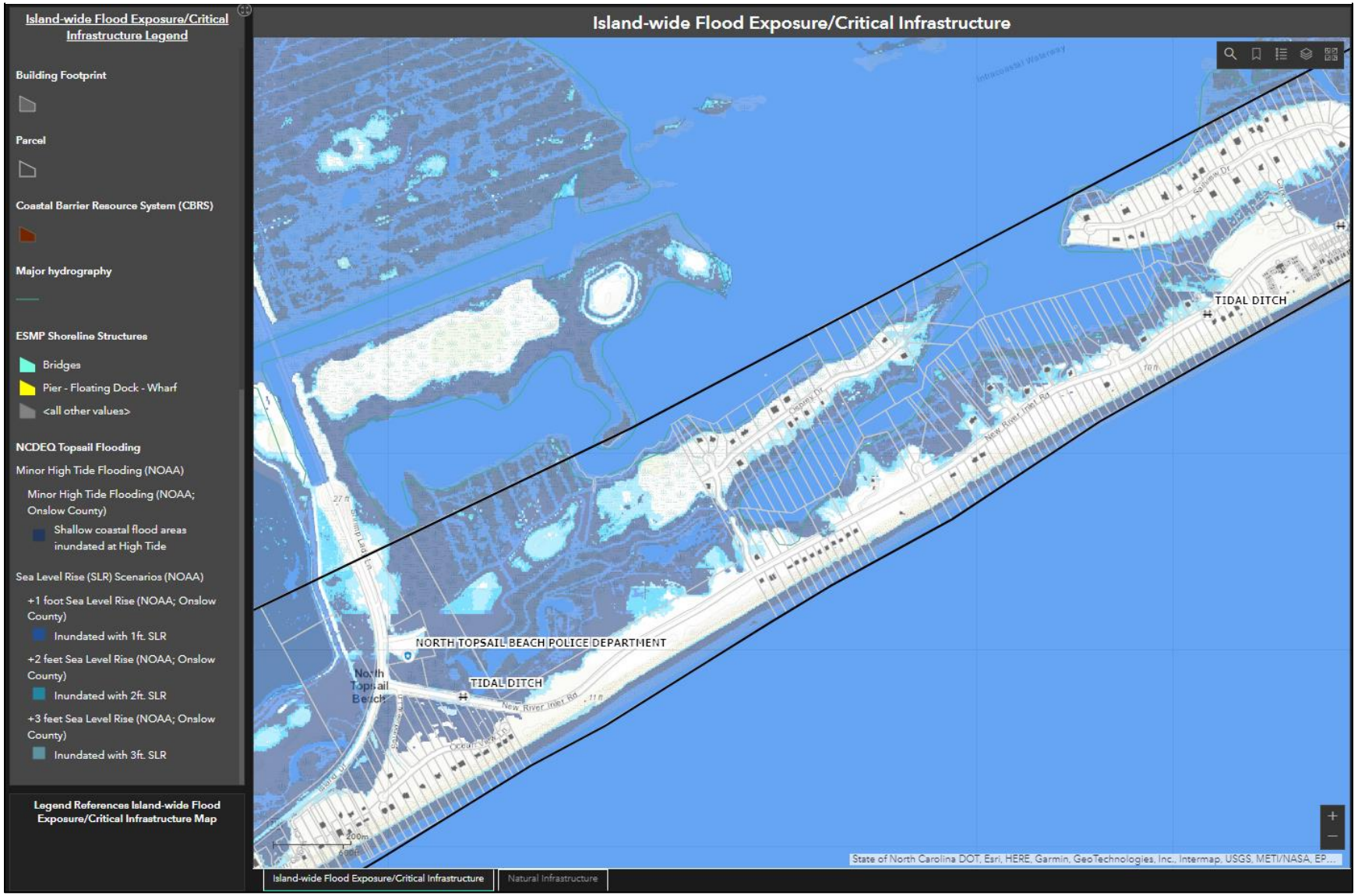


FIGURE A.12 – SEA LEVEL RISE (+1, +2, +3 FEET) AND PRESENT-DAY HIGH TIDE FLOODING IN NORTH TOPSAIL BEACH, NORTH OF NC-210 BRIDGE ALONG NEW RIVER INLET ROAD FROM CAPE LANE TO LACOSTA PLACE

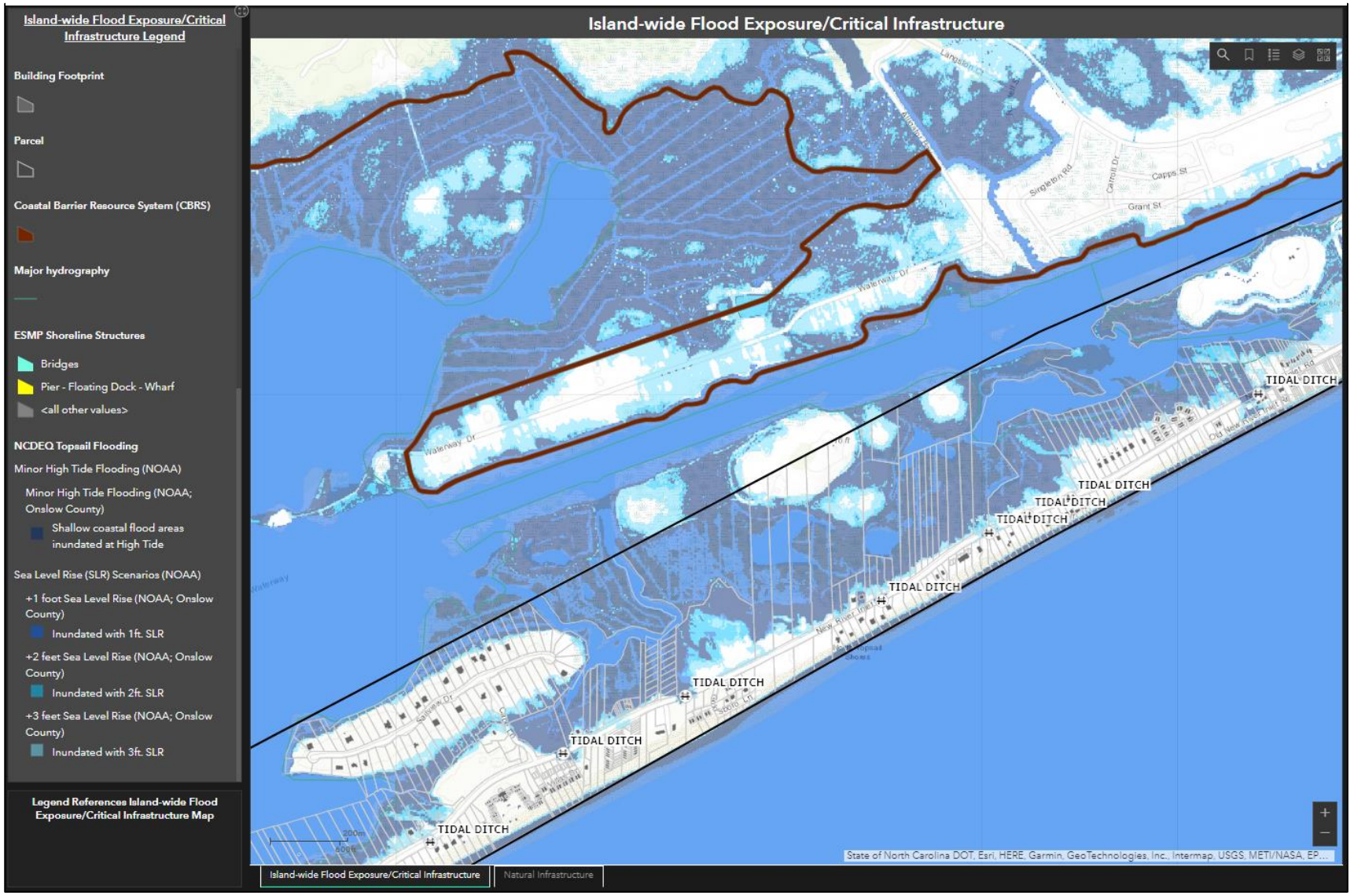


FIGURE A.13 – SEA LEVEL RISE (+1, +2, +3 FEET) AND PRESENT-DAY HIGH TIDE FLOODING IN NORTH TOPSAIL BEACH, ALONG NEW RIVER INLET ROAD FROM LACOSTA PLACE TO BOTTLENOSE BOULEVARD

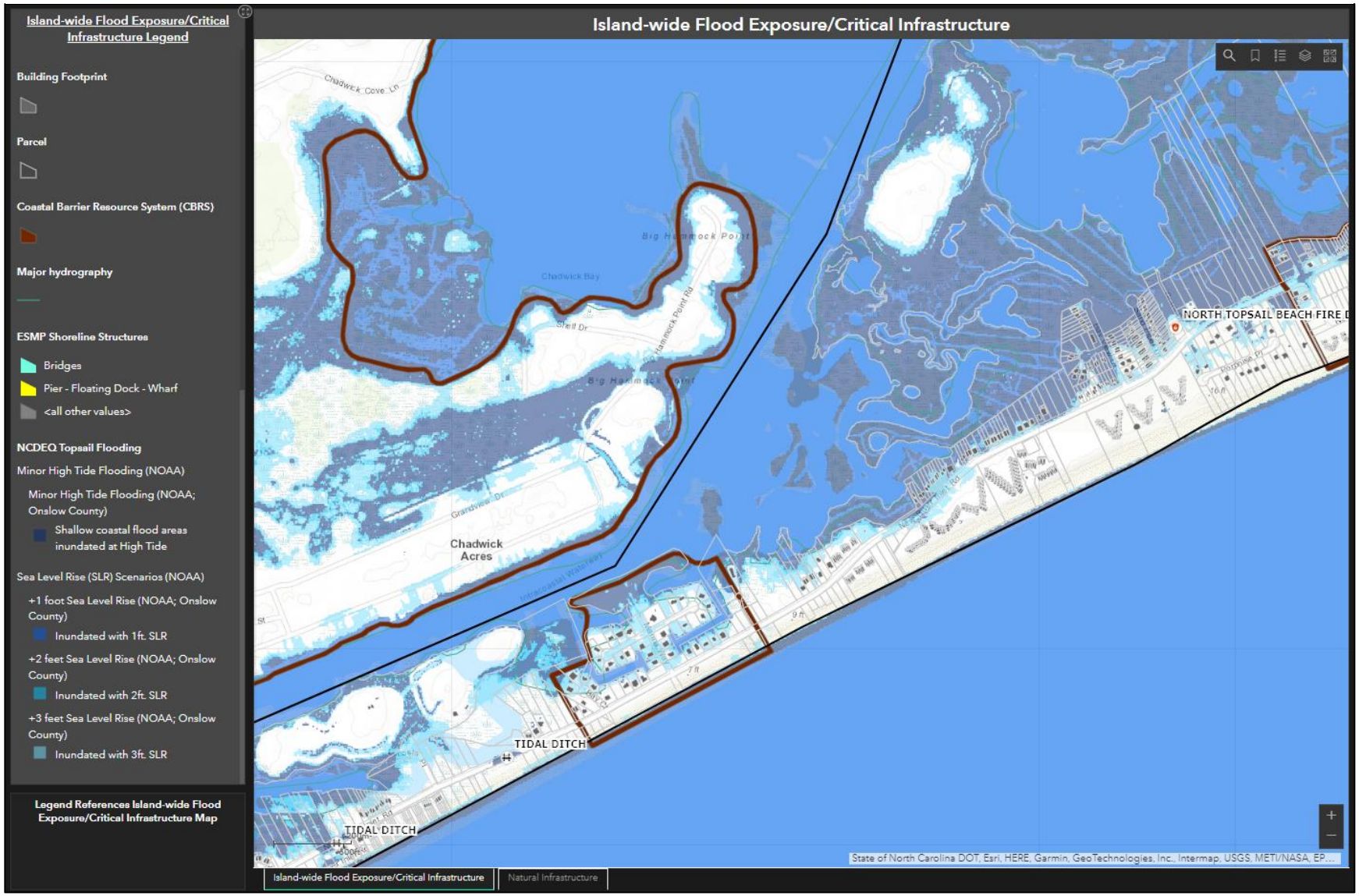


FIGURE A.14 – SEA LEVEL RISE (+1, +2, +3 FEET) AND PRESENT-DAY HIGH TIDE FLOODING IN NORTH TOPSAIL BEACH, ALONG NEW RIVER INLET ROAD FROM BOTTLENOSE BOULEVARD TO NEW RIVER INLET

2. Sound Side Tidal and Higher-Recurrence Storm Flooding "Hotspots"

FIGURE A.15 – With moderate sea level rise (between +1 to +1.5 feet by 2040-2060, shown in graphic), some particularly low-lying residential communities, such as Surf City near the county line, may flood frequently due to sunny day tidal flooding absent a significant storm event.

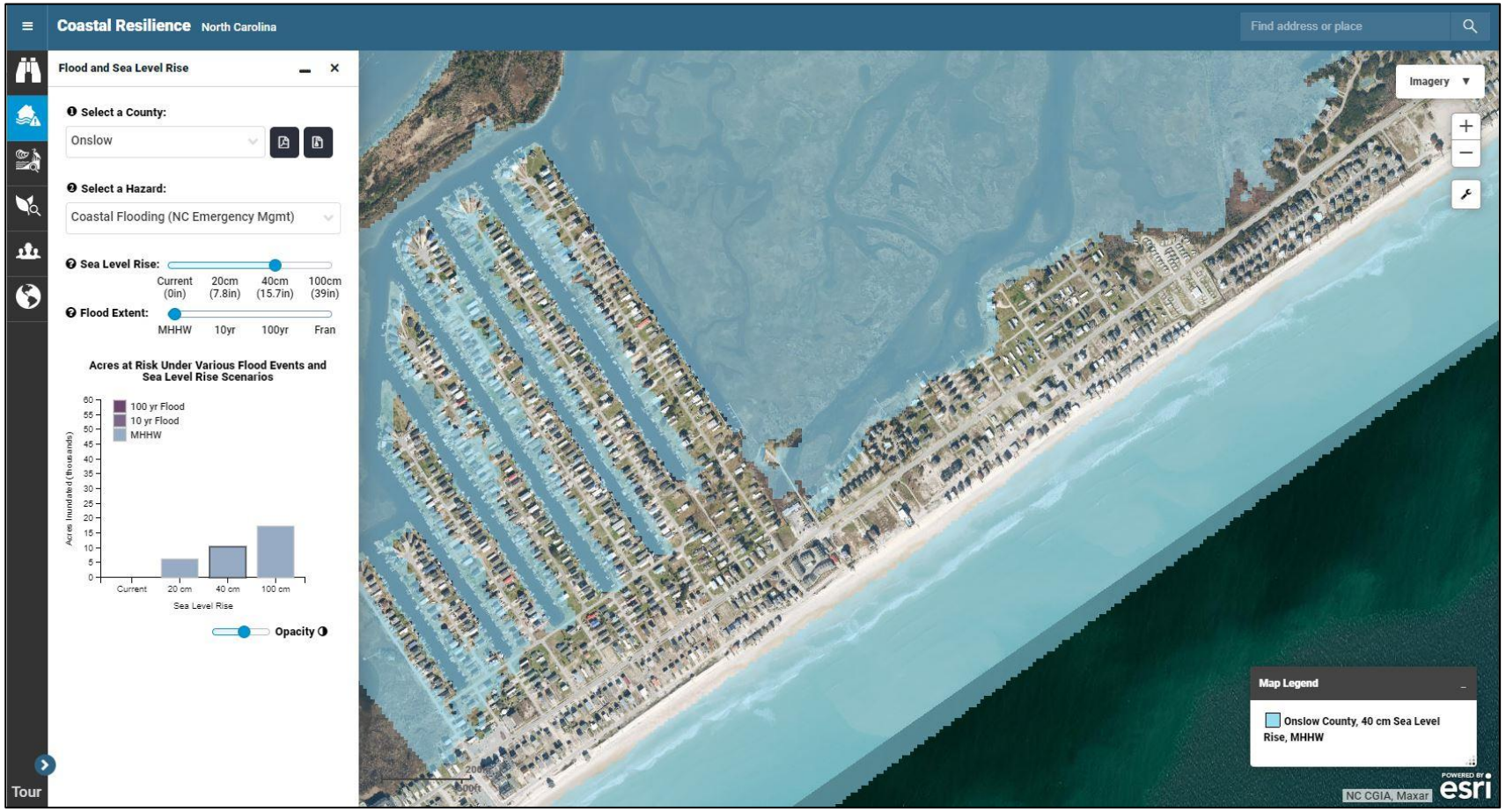


FIGURE A.16 – With additional sea level rise (between +1 to +1.5 feet by 2040-2060, shown in graphic), a 10-year storm event would cause significant sound side flooding along main evacuation routes and isolate entire residential communities, such as those in Surf City near the county line.

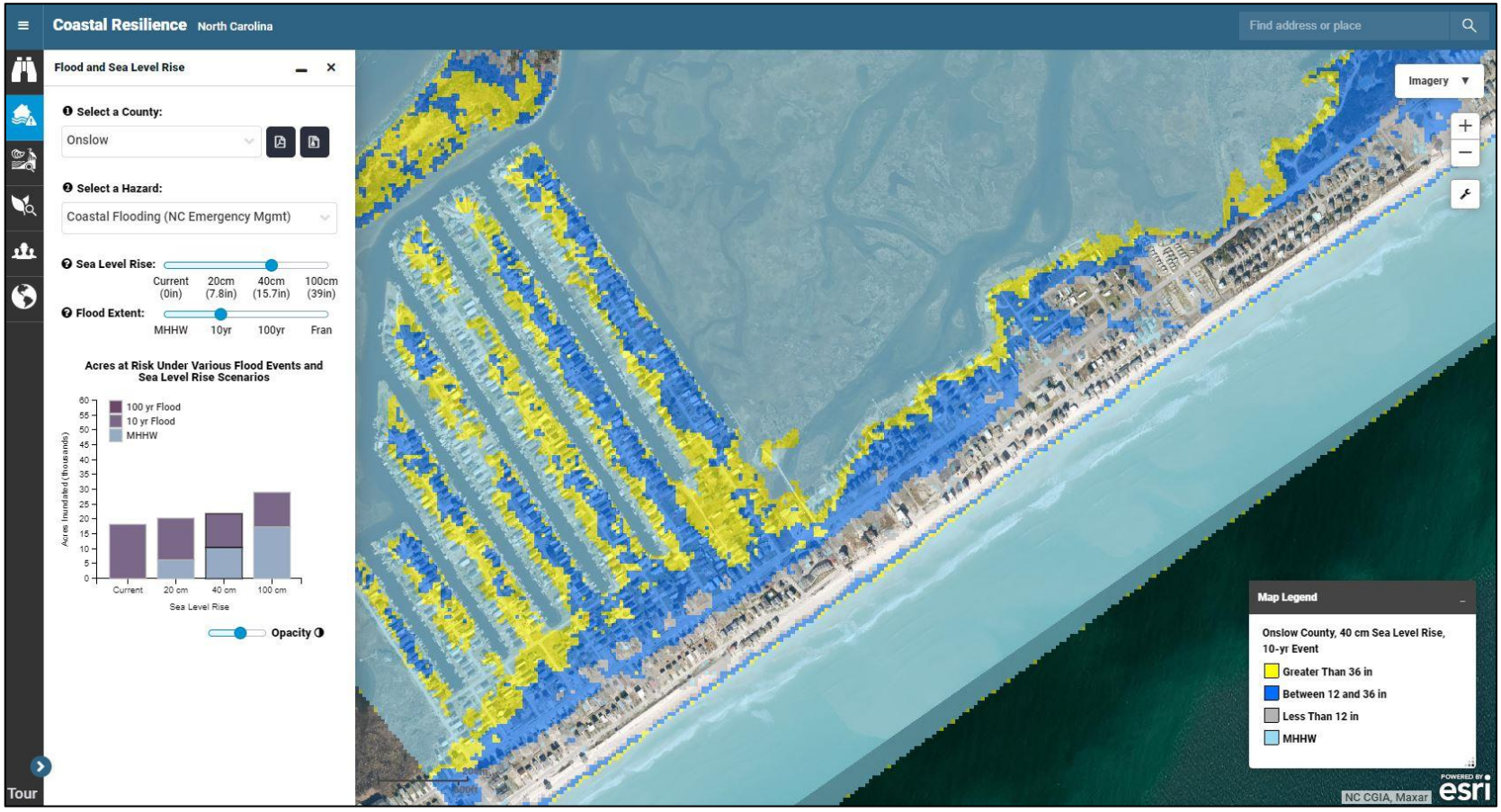
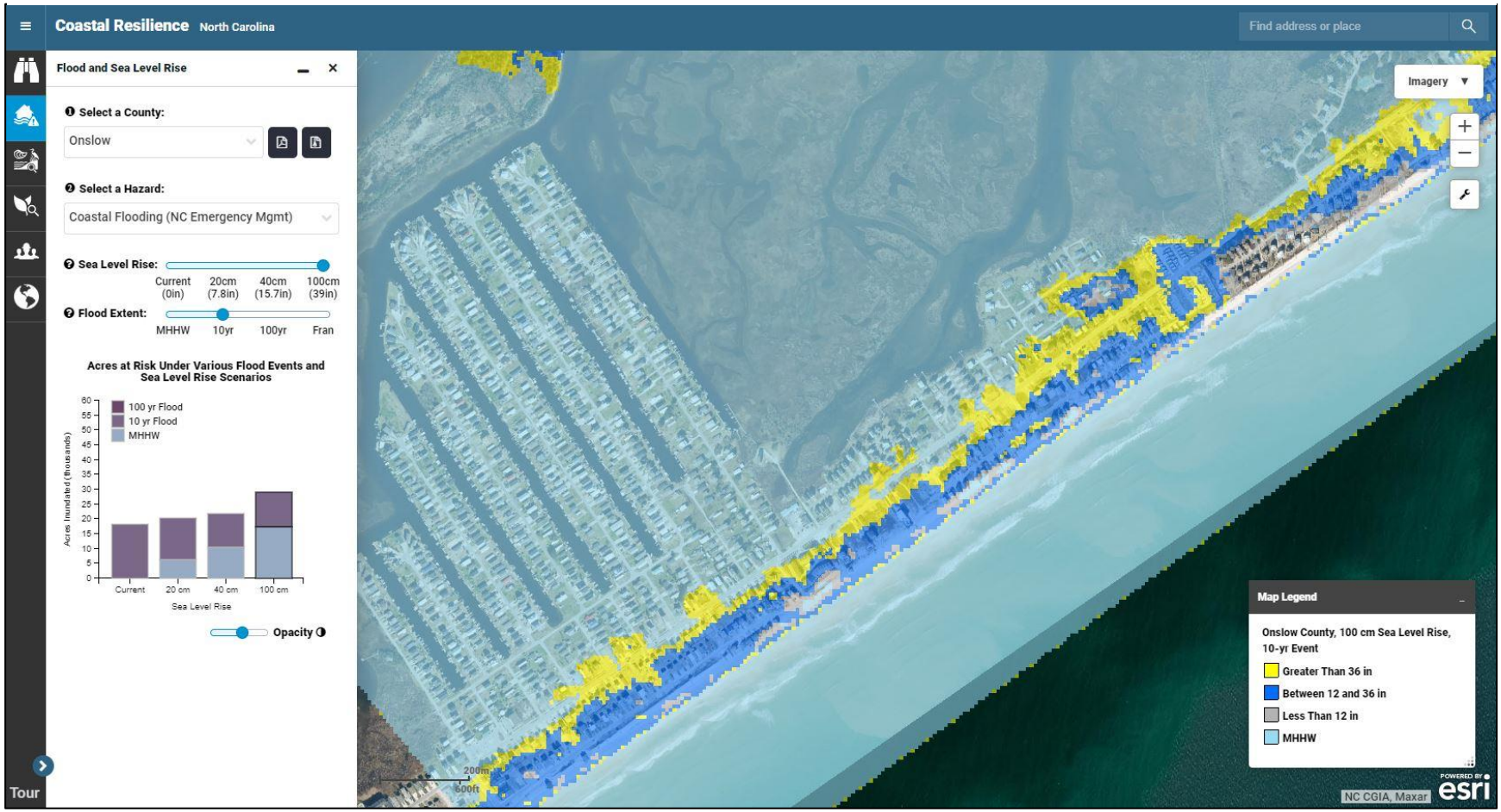


FIGURE A.17 – With additional sea level rise (+3 feet by 2090-2100, shown in graphic), a 10-year storm event would flood most of the barrier island up to 7 feet NAVD88, including portions behind frontal dunes that do not flood during the Present-Day 10-year storm event by more than 3 feet of inundation.



3. Flood Exposure of Critical Infrastructure

FIGURE A.18 – EXPOSURE TO INCREASING SOUND SIDE NUISANCE TIDAL FLOODING WITH SEA LEVEL RISE (+1, +2, +3 FEET SLR) NEAR ROCKY MOUNT AVE IN TOPSAIL BEACH

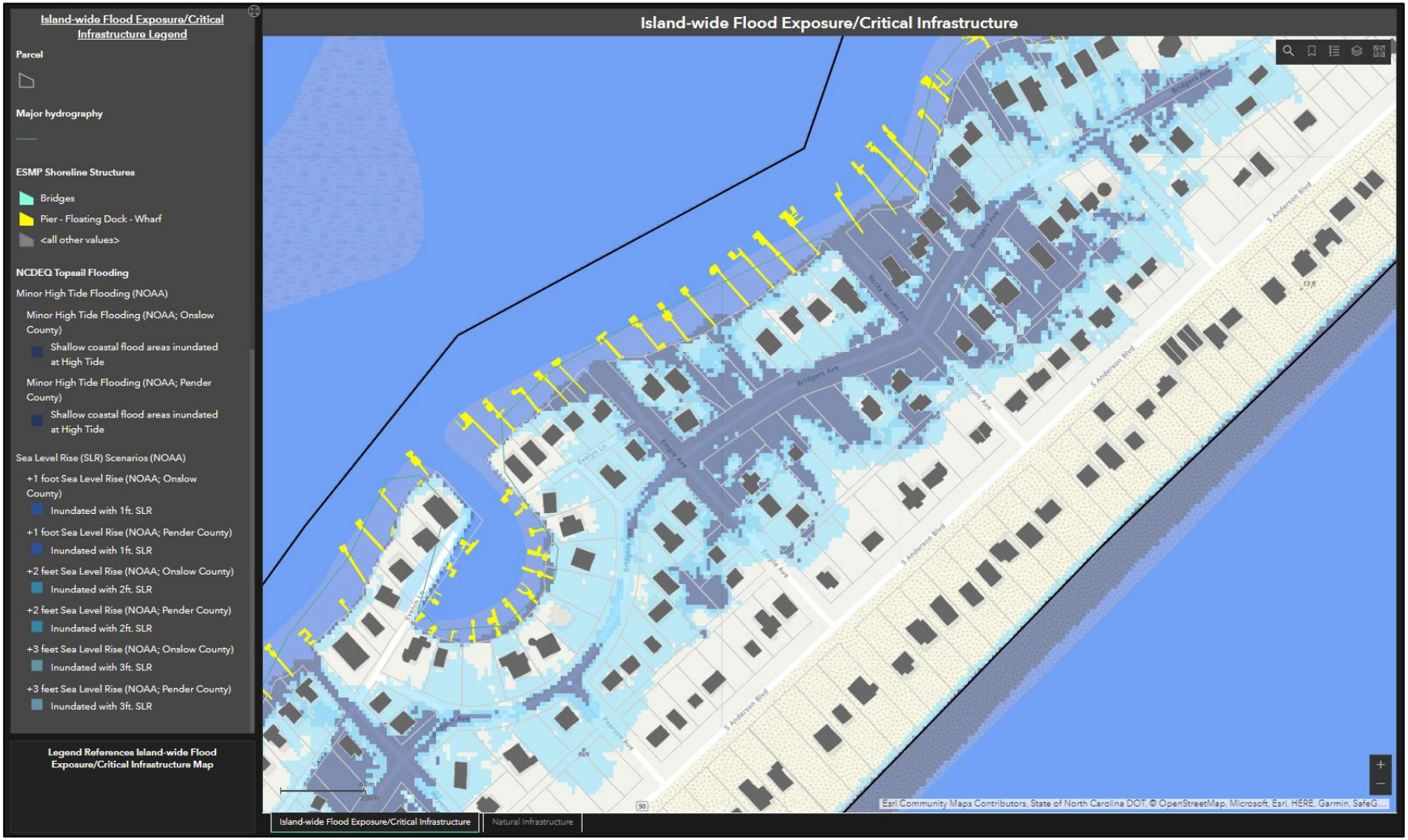


FIGURE A.19 – EXPOSURE TO INCREASING SOUND SIDE NUISANCE TIDAL FLOODING WITH SEA LEVEL RISE (+1, +2 FEET SLR) NEAR NEW RIVER INLET IN NORTH TOPSAIL BEACH

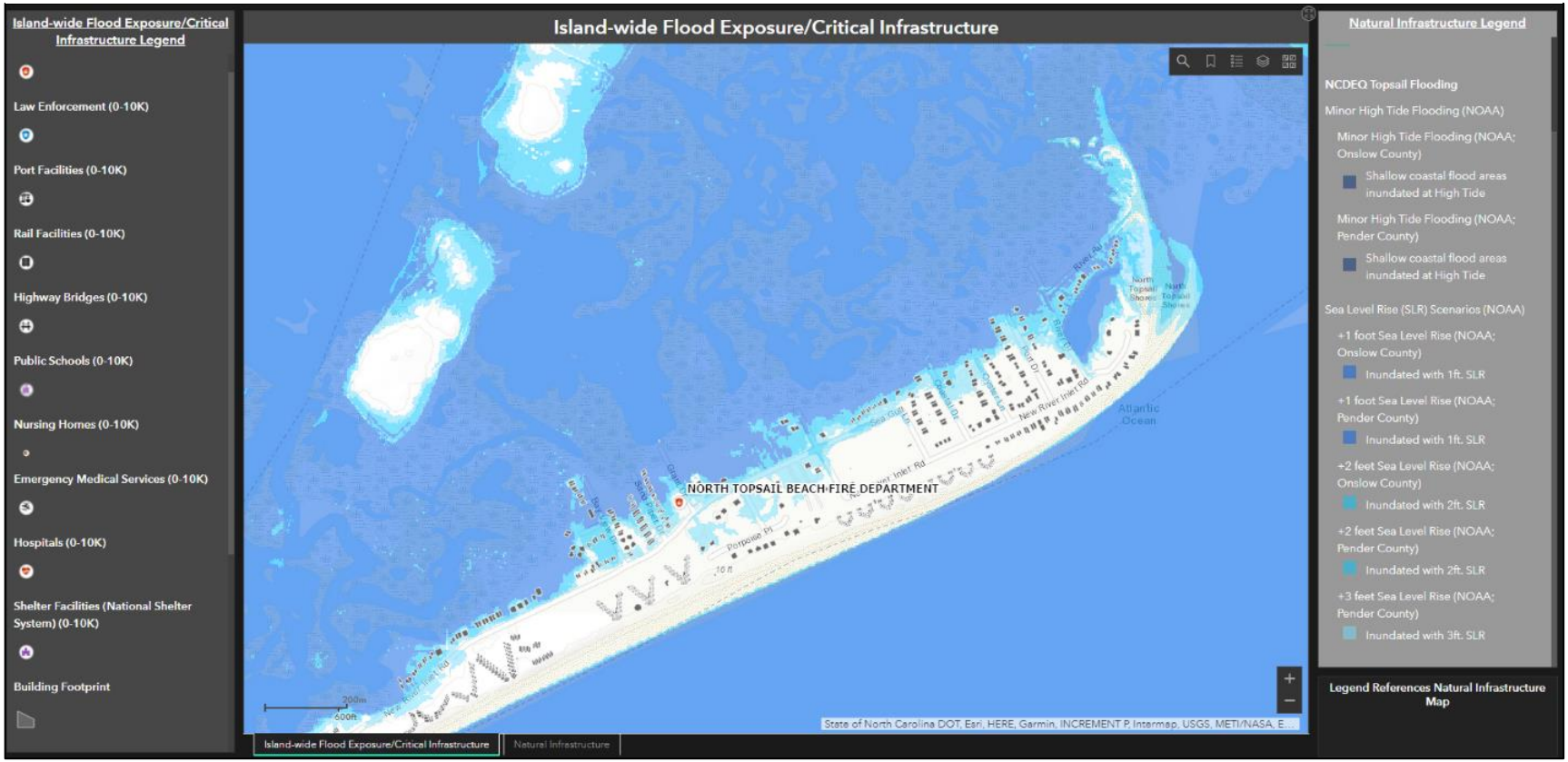
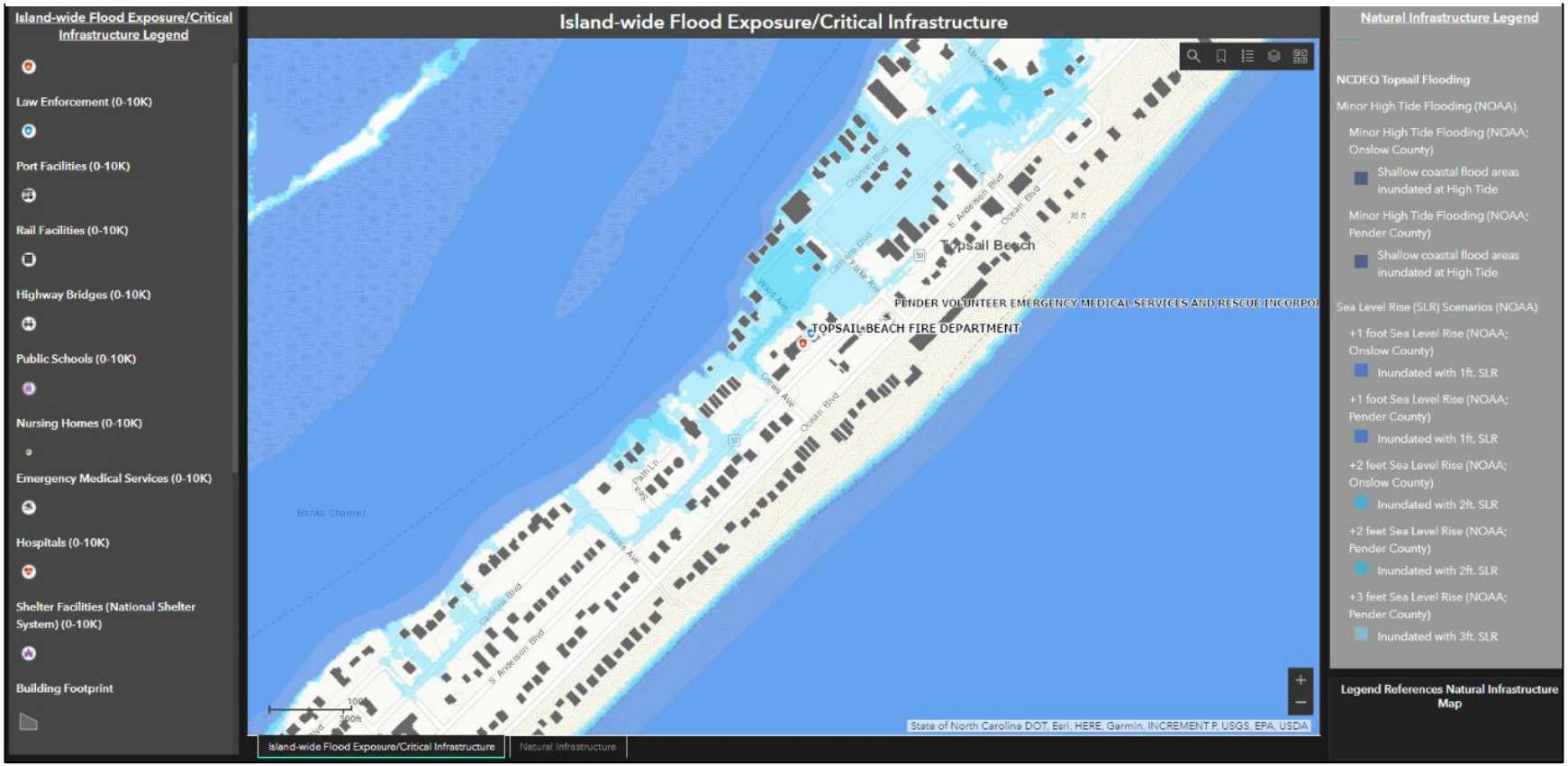


FIGURE A.20 – EXPOSURE TO INCREASING SOUND SIDE NUISANCE TIDAL FLOODING WITH SEA LEVEL RISE (+1, +2 FEET SLR) NEAR WARD AVE. LIVING SHORELINE PILOT SITE IN TOPSAIL BEACH



4. Coastal Erosion and Accretion Rates

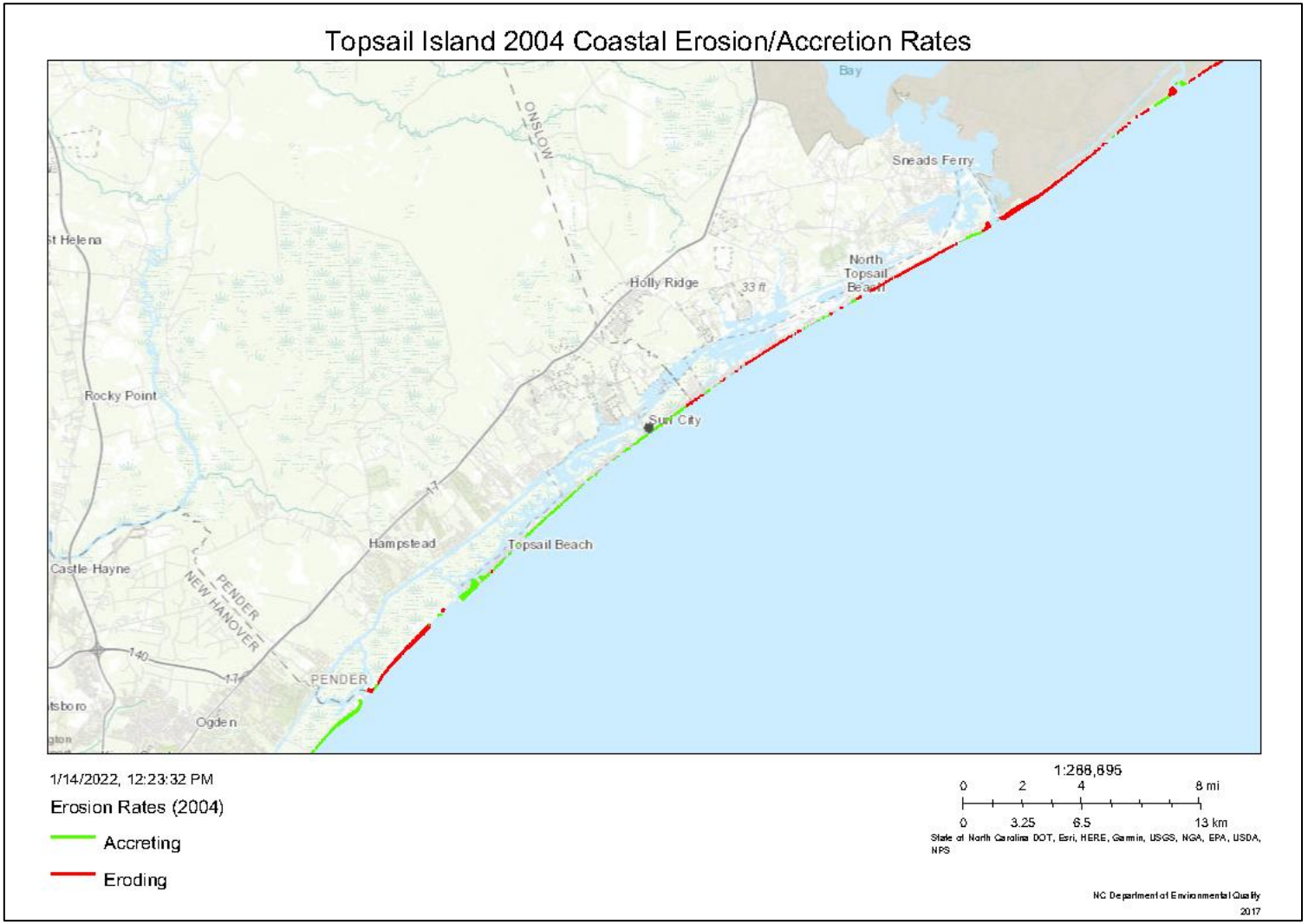


FIGURE A.21 – HISTORIC (2004) COASTAL EROSION/ACCRETION RATES FOR TOPSAIL ISLAND (SOURCE: NC DCM WEB VIEWER - https://ncdenr.maps.arcgis.com/apps/webappviewer/index.html?id=f5e463a929ed430095e0a17ff803e156)

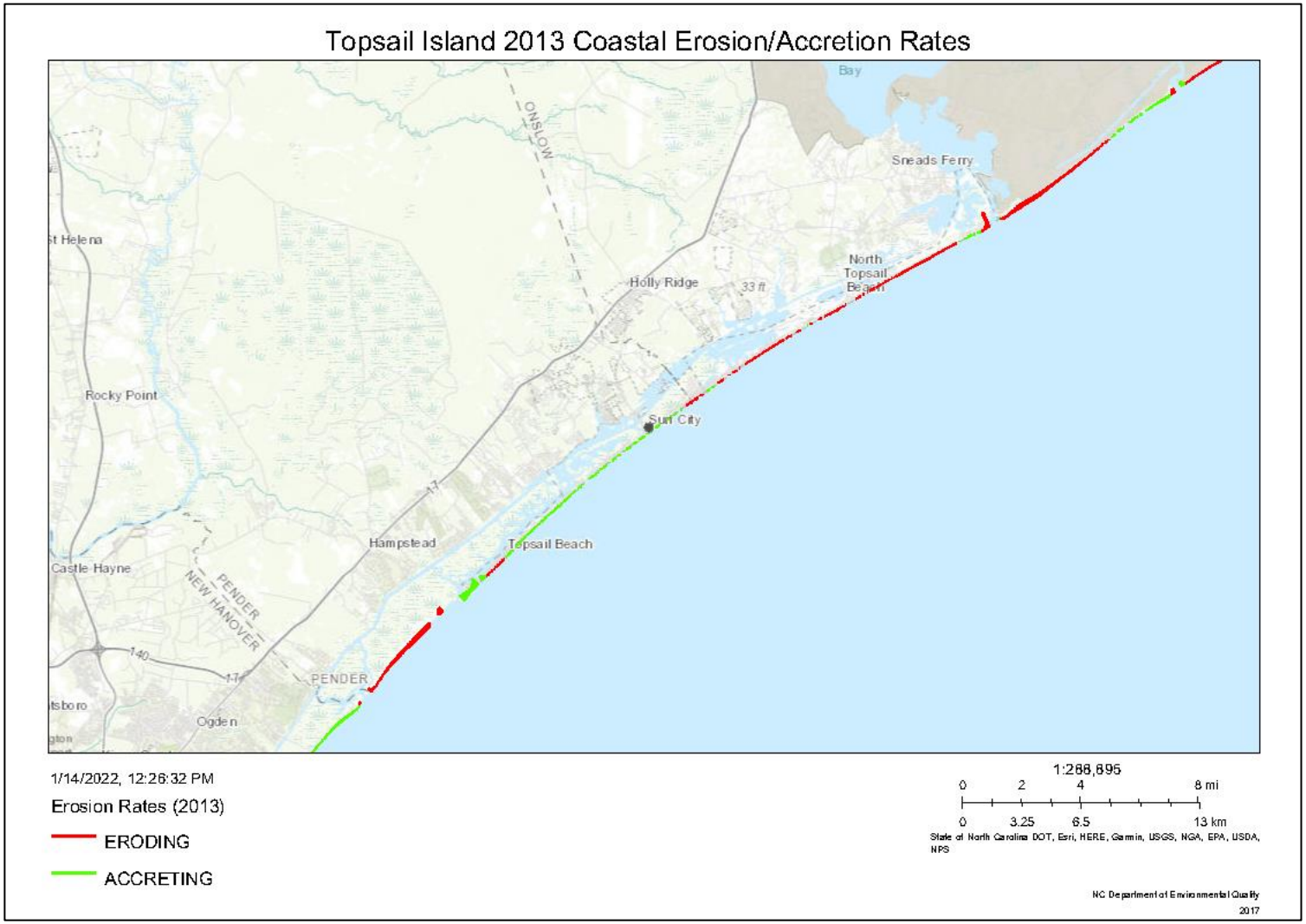


FIGURE A.22 – HISTORIC (2013) COASTAL EROSION/ACCRETION RATES FOR TOPSAIL ISLAND (SOURCE: NC DCM WEB VIEWER - https://ncdenr.maps.arcgis.com/apps/webappviewer/index.html?id=f5e463a929ed430095e0a17ff803e156)

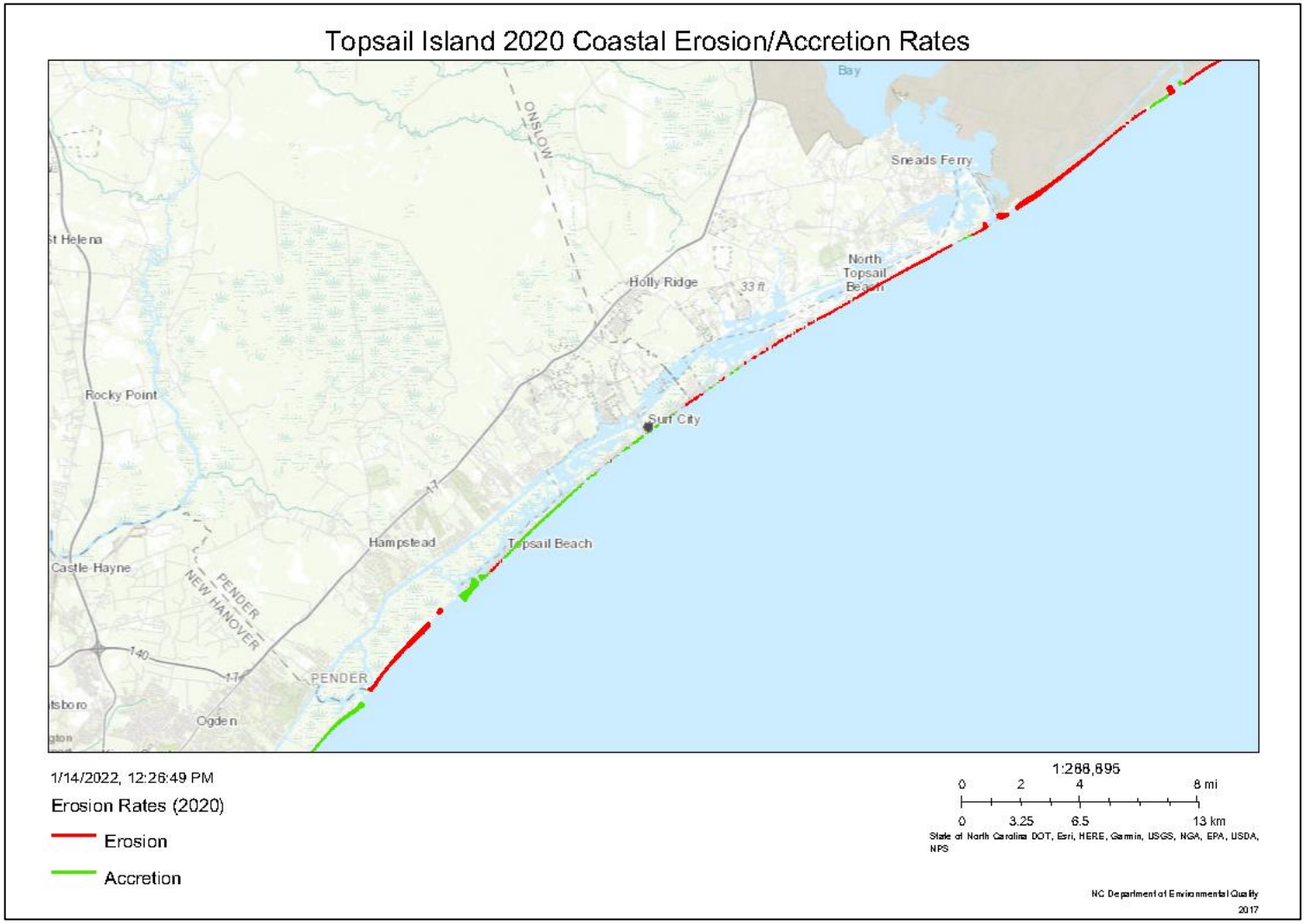


FIGURE A.23 – PRESENT DAY (2020) COASTAL EROSION/ACCRETION RATES FOR TOPSAIL ISLAND (SOURCE: NC DCM WEB VIEWER - https://ncdenr.maps.arcgis.com/apps/webappviewer/index.html?id=f5e463a929ed430095e0a17ff803e156)

FIGURE A.24 - CATEGORY 1 STORM SURGE AT NORTH TOPSAIL BEACH (SOURCE: NOAA/NATIONAL WEATHER SERVICE/NATIONAL HURRICANE CENTER'S NATIONAL STORM SURGE HAZARD MAPS - https://noaa.maps.arcgis.com/apps/MapSeries/index.html?appid=d9ed7904dbec441a9c4dd7b277935fad&entry=1)

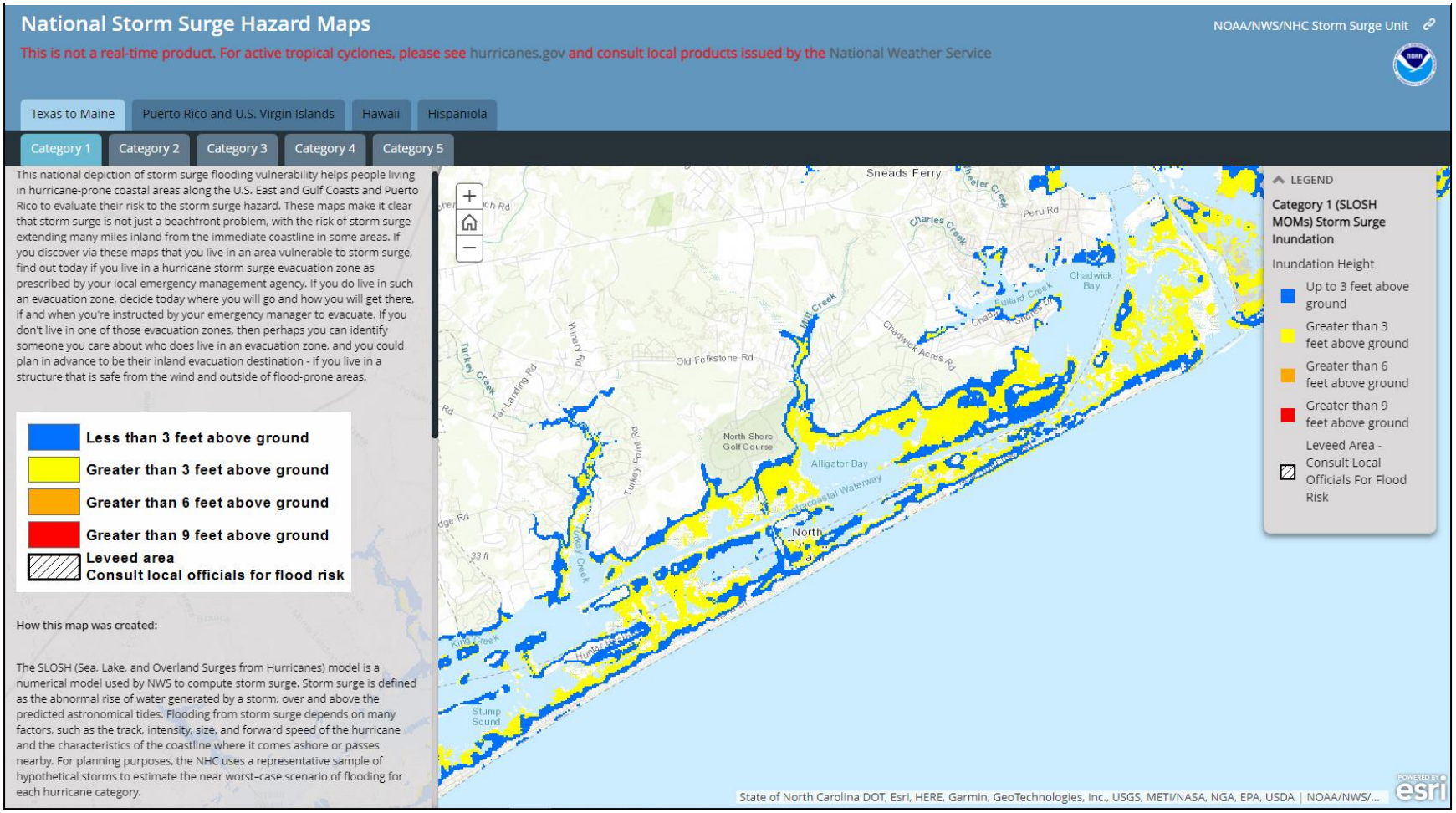


FIGURE A.25 - CATEGORY 2 STORM SURGE AT NORTH TOPSAIL BEACH (SOURCE: NOAA/NATIONAL WEATHER SERVICE/NATIONAL HURRICANE CENTER'S NATIONAL STORM SURGE HAZARD MAPS - https://noaa.maps.arcgis.com/apps/MapSeries/index.html?appid=d9ed7904dbec441a9c4dd7b277935fad&entry=1)

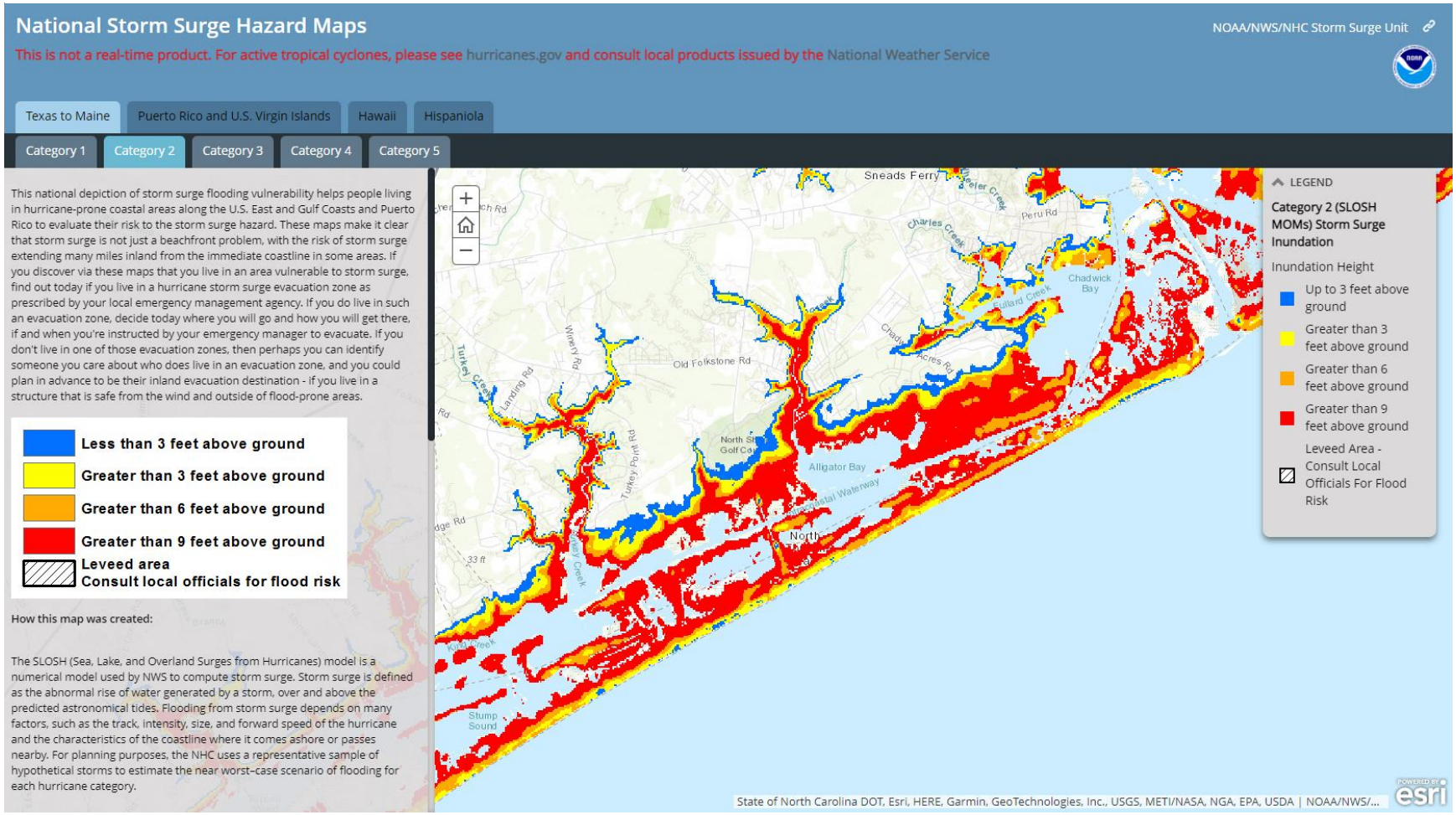


FIGURE A.26 - CATEGORY 3 STORM SURGE AT NORTH TOPSAIL BEACH (SOURCE: NOAA/NATIONAL WEATHER SERVICE/NATIONAL HURRICANE CENTER'S NATIONAL STORM SURGE HAZARD MAPS - https://noaa.maps.arcgis.com/apps/MapSeries/index.html?appid=d9ed7904dbec441a9c4dd7b277935fad&entry=1)

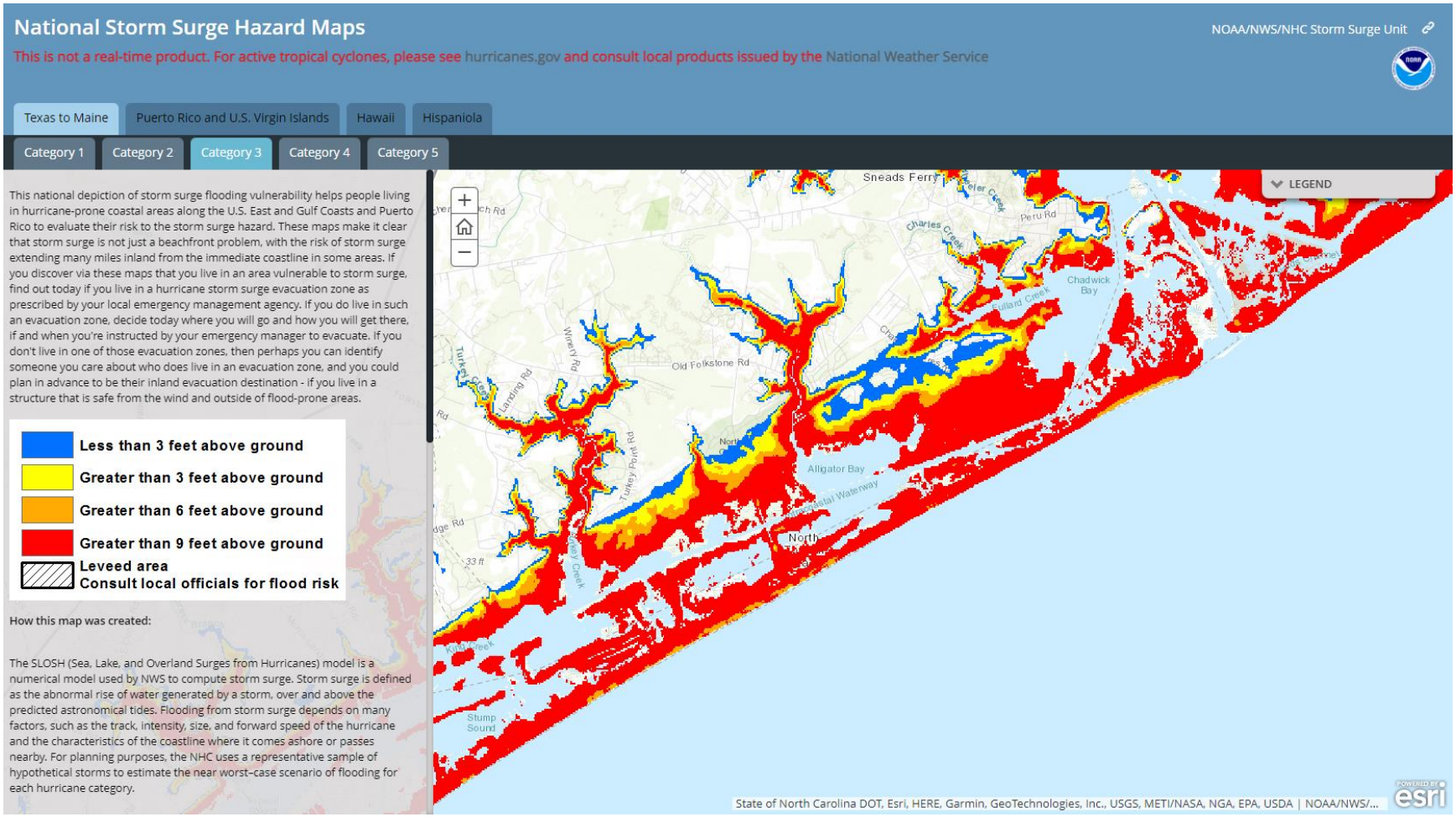


FIGURE A.27 - CATEGORY 4 STORM SURGE AT NORTH TOPSAIL BEACH (SOURCE: NOAA/NATIONAL WEATHER SERVICE/NATIONAL HURRICANE CENTER'S NATIONAL STORM SURGE HAZARD MAPS - https://noaa.maps.arcgis.com/apps/MapSeries/index.html?appid=d9ed7904dbec441a9c4dd7b277935fad&entry=1)

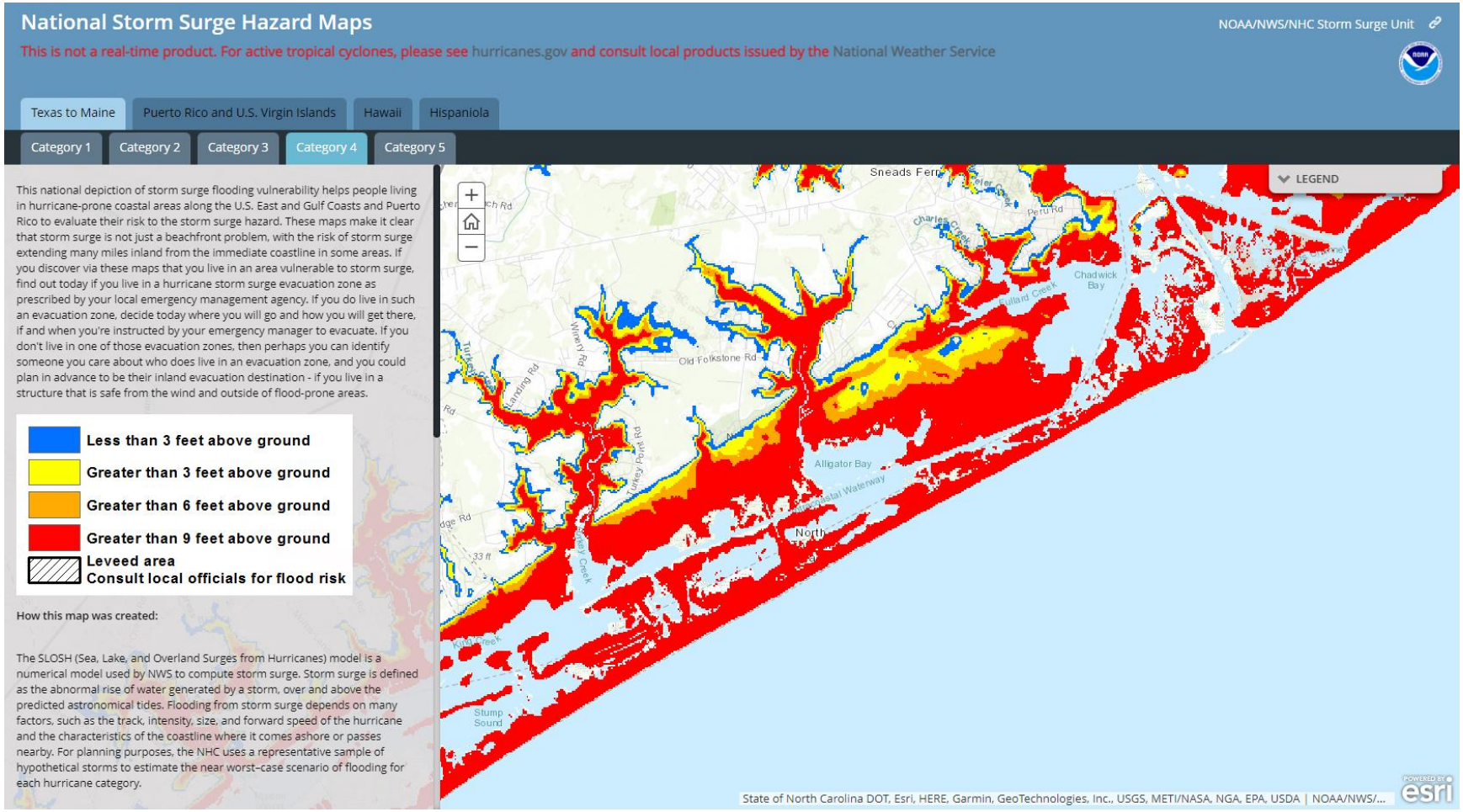


FIGURE A.28 - CATEGORY 5 STORM SURGE AT NORTH TOPSAIL BEACH (SOURCE: NOAA/NATIONAL WEATHER SERVICE/NATIONAL HURRICANE CENTER'S NATIONAL STORM SURGE HAZARD MAPS - https://noaa.maps.arcgis.com/apps/MapSeries/index.html?appid=d9ed7904dbec441a9c4dd7b277935fad&entry=1)

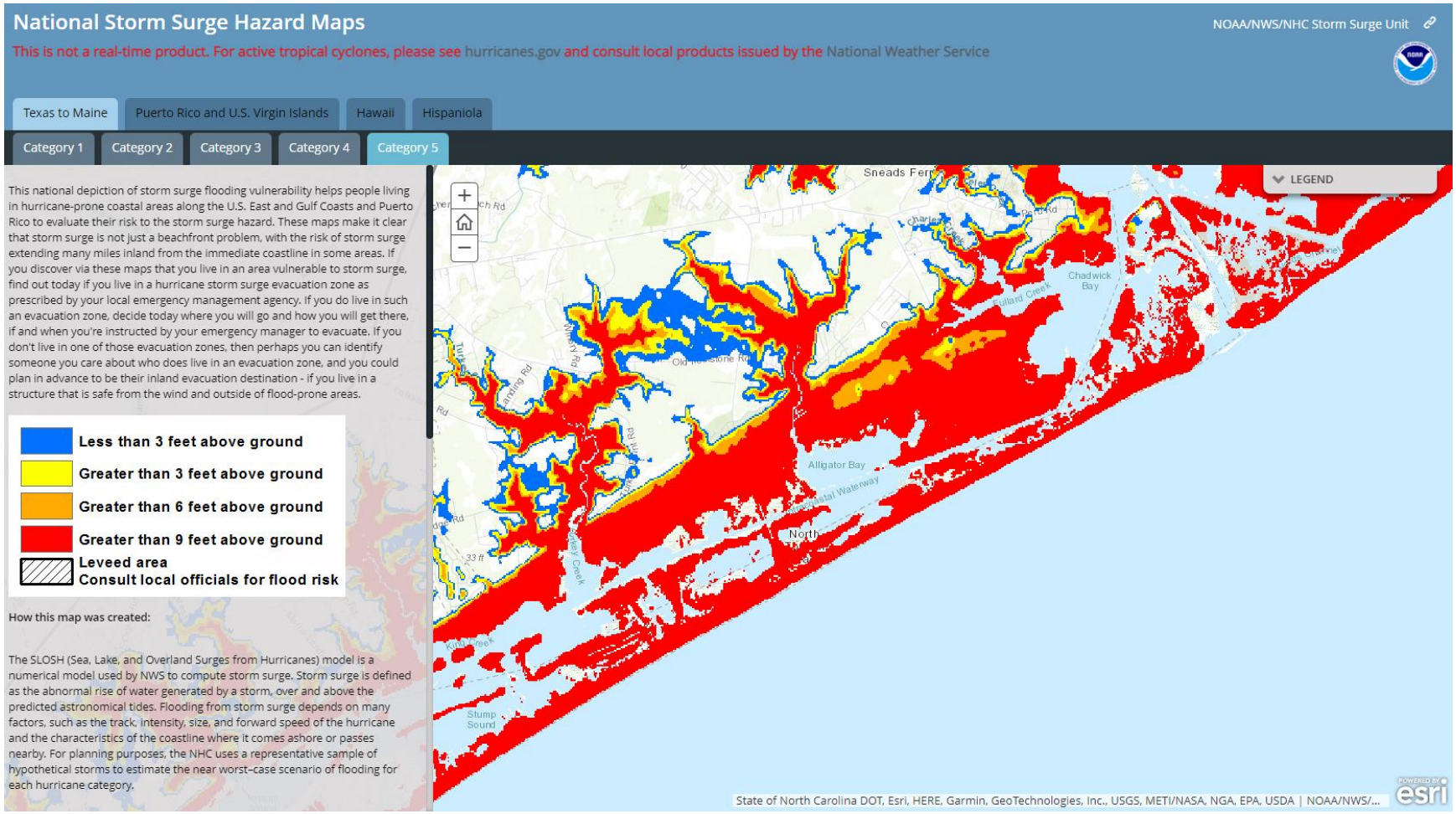


FIGURE A.29 - CATEGORY 1 STORM SURGE AT SURF CITY AND TOPSAIL BEACH (SOURCE: NOAA/NATIONAL WEATHER SERVICE/NATIONAL HURRICANE CENTER'S NATIONAL STORM SURGE HAZARD MAPS - https://noaa.maps.arcgis.com/apps/MapSeries/index.html?appid=d9ed7904dbec441a9c4dd7b277935fad&entry=1)

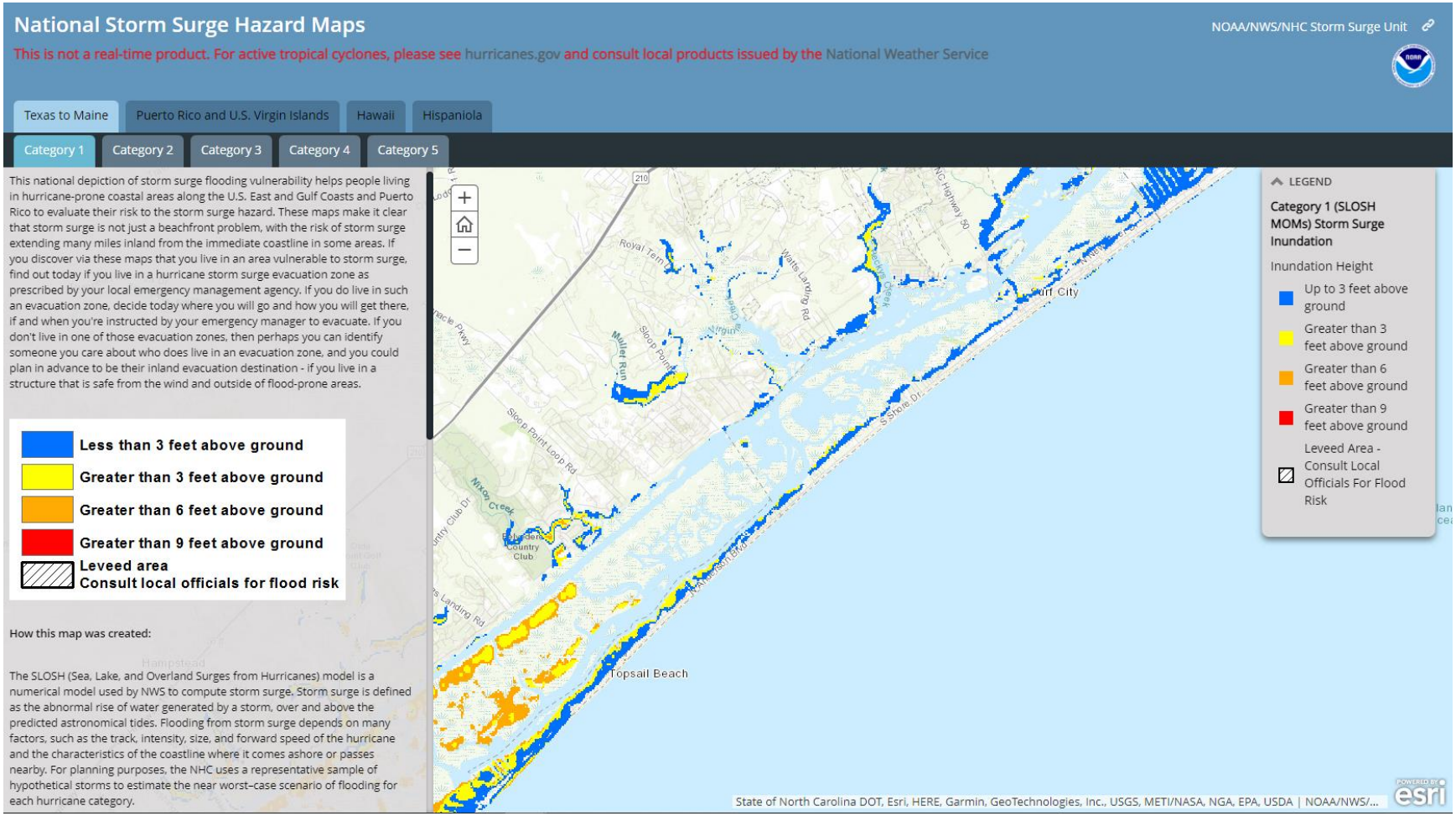


FIGURE A.30 - CATEGORY 2 STORM SURGE AT SURF CITY AND TOPSAIL BEACH (SOURCE: NOAA/NATIONAL WEATHER SERVICE/NATIONAL HURRICANE CENTER'S NATIONAL STORM SURGE HAZARD MAPS - https://noaa.maps.arcgis.com/apps/MapSeries/index.html?appid=d9ed7904dbec441a9c4dd7b277935fad&entry=1)

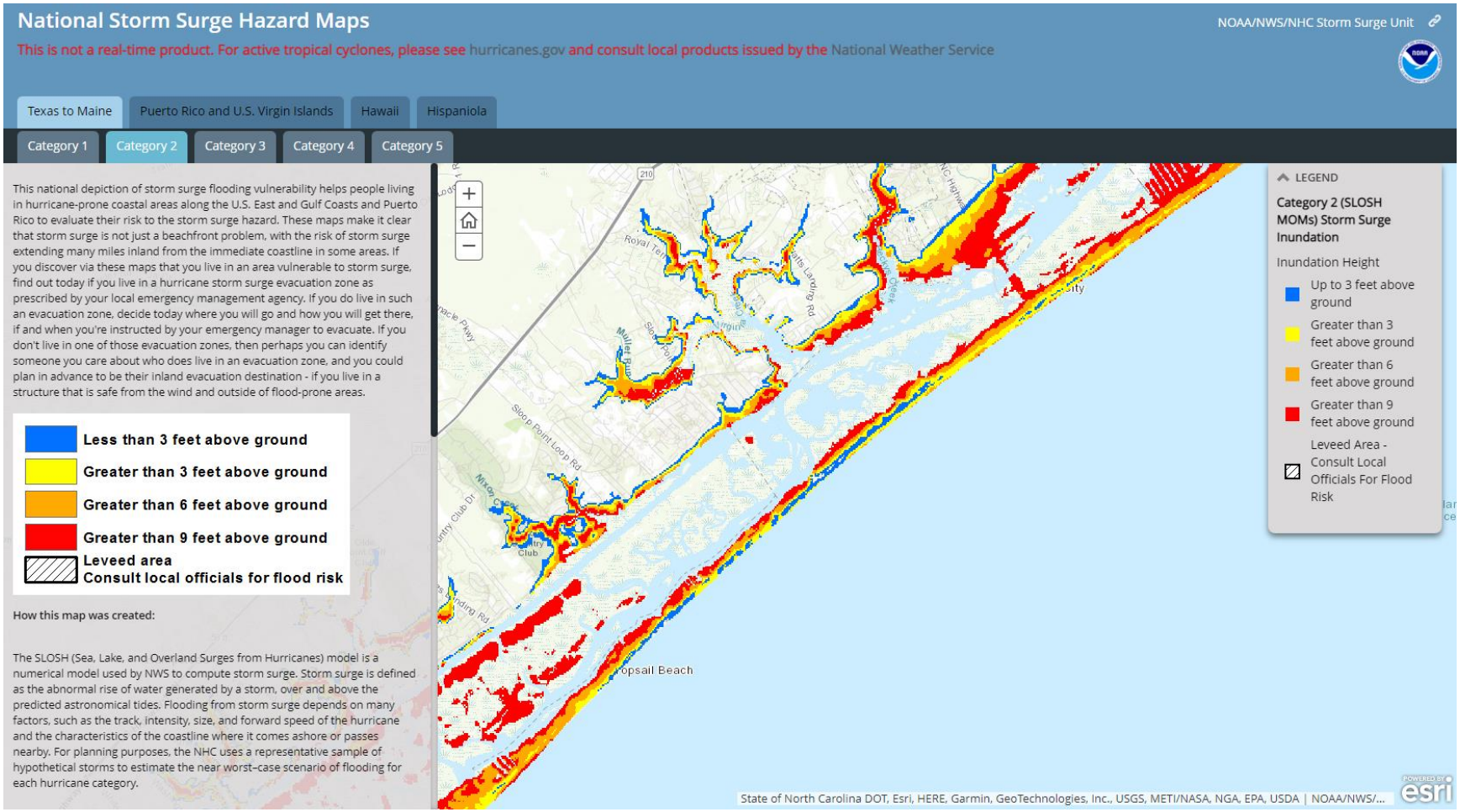


FIGURE A.31 - CATEGORY 3 STORM SURGE AT SURF CITY AND TOPSAIL BEACH (SOURCE: NOAA/NATIONAL WEATHER SERVICE/NATIONAL HURRICANE CENTER'S NATIONAL STORM SURGE HAZARD MAPS - https://noaa.maps.arcgis.com/apps/MapSeries/index.html?appid=d9ed7904dbec441a9c4dd7b277935fad&entry=1)

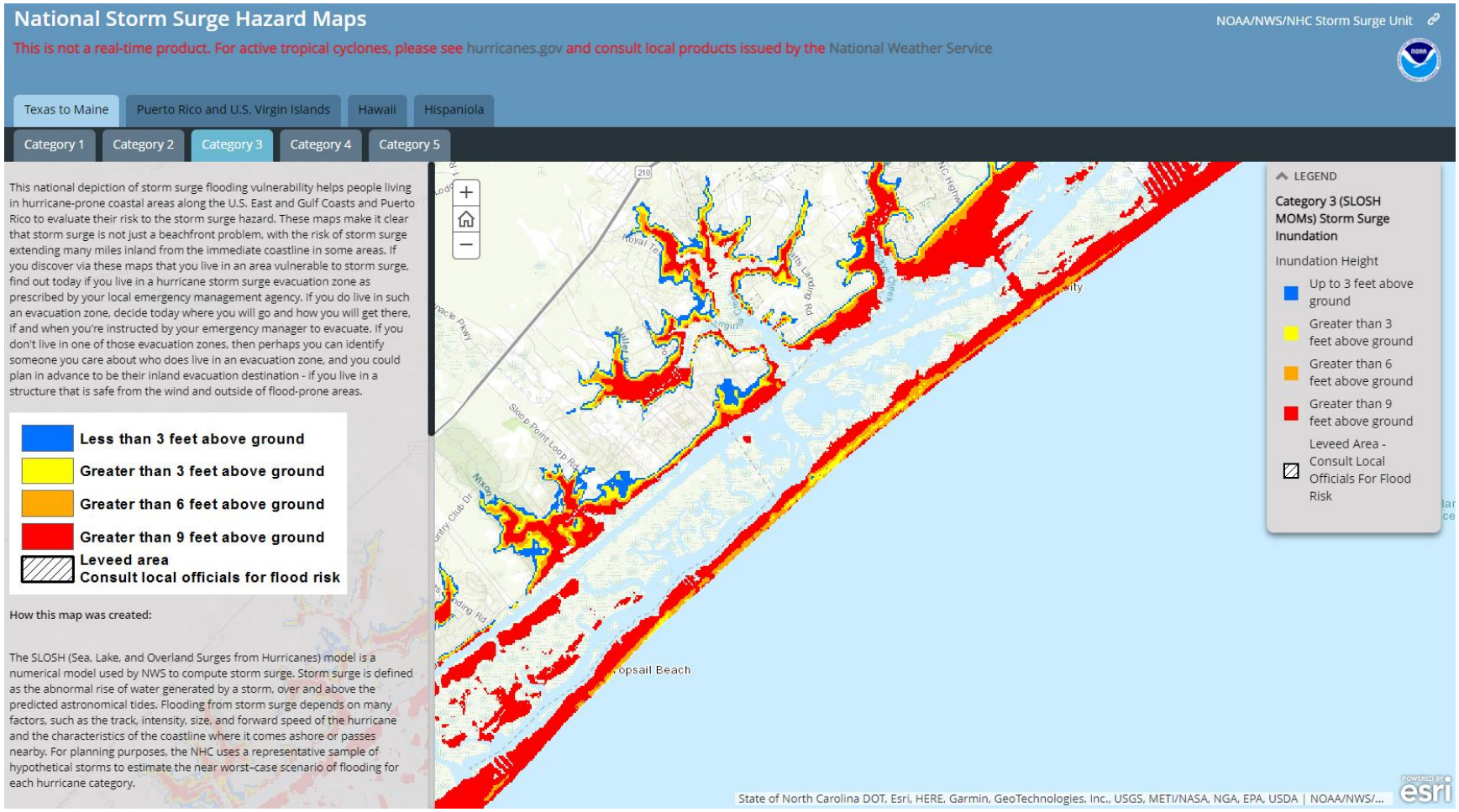


FIGURE A.32 - CATEGORY 4 STORM SURGE AT SURF CITY AND TOPSAIL BEACH (SOURCE: NOAA/NATIONAL WEATHER SERVICE/NATIONAL HURRICANE CENTER'S NATIONAL STORM SURGE HAZARD MAPS - https://noaa.maps.arcgis.com/apps/MapSeries/index.html?appid=d9ed7904dbec441a9c4dd7b277935fad&entry=1)

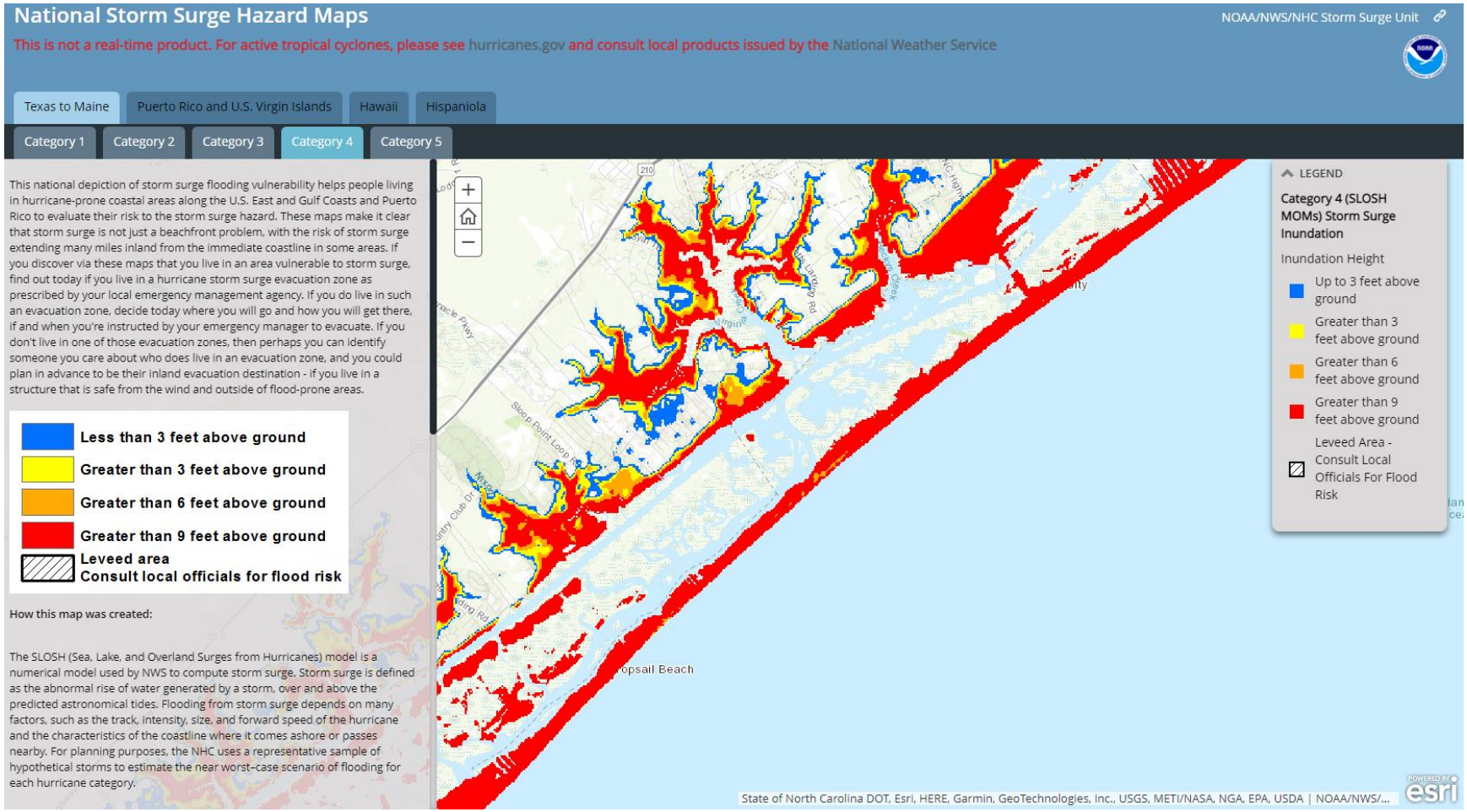
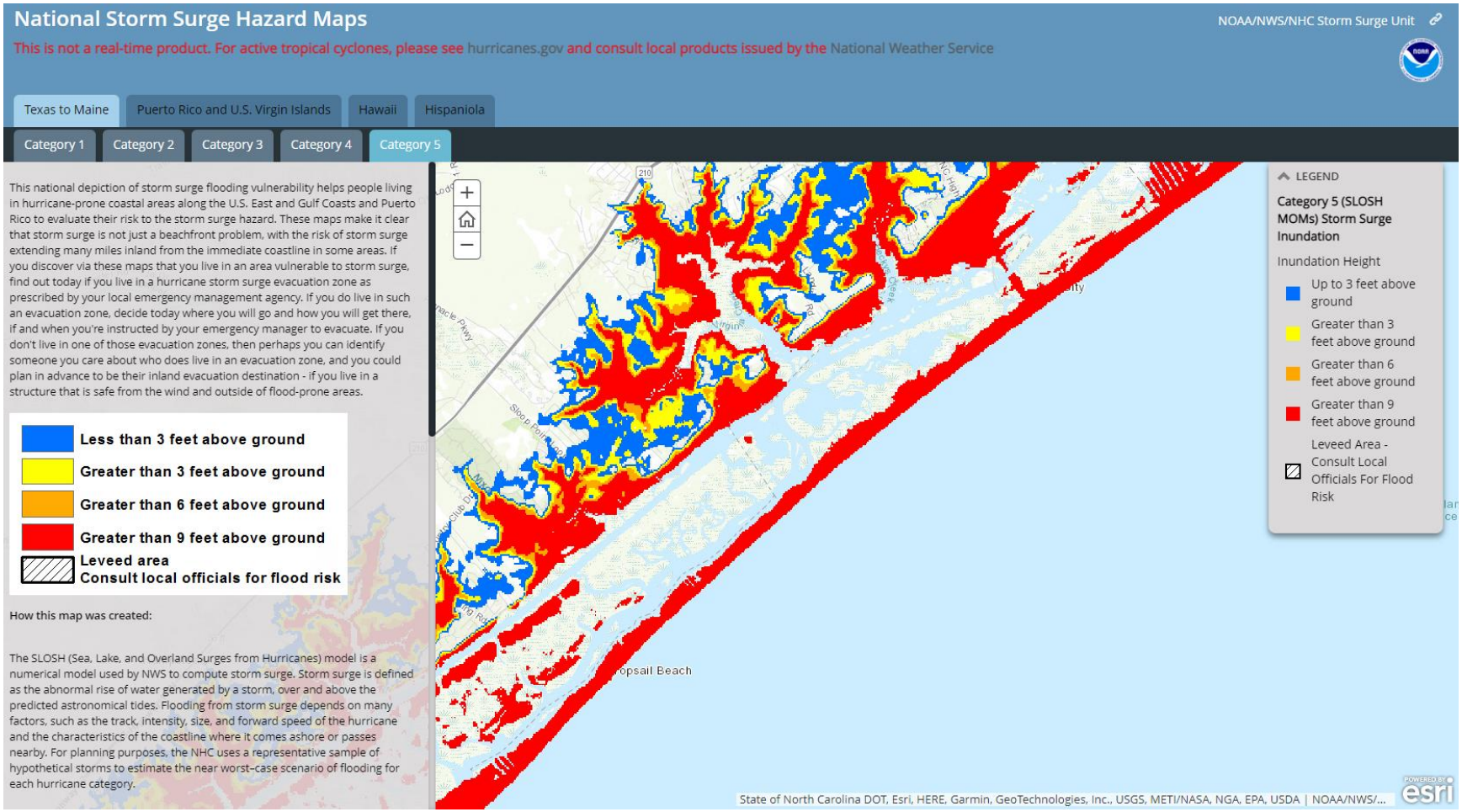


FIGURE A.33 - CATEGORY 5 STORM SURGE AT SURF CITY AND TOPSAIL BEACH (SOURCE: NOAA/NATIONAL WEATHER SERVICE/NATIONAL HURRICANE CENTER'S NATIONAL STORM SURGE HAZARD MAPS - https://noaa.maps.arcgis.com/apps/MapSeries/index.html?appid=d9ed7904dbec441a9c4dd7b277935fad&entry=1)



6. Flood Hazard Areas

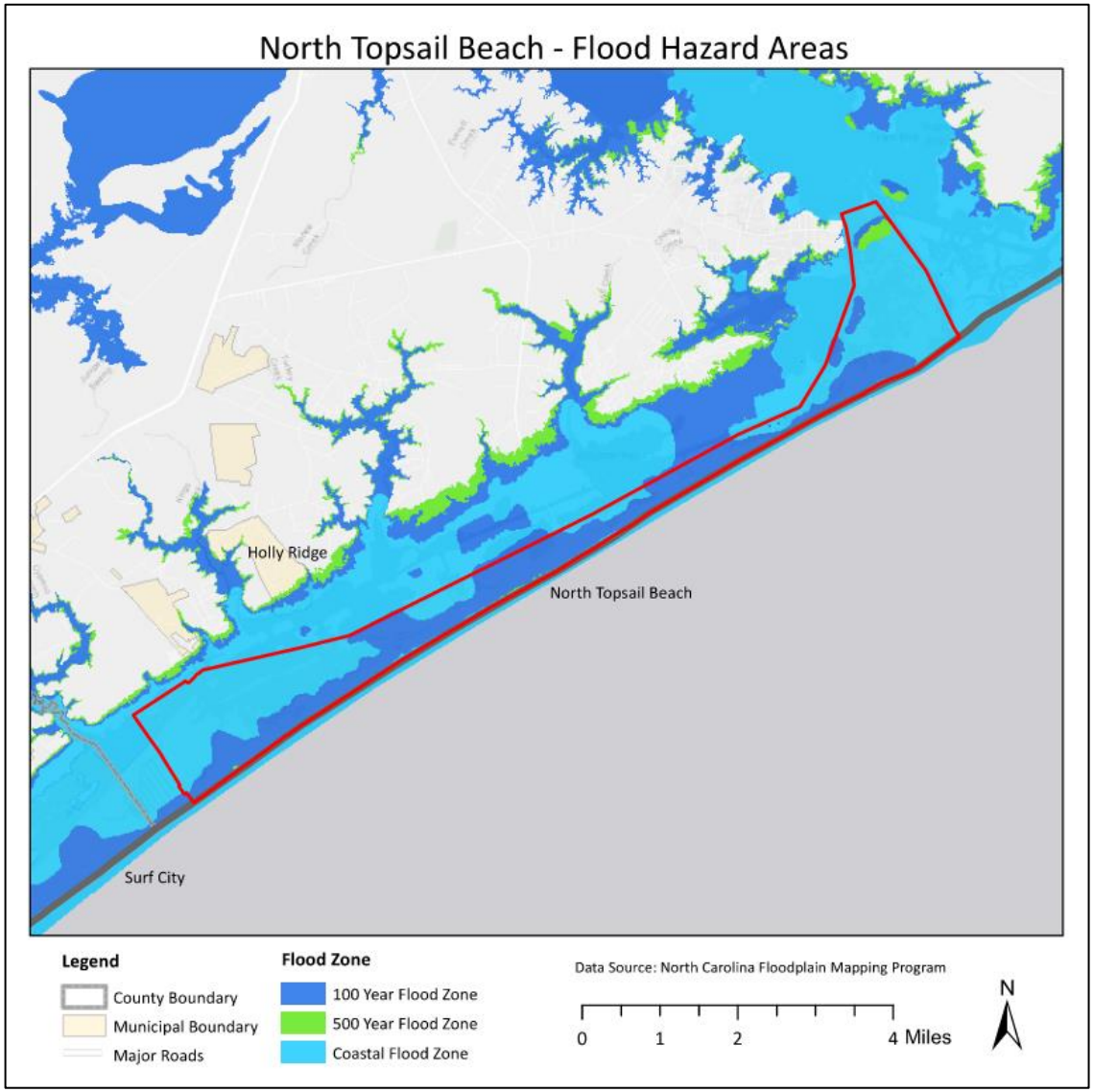


FIGURE A.34 – North Topsail Beach FEMA Flood Hazard Areas. Red borders denote Town Boundaries (source: 2021 Southeastern North Carolina Regional Hazard Mitigation Plan)

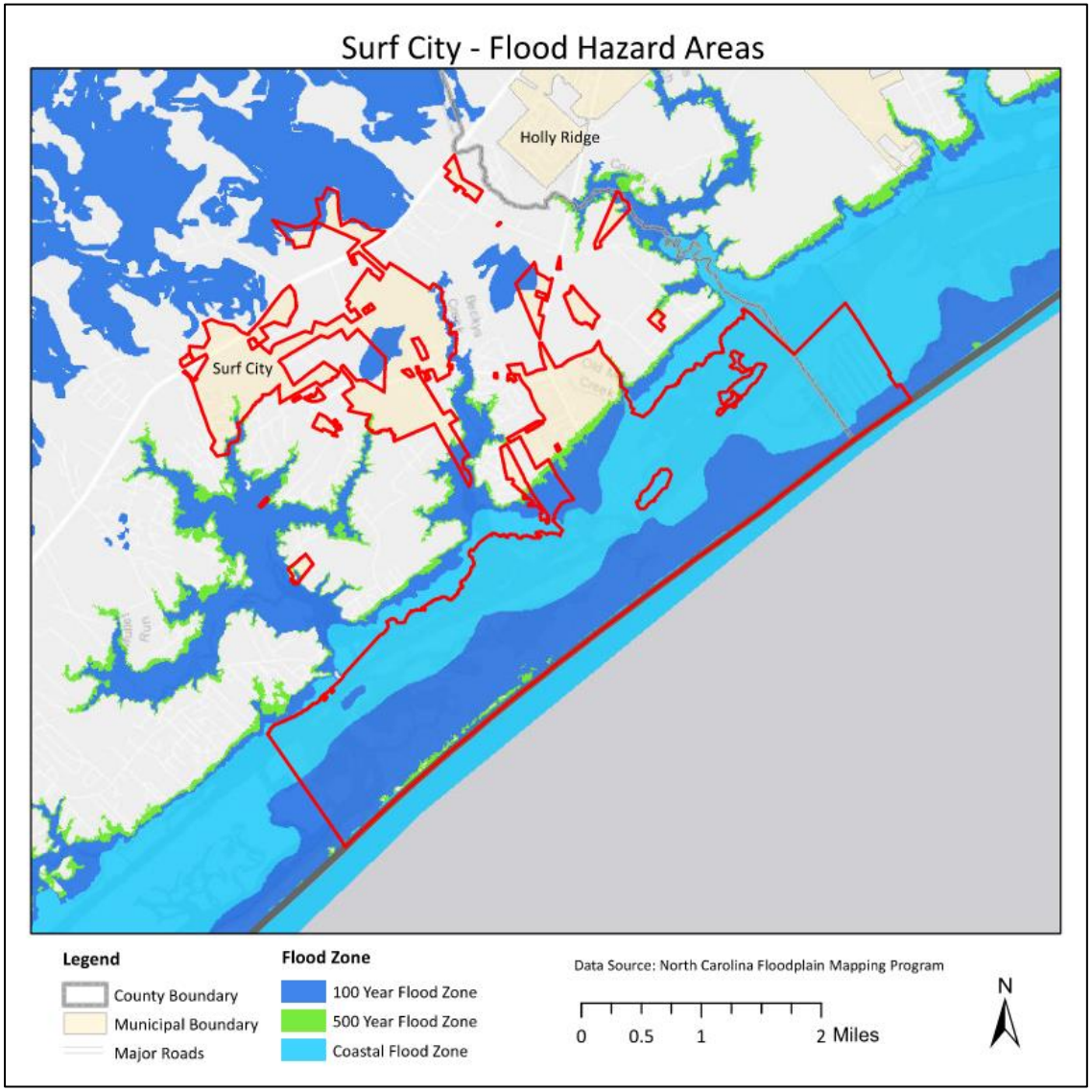


FIGURE A.35 – Surf City FEMA Flood Hazard Areas. Red borders denote Town Boundaries (source: 2021 Southeastern North Carolina Regional Hazard Mitigation Plan)

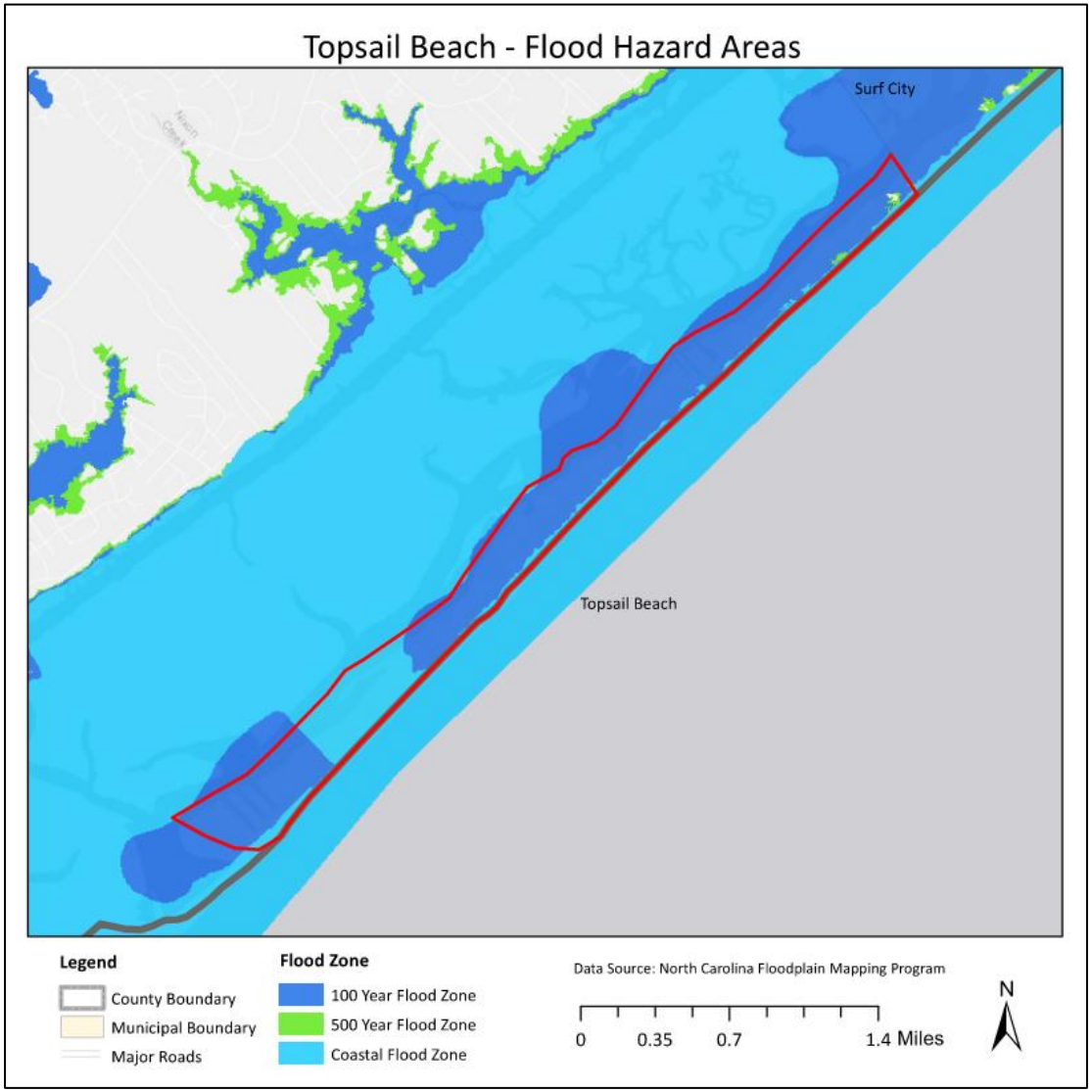


FIGURE A.36 – Topsail Beach FEMA Flood Hazard Areas. Red borders denote Town Boundaries (source: 2021 Southeastern North Carolina Regional Hazard Mitigation Plan)

7. Vulnerability of Coastal Ecosystems and Marsh Migration with Sea Level Rise

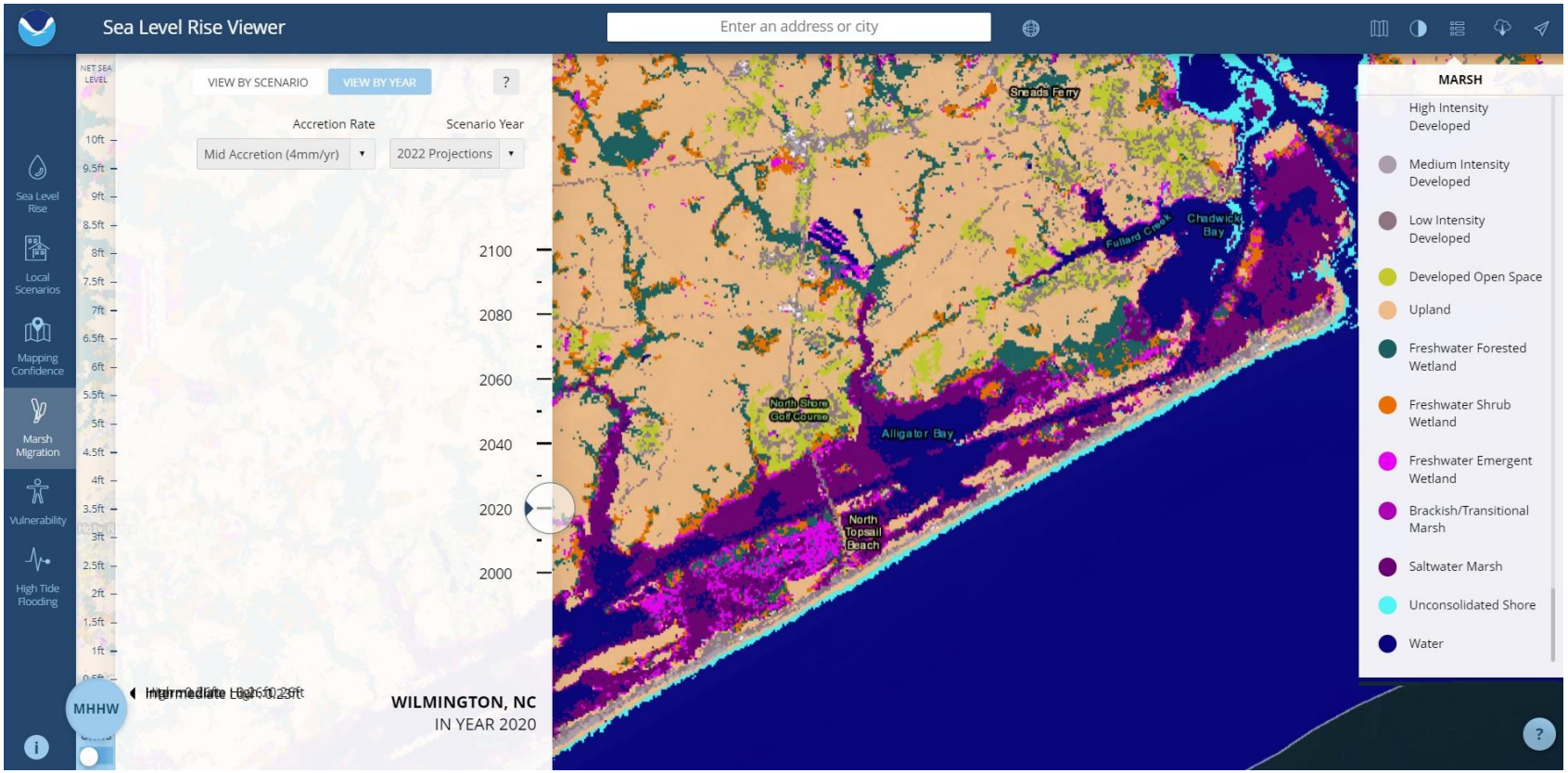


FIGURE A.37 – North Topsail Beach present-day (2020) coastal marsh and ecosystem conditions (source: NOAA Sea Level Rise Viewer, https://bit.ly/398EjLe).

At present, sound side areas in North Topsail Beach have a mix of Fresh Forested Wetlands, Freshwater Shrub Wetlands, Freshwater Emergent Wetlands, Brackish/Traditional Marsh, and Saltwater Marsh.

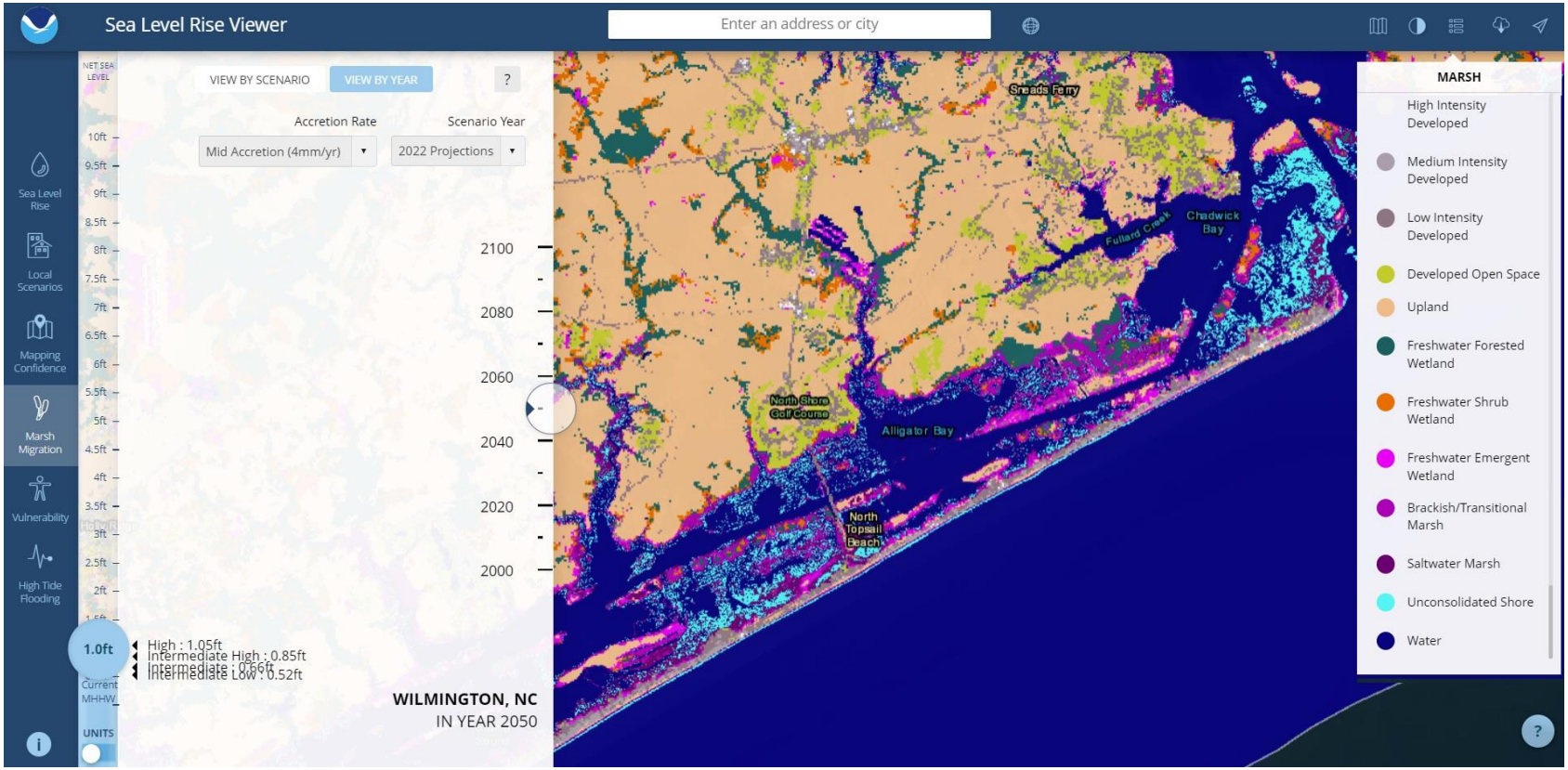


FIGURE A.38 – North Topsail Beach projected coastal marsh migration and ecosystem change by ~2050 with +1 foot sea level rise (source: NOAA Sea Level Rise Viewer, https://bit.ly/398EjLe).

By 2050, most of the Freshwater Emergent Wetlands, particularly those west of State Highway 210, are projected to transition to Brackish/Transitional Marsh and Saltwater Marsh, Unconsolidated Shore, and Open Water. Around this timeframe, a transition of larger Saltwater marsh areas within Alligator Bay and Chadwick Bay near the Inlet to “unconsolidated shore” is also projected to occur.

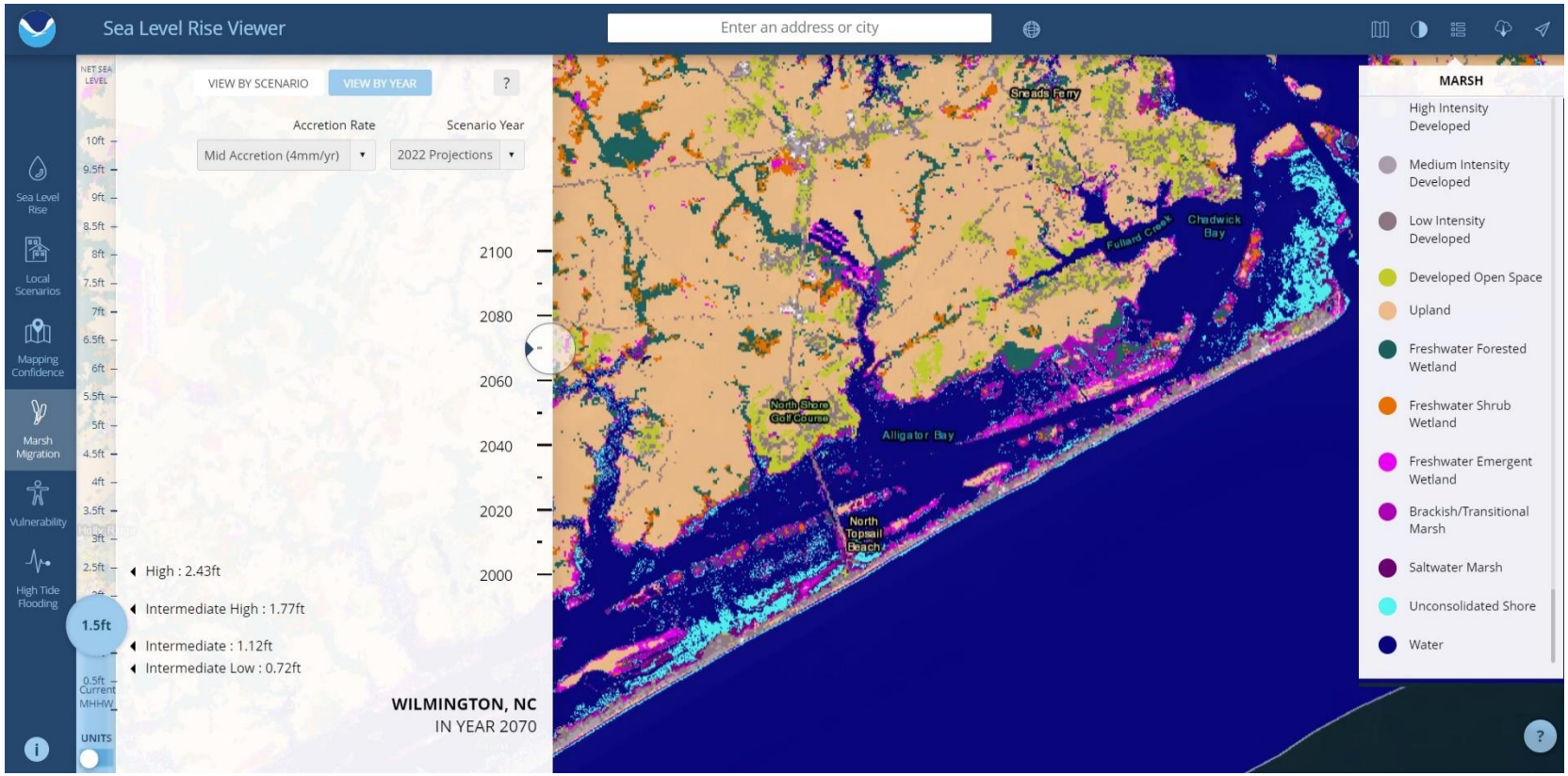


FIGURE A.39 - North Topsail Beach projected coastal marsh migration and ecosystem change by ~2070 with +1.5 feet sea level rise (source: NOAA Sea Level Rise Viewer, https://bit.ly/398EjLe).

By 2070, projections of 1.5 to 2 feet of sea level rise result in nearly full loss of Fresh Forested Wetland and Freshwater Shrub Wetland areas. This is accompanied by a major decrease in Freshwater Emergent Wetland and Saltwater Marsh area to Open Water.

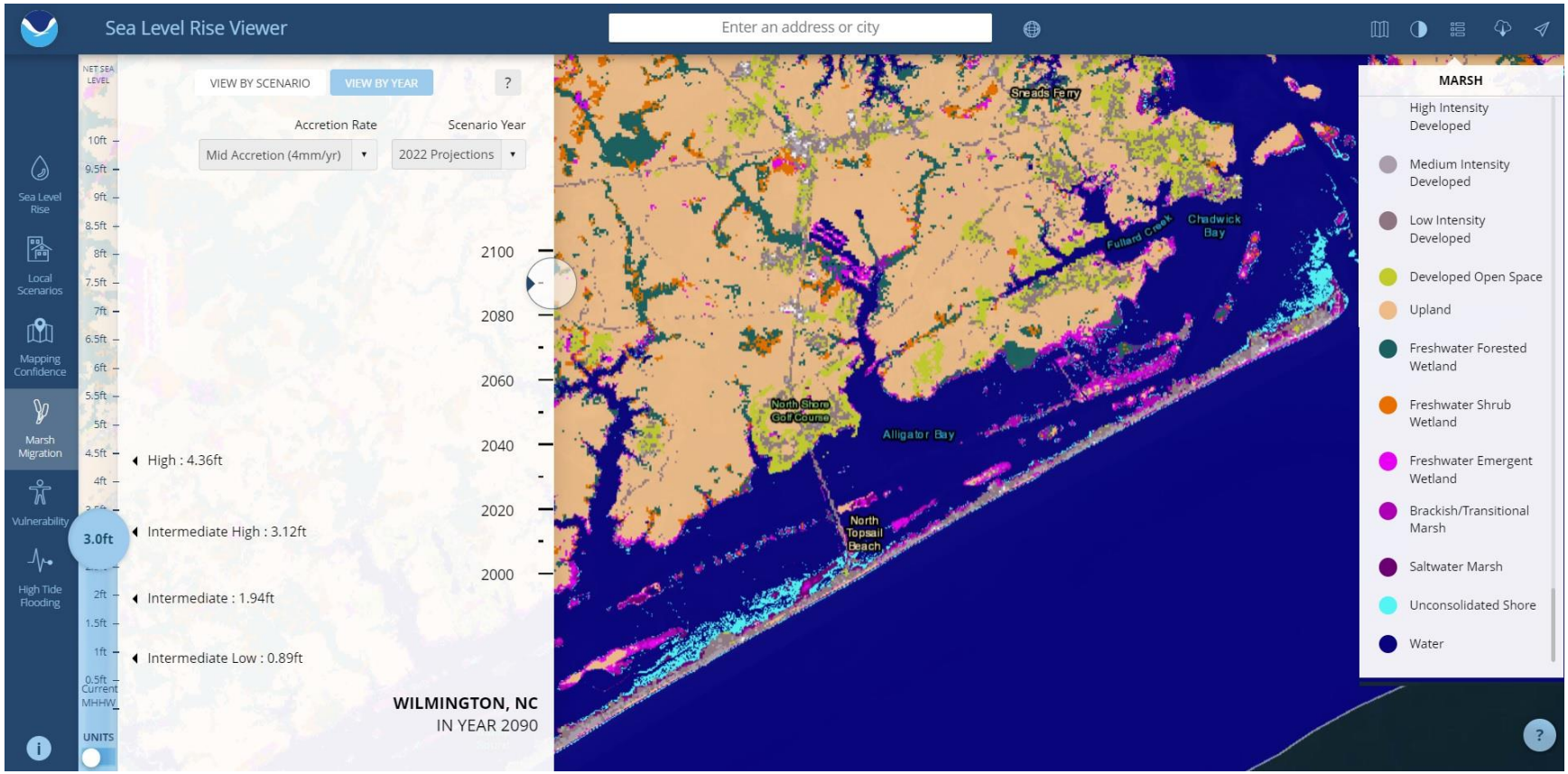


FIGURE A.40 - North Topsail Beach projected coastal marsh migration and ecosystem change by ~2090 with +3 feet sea level rise (source: NOAA Sea Level Rise Viewer, https://bit.ly/398EjLe).

By 2090-2100, most coastal ecosystems are stressed to keep pace with 3 feet of sea level rise and projected to transition to deeper pockets of Open Water.

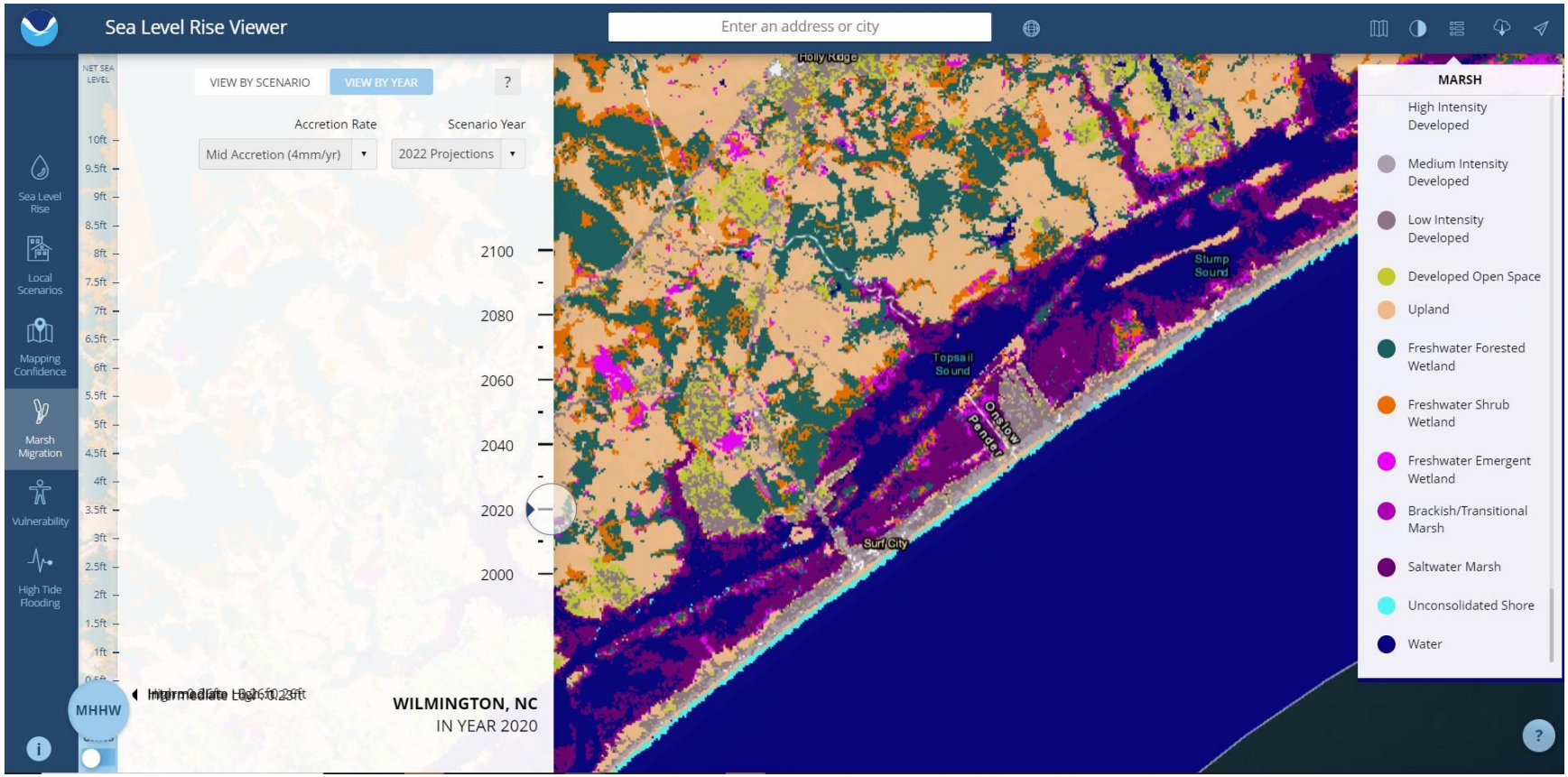


FIGURE A.41 – Surf City present day (2020) coastal marsh and ecosystem conditions (source: NOAA Sea Level Rise Viewer, https://bit.ly/398EjLe).

At present, sound-side areas in Surf City have a mix of Fresh Forested Wetlands, Freshwater Emergent Wetlands with particularly large Saltwater Marsh and Brackish/Transitional Marsh areas.

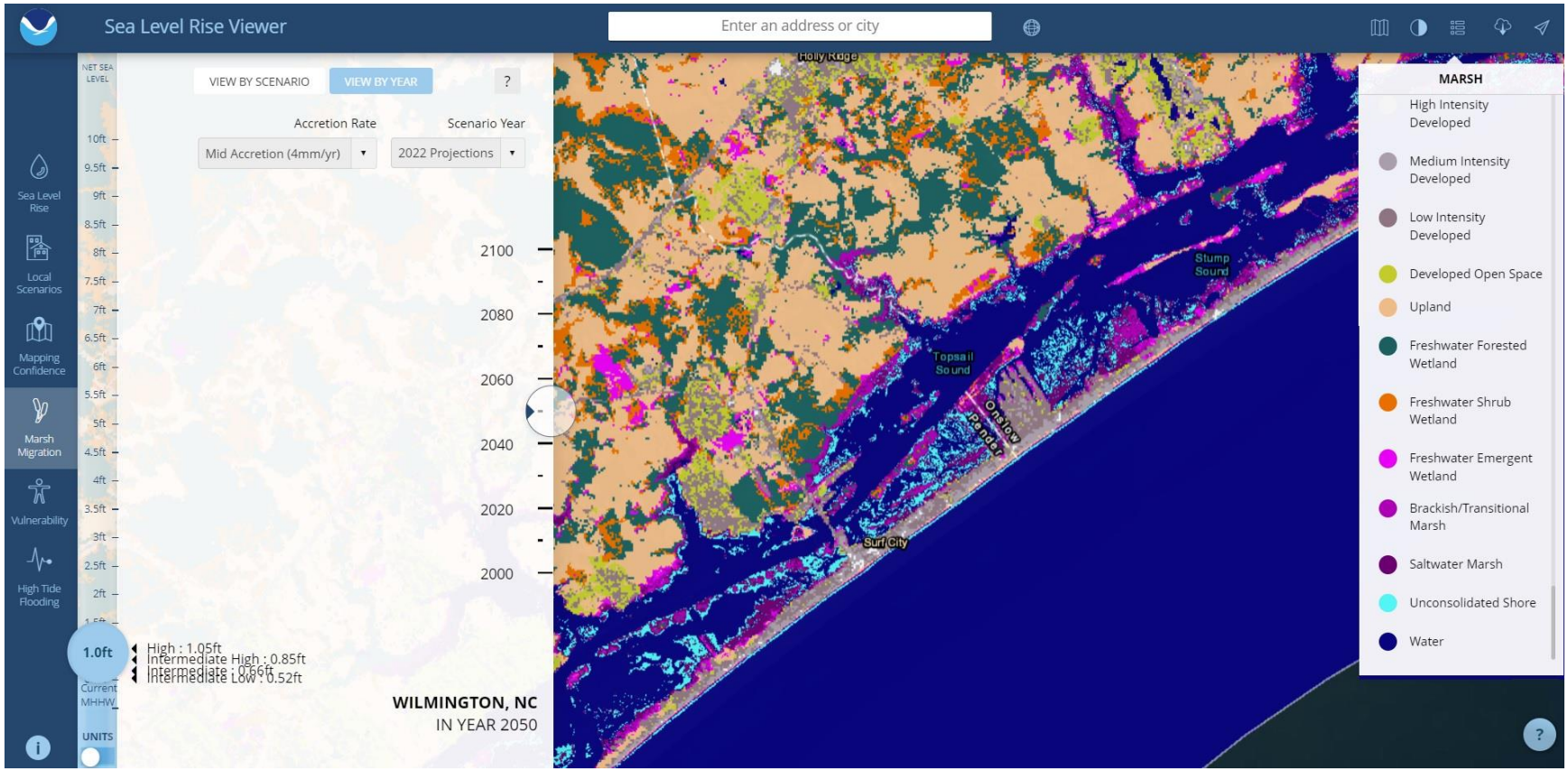


FIGURE A.42 – Surf City projected coastal marsh migration and ecosystem change by ~2050 with +1-foot sea level rise (source: NOAA Sea Level Rise Viewer, https://bit.ly/398EjLe).

By 2050, areas of Freshwater Emergent Wetlands and Freshwater Shrub Wetland areas are projected to transition to Saltwater Marsh, Unconsolidated Shore, and Open Water. Around this timeframe, a transition of larger Saltwater marsh area to "unconsolidated shore" and Open Water is projected to occur west of the Surf City Bridge, between the Bridge and West Onslow Beach.

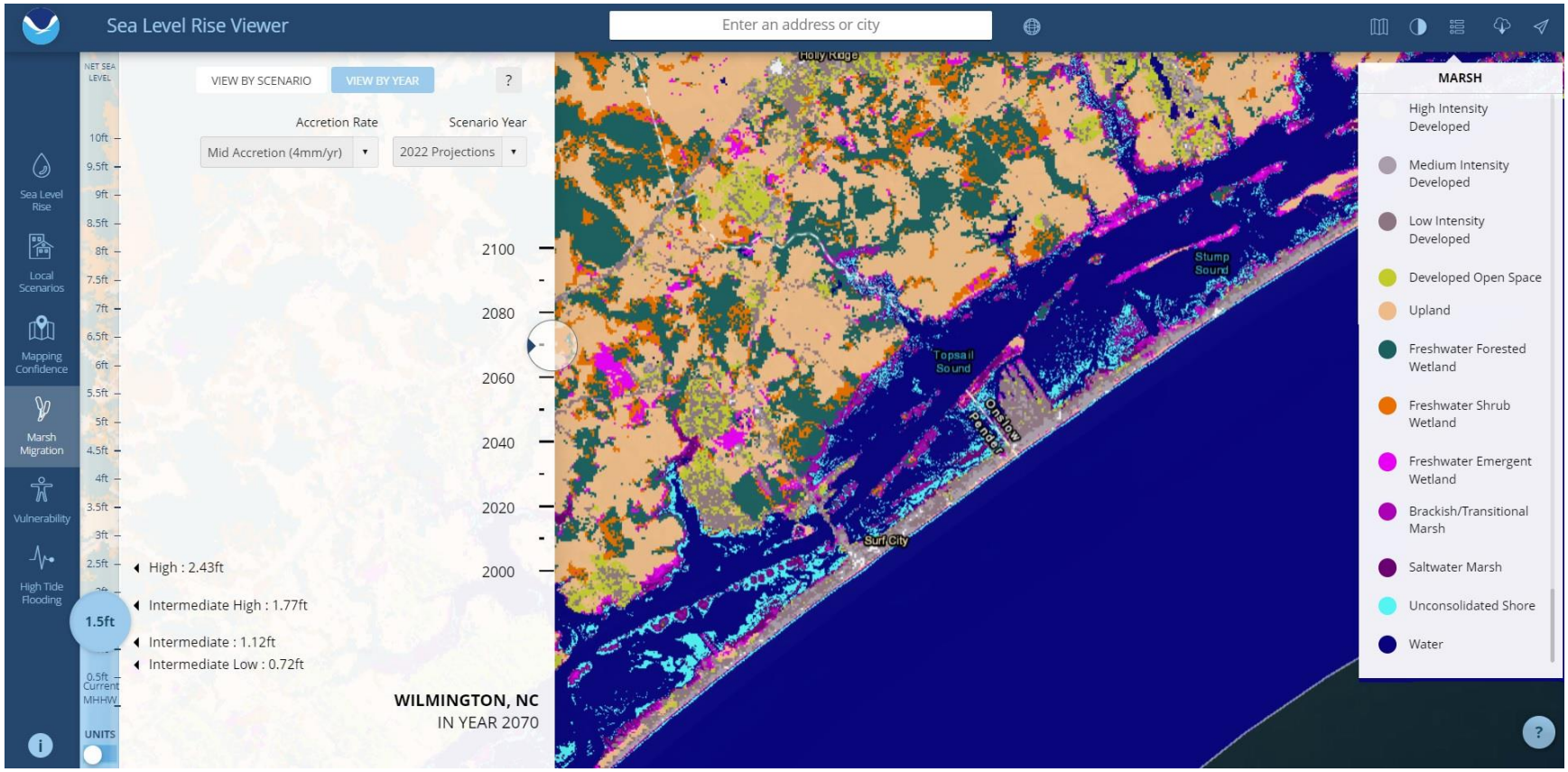


FIGURE A.43 – Surf City projected coastal marsh migration and ecosystem change by ~2070 with +1.5 feet sea level rise (source: NOAA Sea Level Rise Viewer, https://bit.ly/398EjLe).

By 2070, projections of 1.5 to 2 feet of sea level rise result in large losses of Brackish/Transitional Marsh, Freshwater Emergent Wetlands, and Saltwater Marsh area areas within Stump Sound south of Permuda Island Reserve. This is accompanied by an expansion of areas with deeper Open Water.

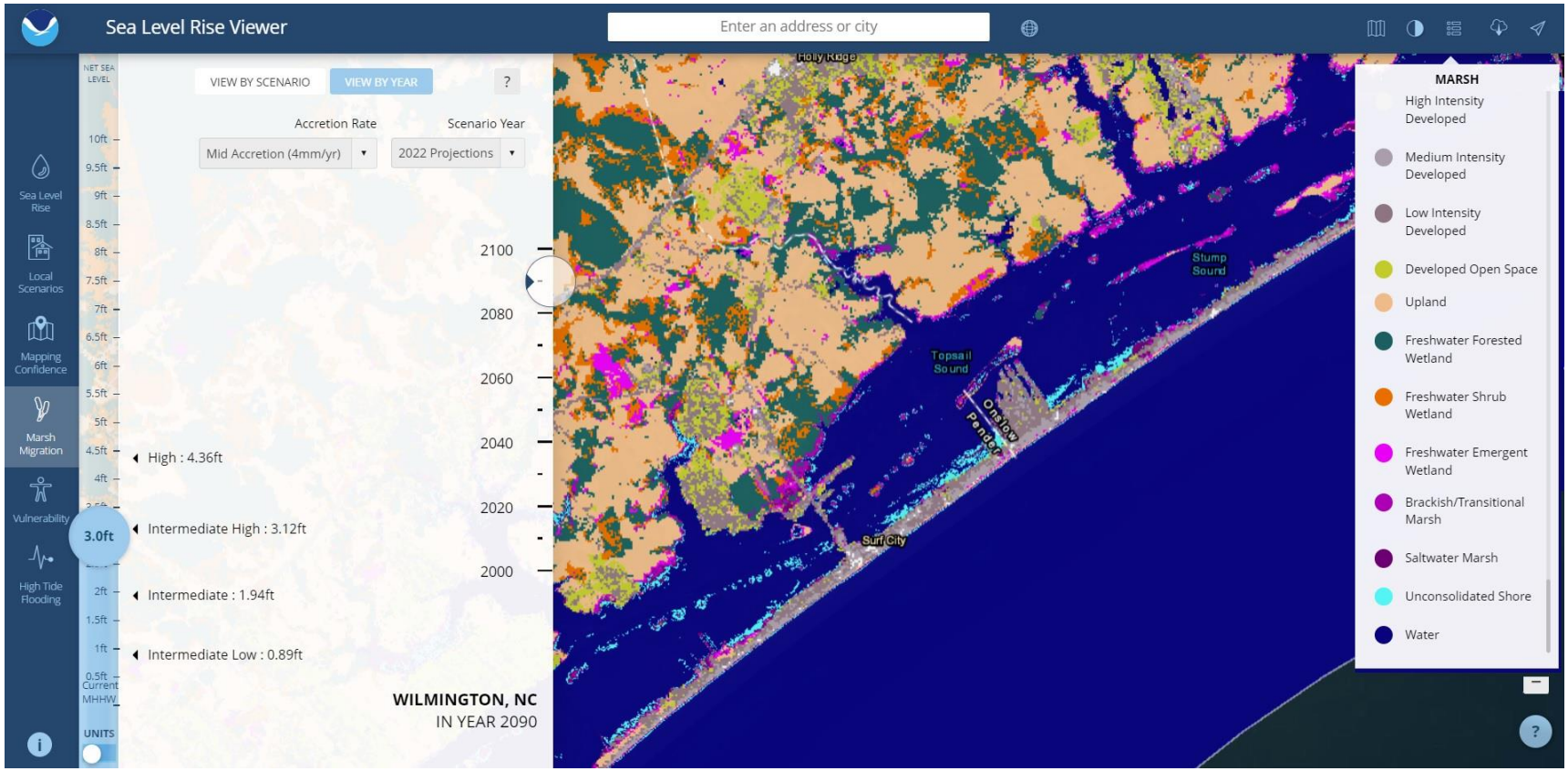


FIGURE A.44 – Surf City projected coastal marsh migration and ecosystem change by ~2090 with +3 feet sea level rise (source: NOAA Sea Level Rise Viewer, https://bit.ly/398EjLe).

By 2090-2100, most coastal ecosystems are stressed to keep pace with 3 feet of sea level rise, and the projected to transition to deeper pockets of Open Water resulting in nearly full loss of wetland areas in Stump Sound.

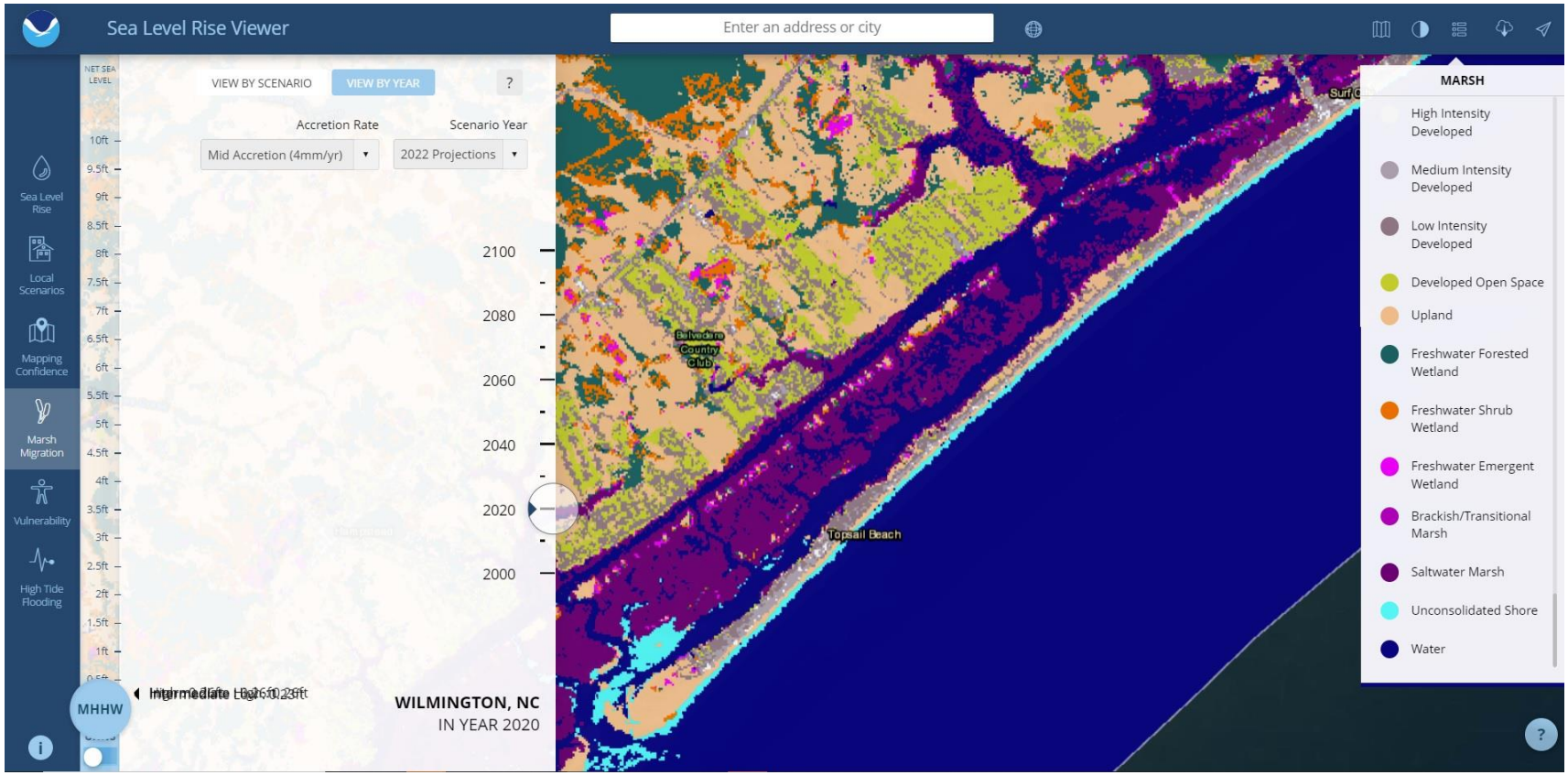


FIGURE A.45 – Topsail Beach present day (2020) coastal marsh and ecosystem conditions (source: NOAA Sea Level Rise Viewer, https://bit.ly/398EjLe).

At present, sound-side areas in Topsail Beach are primarily Saltwater Marsh. Freshwater Forested and Shrub Wetlands exist near smaller islands along the Intracoastal Waterway.

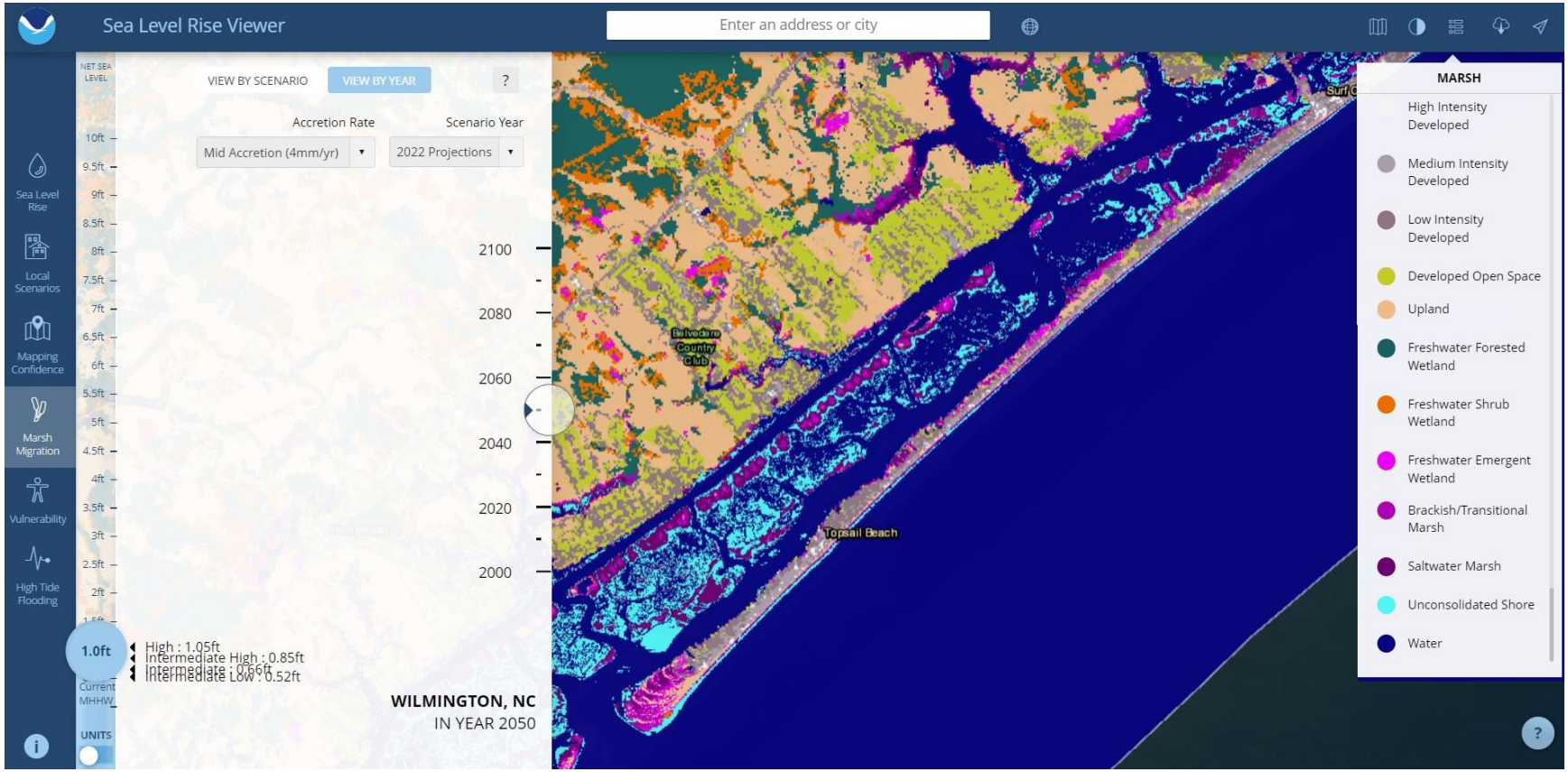


FIGURE A.46 – Topsail Beach projected coastal marsh migration and ecosystem change by ~2050 with +1-foot sea level rise (source: NOAA Sea Level Rise Viewer, https://bit.ly/398EjLe).

By 2050, with just one foot of sea level rise, large Saltwater Marsh areas are projected to transition to “unconsolidated shore” and Open Water. Areas near the Inlet that are currently upland areas and “unconsolidated shore” may transition to Brackish/Transitional Marshes and Saltwater Marsh.

FIGURE A.47 – Topsail Beach projected coastal marsh migration and ecosystem change by ~2070 with +1.5 feet sea level rise (source: NOAA Sea Level Rise Viewer, https://bit.ly/398EjLe).

By 2070, projections of 1.5 to 2 feet of sea level rise result in nearly full loss of Fresh Forested Wetland and Freshwater Shrub Wetland areas. This is accompanied by a major decrease in Freshwater Emergent Wetland and Saltwater Marsh area to Open Water.

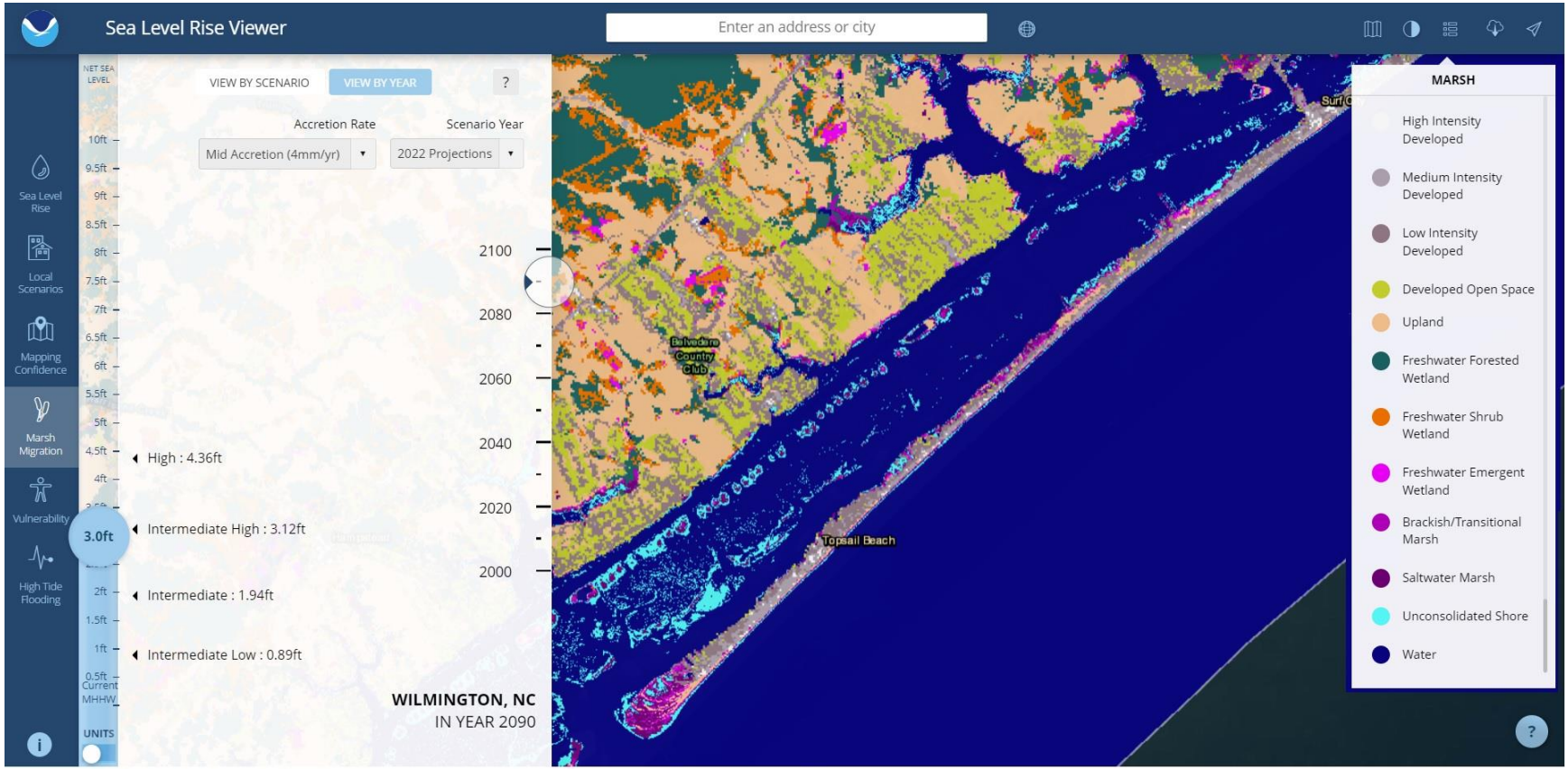


FIGURE A.48 – Topsail Beach projected coastal marsh migration and ecosystem change by ~2090 with +3 feet sea level rise (source: NOAA Sea Level Rise Viewer, https://bit.ly/398EjLe).

By 2090-2100, most coastal ecosystems are stressed to keep pace with 3 feet of sea level rise and are projected to transition to deeper pockets of Open Water.

B. Social Vulnerability Index (SVI) Maps

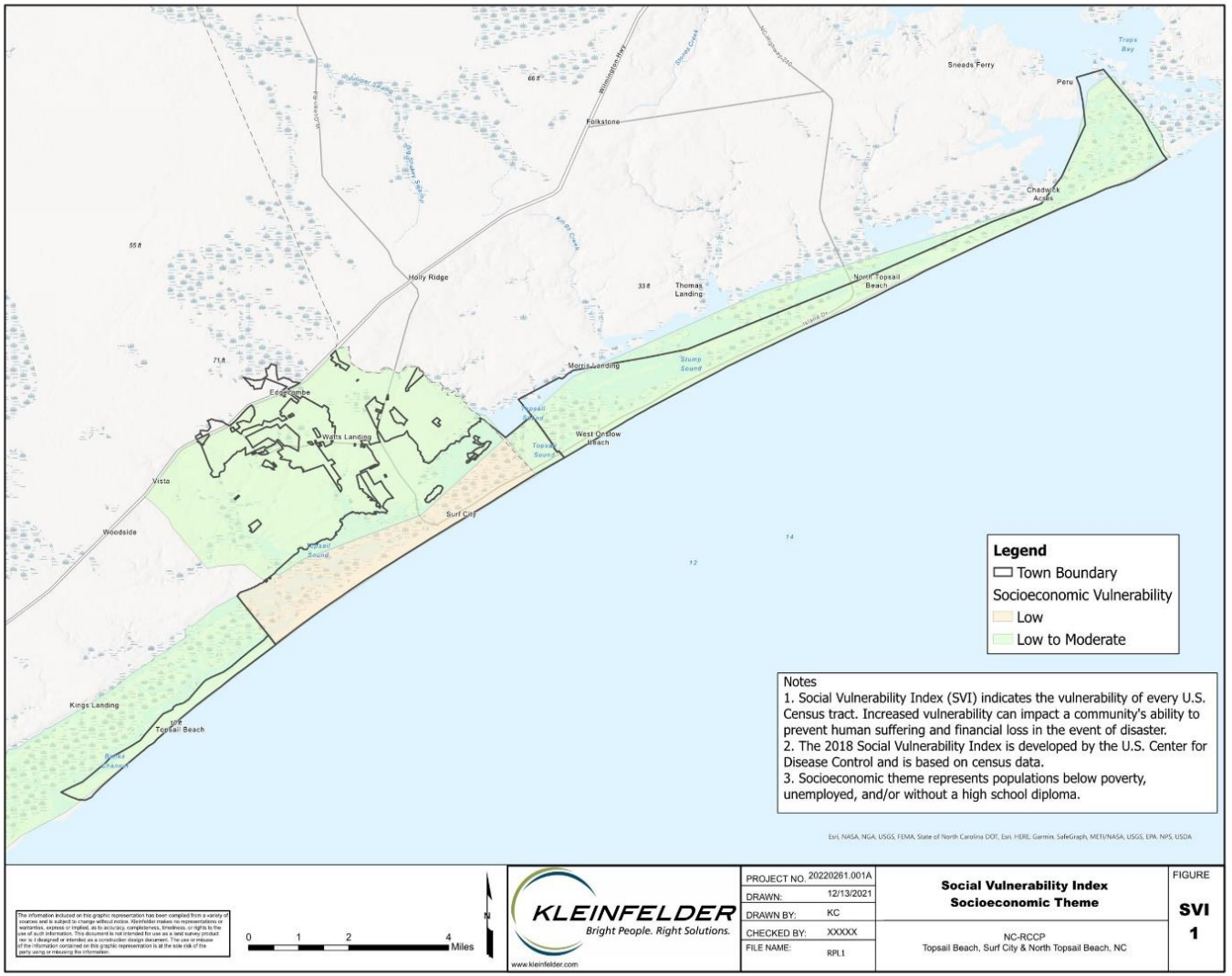


FIGURE A.49 – SVI SOCIOECONOMIC STATUS (THEME 1)

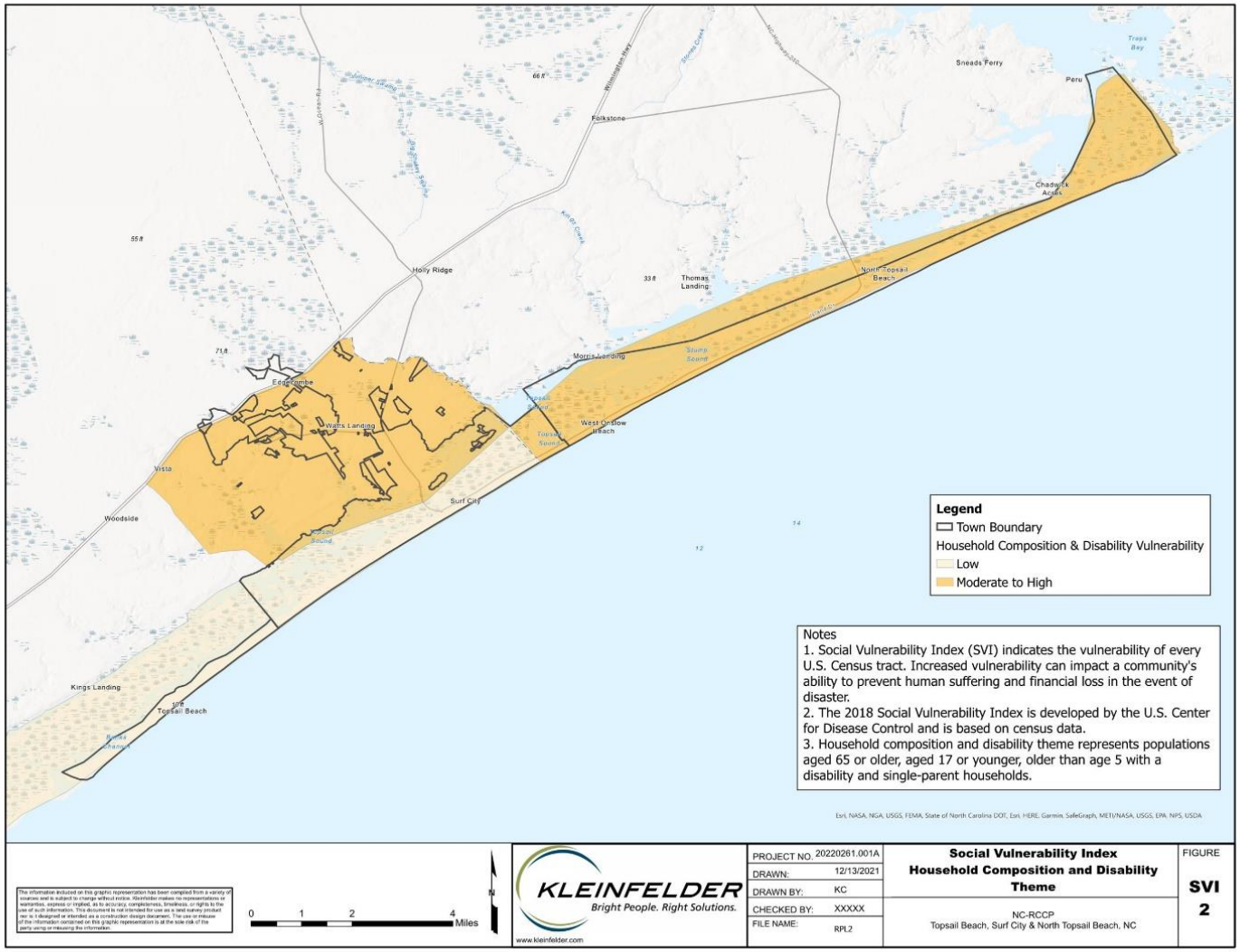


FIGURE A.50 – SVI HOUSEHOLD COMPOSITION AND DISABILITY (THEME 2)

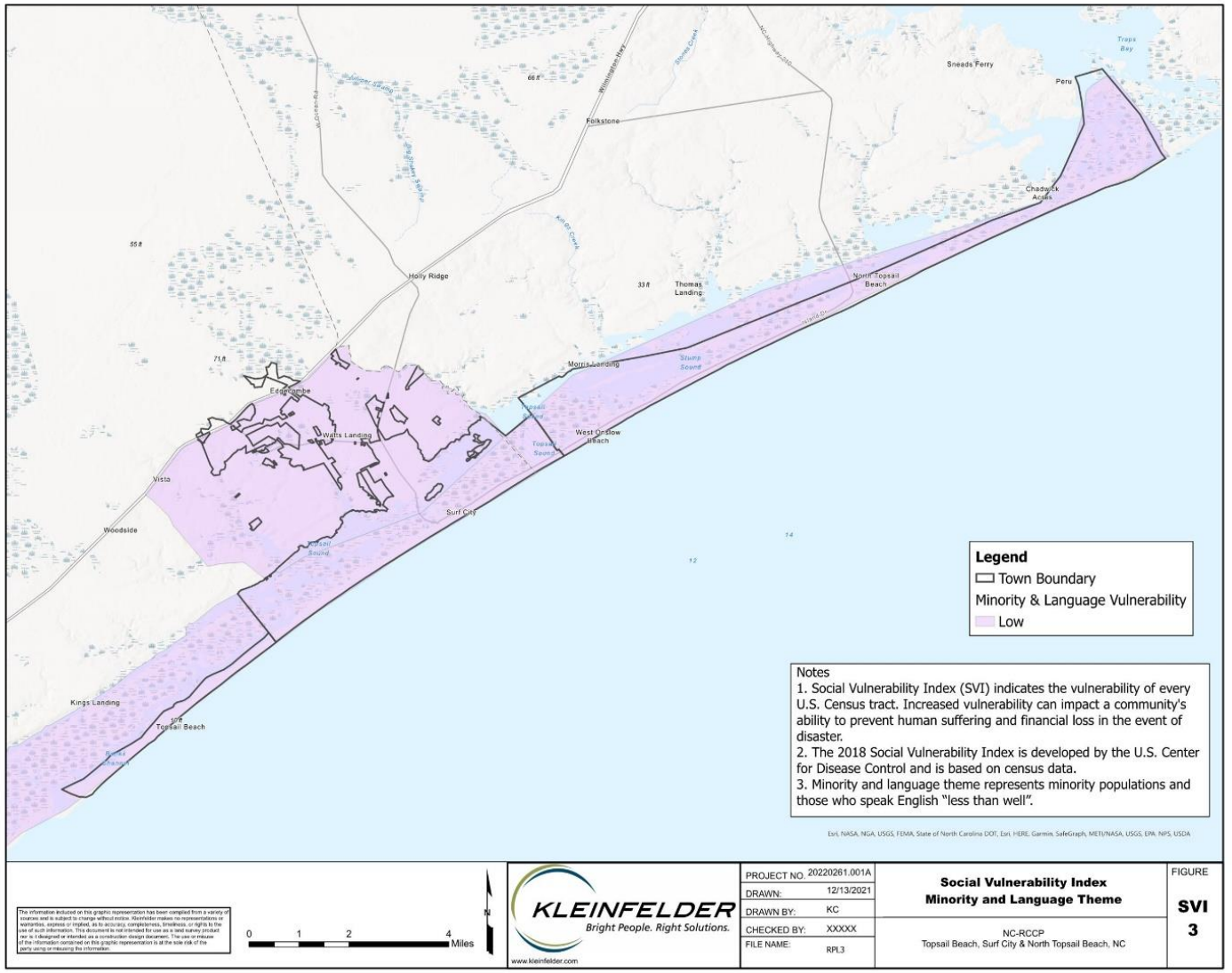


FIGURE A.51 – SVI MINORITY AND LANGUAGE (THEME 3)

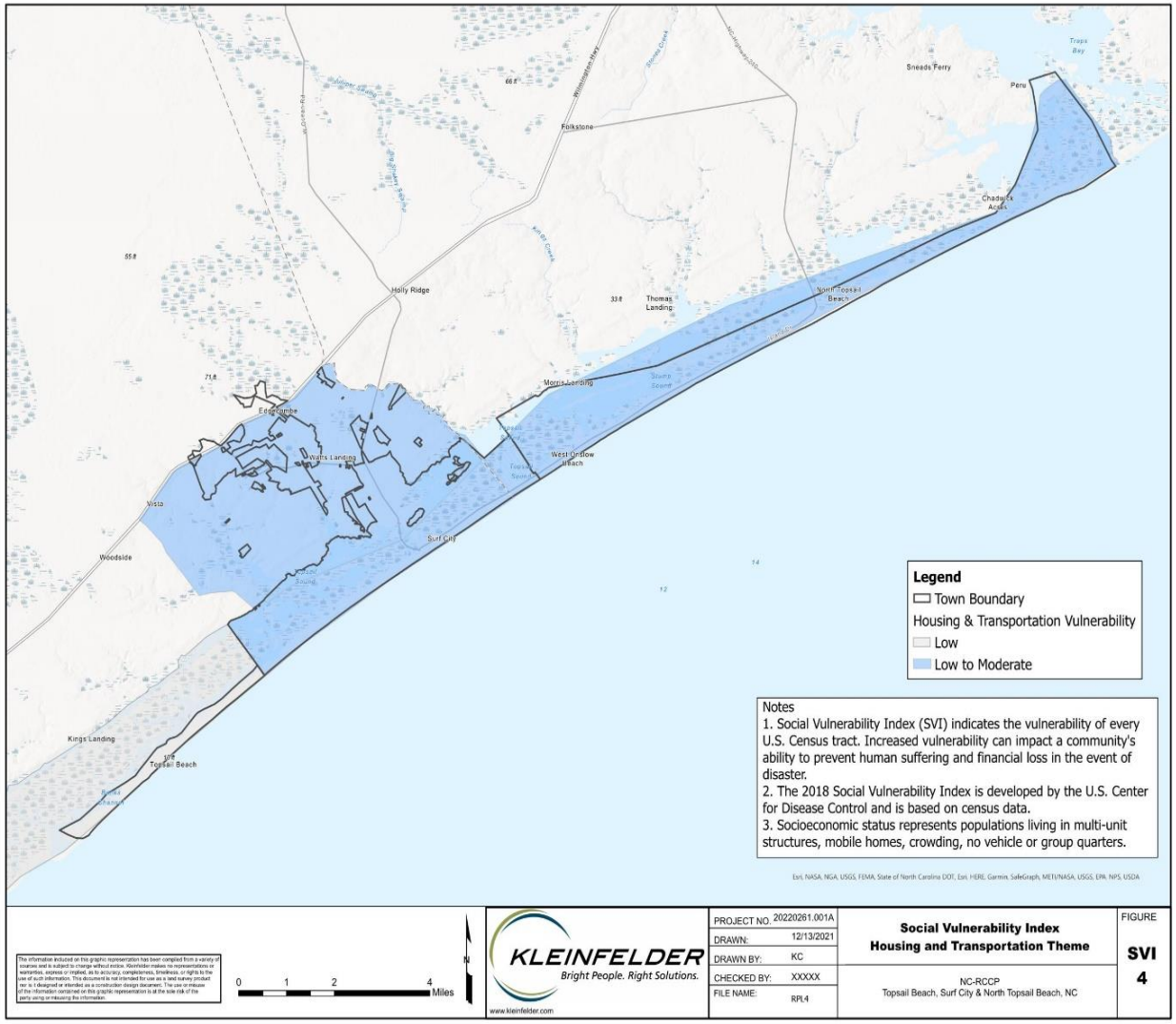


FIGURE A.52 – SVI HOUSING AND TRANSPORTATION (THEME 4)

X. APPENDIX B – INFRASTRUCTURE

A. Natural Asset Inventory and Estimated Vulnerability

TABLE B.1 – NATURAL ASSET INVENTORY AND ESTIMATED VULNERABILITY (NOT COMPREHENSIVE)

Asset Type	Sector	Asset Name	Location	100-yr floodplain ?	500-year floodplain ?	Estimated Vulnerability	Ownership	Source
Natural infrastructure	Environmental Area	Surf City Maritime Forest	Surf City	Yes	Yes	**High**	Public	NC GIS layer
Natural infrastructure	Environmental Area	New River Inlet Bird Nesting Islands	North Topsail Beach	Yes	Yes	**High**	Public	NC GIS layer
Natural infrastructure	Environmental Area	New River Inlet	North Topsail Beach	Yes	Yes	**High**	Public	Identified by CAT
Natural infrastructure	Environmental Area	Permuda Island Reserve	North Topsail Beach	Yes	Yes	**High**	Public	Identified by KLF
Natural infrastructure	Environmental Area	Brackish/Freshwater Wetlands	Island-wide / North Topsail Beach	Yes	Yes	**High**	Public	Identified by CAT

Asset Type	Sector	Asset Name	Location	100-yr floodplain ?	500-year floodplain ?	Estimated Vulnerability	Ownership	Source
Natural infrastructure	Environmental Area	Salt Marshes	Island-wide	Yes	Yes	High	Public	Identified by CAT
Natural infrastructure	Environmental Area	Public beaches	Island-wide	Yes	Yes	High	Public	Identified by CAT
Natural infrastructure	Environmental Area	North Topsail Beach Maritime Forest	North Topsail Beach	Yes	Yes	High	Public	NC GIS layer
Natural infrastructure	Environmental Area	Soundside Park	Surf City	Yes	Yes	Medium	Public	Identified by CAT
Natural infrastructure	Environmental Area	Richard C. Peters Town Park	North Topsail Beach	Yes	Yes	Medium	Public	Identified by KLF
Natural infrastructure	Environmental Area	W. Rodney Knowles Park	North Topsail Beach	Yes	Yes	Medium	Public	Identified by KLF

B. Critical Asset Vulnerability

TABLE B.2 – CRITICAL ASSET VULNERABILITY

Sector	Asset Name	Location	Address	FEMA 100-yr floodplain?	FEMA 500-year floodplain?	Estimated Vulnerability	Ownership	Estimated Value[1]	Source	FEMA Zone / Base Flood Elevation (BFE)	Finish Floor Elevation (FFE)[2]	Structure Built[2]
Public Safety	North Topsail Beach Fire Station - South End	North Topsail Beach	3304 GRAY ST	Yes	Yes	High	Public	$ 108,698	HMP	AE zone; BFE 12.0 ft. NAVD88	8.35 NAVD88	1983
Public Safety	Topsail Beach Fire Department	Topsail Beach	816 SOUTH ANDERSON BOULEVARD	Yes	Yes	High	Public	$ 547,539	HMP	AE zone; BFE 11.0 ft. NAVD88	4.71 NAVD88	1977
Public Safety	Topsail Beach Police Department	Topsail Beach	812 S ANDERSON BLVD	Yes	Yes	High	Public	$ 158,788	HMP	AE zone; BFE 11.0 ft. NAVD88	4.22 NAVD88	1952
Public Safety	Pender Volunteer EMS and Rescue - Station 4	Topsail Beach	801 S ANDERSON BLVD / FLAKE AVE	Yes	Yes	High	Public	$ 192,628	Identified by Community Action Team (CAT)	AE zone; BFE 11.0 ft. NAVD88	5.57 NAVD88	1967
Civic Building	Topsail Beach Town Hall	Topsail Beach	820 S Anderson Blvd, Topsail Beach, NC 28445	Yes	Yes	High	Public	$ 258,298	HMP	AE zone; BFE 11.0 ft. NAVD88	5.56 NAVD88	
Place of Worship	Wade H. Chestnut Memorial Church	North Topsail Beach	2649 Island Dr, North Topsail Beach, NC	Yes	Yes	High	Private	$ 108,462	NC GIS layer	AE zone; BFE 12.0 ft. NAVD88	7.60 NAVD88	1965
Utilities	South Beach electrical substation	Topsail Beach	~500 N Anderson Blvd. (near Sidbury Ave), Topsail Beach, NC	Yes	Yes	High	Private	value not estimated	Identified by Kleinfelder	AE zone; BFE 12.0 ft. NAVD88	n/a	
Cultural/ Historic	Assembly Hall and Missiles and More Museum, Topsail Beach	Topsail Beach	720 Channel Blvd., Topsail Beach	Yes	Yes	High	Private	$ 202,477	Identified by Kleinfelder	AE zone; BFE 10.0 ft. NAVD88	8.12 NAVD88	2000
Public Safety	North Topsail Beach Fire Station - North End	North Topsail Beach	2049 NEW RIVER INLET ROAD	Yes	Yes	High	Public	$ 2,650,208	Hazard Mitigation Plan (HMP)	AE zone; BFE 11.0 ft. NAVD88	9.06 NAVD88	1983

Sector	Asset Name	Location	Address	FEMA 100-yr floodplain?	FEMA 500-year floodplain?	Estimated Vulnerability	Ownership	Estimated Value[1]	Source	FEMA Zone / Base Flood Elevation (BFE)	Finish Floor Elevation (FFE)[2]	Structure Built[2]
Public Safety	North Topsail Beach Police Department / Town Hall	North Topsail Beach	2008 LOGGERHEAD COURT	Yes	Yes	Medium	Public	$ 942,910	HMP	AE zone; BFE 12.0 ft. NAVD88	11.9 NAVD88	2006
Public Safety	Surf City Fire Department-Station #23	Surf City	200 Wilmington Ave	Yes	Yes	Medium	Public	$ 257,699	HMP	AE zone; BFE 12.0 ft. NAVD88	13.65 NAVD88	2000
Place of Worship	All Saints Catholic Church Surf City	Surf City	420 N Topsail Dr, Surf City, NC 28445	Yes	Yes	Medium	Private	$ 179,524	NC GIS layer	AE zone; BFE 12.0 ft. NAVD88	9.16 NAVD88	2000
Housing	Rogers bay RV park (a travel trailer park)	North Topsail Beach	4021 Island Dr, North Topsail Beach, NC 28460	Yes	Yes	Medium	Private	value not estimated	Identified by CAT	AE; BFE 12.0 NAVD88	varies; 3.0 to 11.8 NAVD88	1976
Public Safety	Surf City Fire Department-Station #25	Hampstead, NC	100 Deer Run Rd, Surf City	No	No	Low	Public	$ 1,541,640	HMP	X -Minimal Hazard; n/a	31.98 NAVD88	1991
Public Safety	Surf City Police Department and Town Hall	Surf City	214 W. Florence Way Hampstead NC 28443	No	No	Low	Public	$ 2,100,000	Identified by CAT	X -Minimal Hazard; n/a	~32 NAVD88	2020
Healthcare	Surf City Urgent Care and Family Medicine	Surf City	13520 NC-50, Surf City	No	No	Low	Private	$ 337,922	NC GIS layer	X -Minimal Hazard; n/a	~32 NAVD88	2009
Civic Building	North Topsail Beach Public Works Building	North Topsail Beach	3315 Gray Street, NTB	Yes	Yes	Medium	Public	$ 215,263	HMP	AE zone; BFE 12.0 ft. NAVD88	7.20 NAVD88	1980
Place of Worship	Emma Anderson Memorial Chapel	Topsail Beach	1040 S Anderson Blvd, Topsail Beach, NC 28445	Yes	Yes	Medium	Private	$ 343,875	NC GIS layer	AE zone; BFE 11.0 ft. NAVD88	11.30 NAVD88	2004
Place of Worship	Chapel Bay Church Surf City	Holly Ridge	216 Michigan Ave, Surf City, NC 28445	Yes	Yes	Medium	Private	$ 450,187	NC GIS layer	AE Zone; BFE 9.0 NAVD88	9.02 NAVD88	1998

Notes:

[1] Where available, **Estimated Value** data represents “Building Replacement Value” of the primary structure per the Statewide Building Footprints Layer (NCEM). This value does not include cost of contents (such as critical equipment), or any estimate of services provided by operations housed at these facilities

[2] Values per the Statewide Building Footprints Layer, which includes FFE estimated using point cloud data from field collected data (NCEM), a statewide effort with greater resolution in coastal counties.

1. High Risk Critical Facilities

FIGURE B.1 – TOPSAIL BEACH FIRE STATION, FFE 4.71 NAVD88 (SOURCE: https://www.helpmecovid.com/us/6958525_topsail-beach-fire-department)

FIGURE B.2 – TOPSAIL BEACH POLICE STATION, FFE 4.22 NAVD88 (SOURCE: https://www.helpmecovid.com/us/6937625_topsail-beach-police-department)

20174914.

FIGURE B.3 – TOPSAIL BEACH TOWN HALL, FFE 5.56 NAVD88 (SOURCE: BING MAPS/MICROSOFT)

FIGURE B.4 – PENDER VOLUNTEER EMERGENCY MEDICAL SERVICES AND RESCUE, FFE 5.57 NAVD88 (SOURCE: BING MAPS/MICROSOFT)

20174914.

FIGURE B.5 – NORTH TOPSAIL BEACH – SOUTH END FIRE STATION, FFE 8.35 NAVD88 (SOURCE: https://www.onslowcountync.gov/1080/Fire-Rescue-Agencies)

FIGURE B.6 – SOUTH BEACH ELECTRICAL SUBSTATION (TOPSAIL BEACH)

Hurricane Florence (2018) flooding in Topsail Beach near Sidbury Ave. and electrical substation. Historic flooding was more than one foot. (source: First Street Foundation FloodFactor https://floodfactor.com/city/topsail-beach-northcarolina/3768040_fsid)

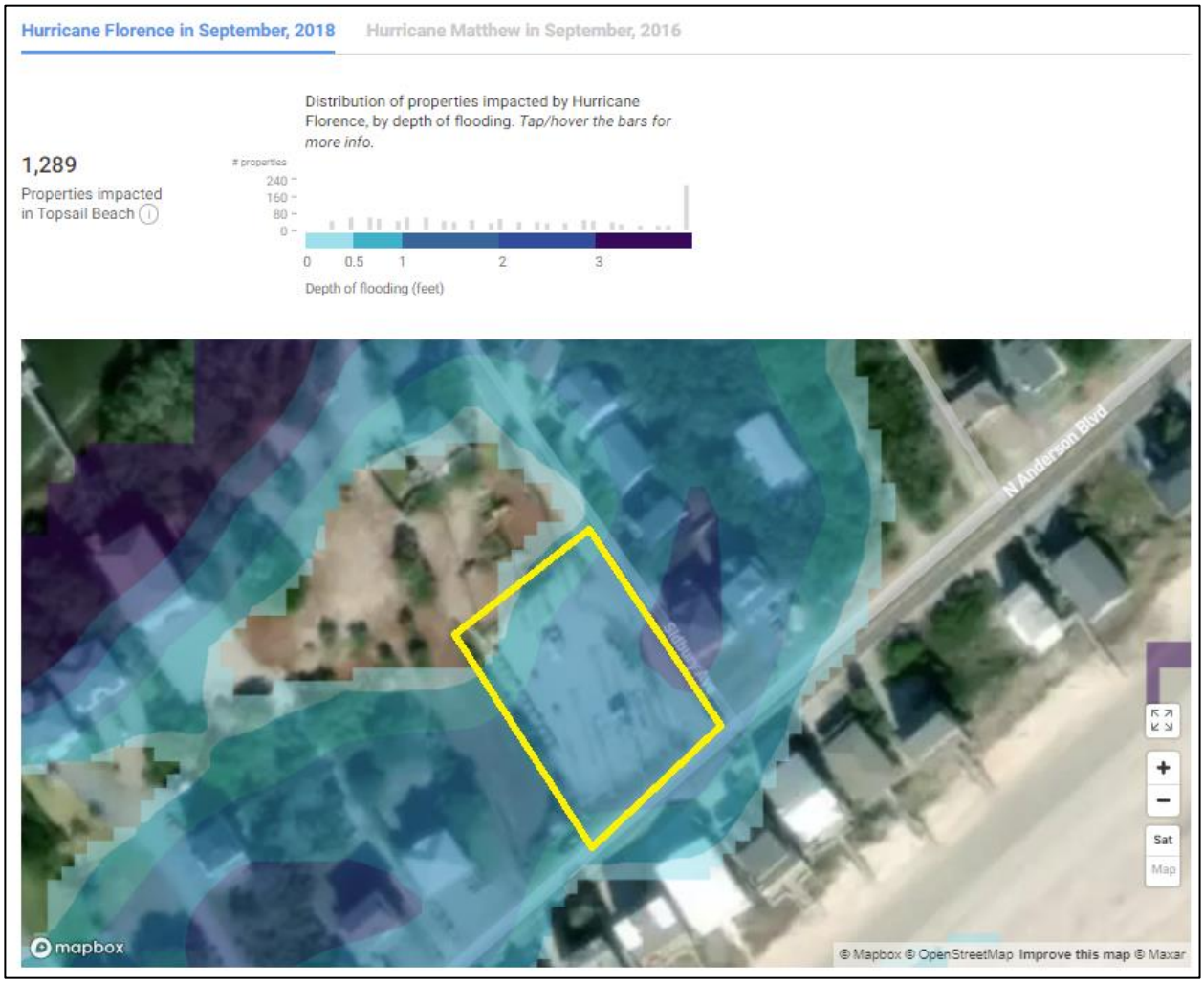


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FIGURE B.7 – HURRICANE MATTHEW (2016) FLOODING IN TOPSAIL BEACH NEAR SIDBURY AVE. AND ELECTRICAL SUBSTATION.

While critical equipment is raised slightly above ground surface, this area is subject to more frequent storm flooding, which future projects show may be subject to more than a foot of flooding on a 5% (i.e., 20-year storm) or more recurrence. (source: First Street Foundation FloodFactor https://floodfactor.com/city/topsail-beach-northcarolina/3768040_fsid)

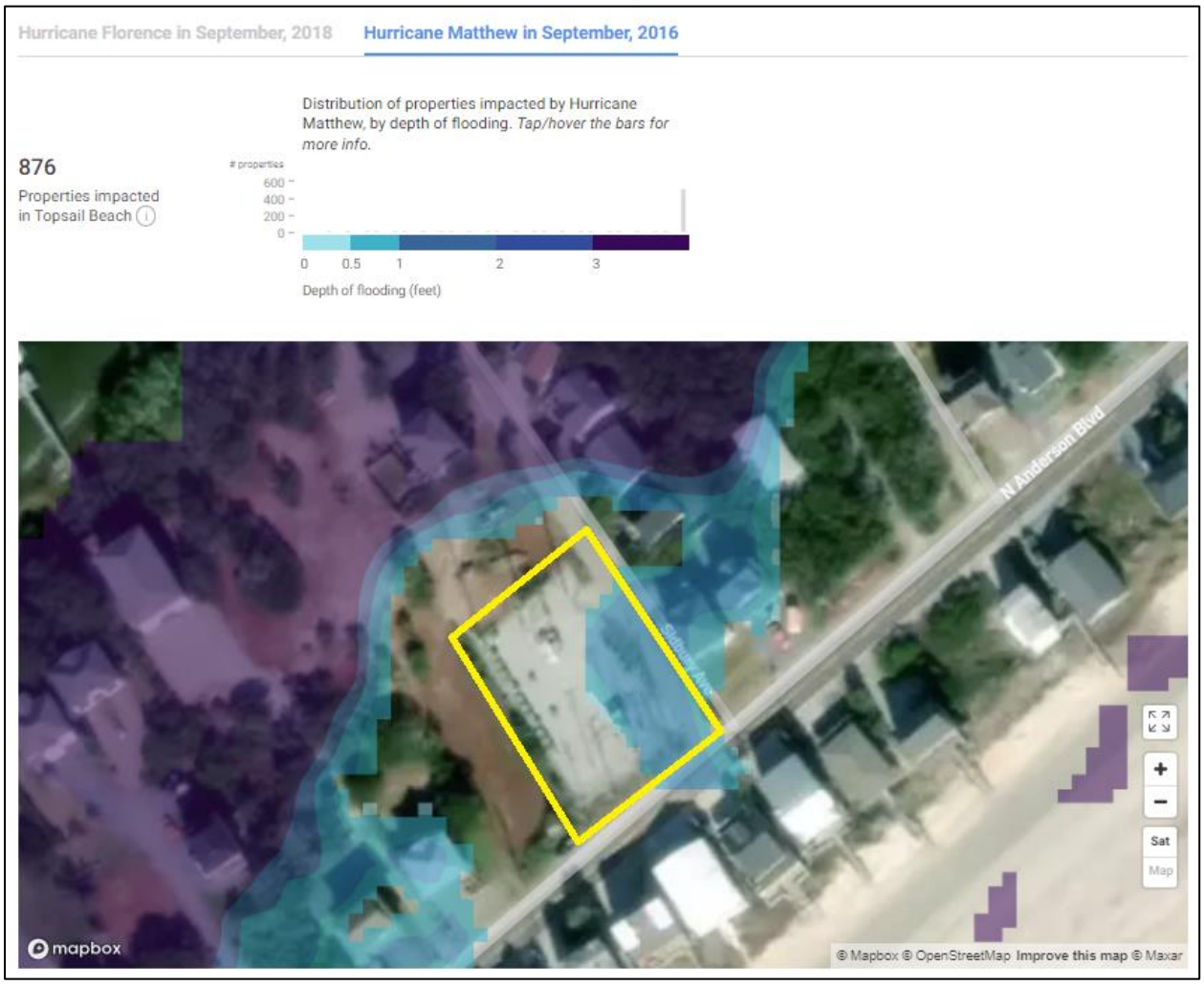

FIGURE B.8 – Modeled 20% event (i.e., 5-year recurrence) flooding in 2050 in Topsail Beach near Sidbury Ave. and electrical substation *(*source: First Street Foundation FloodFactor https://floodfactor.com/city/topsail-beach-northcarolina/3768040_fsid)

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2. High Risk Cultural Assets

FIGURE B.9 – TOPSAIL BEACH ASSEMBLY HALL AND MISSILES AND MORE MUSEUM, FFE 8.12 NAVD88 (SOURCE: https://www.topsailchamber.org/business/the-historic-assembly-

FIGURE B.10 – WADE H. CHESTNUT MEMORIAL CHAPEL, FFE 7.60 NAVD88 (SOURCE:

https://www.carolinacoastonline.com/topsail_voice/news/article_b1de9d82-ae98-

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Topsail Beach
Founded 1990

TOWN OF SURF CITY
1949

TOWN OF
TOPSAIL
BEACH
NORTH CAROLINA

KLEINFELDER
Bright People. Right Solutions.

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