

3D Digital Documentation and Sea Level Rise Visualization

Resilient Nantucket: 3D Digital Documentation and Sea Level Rise Visualization is an initiative to digitally document the core of historic Nantucket Town, its waterfront, and Brant Point and to prepare 3D visualizations of sea level rise projections.

The initiative is a collaboration of the Town of Nantucket, Nantucket Preservation Trust, and University of Florida Preservation Institute Nantucket. Funding was provided by the Nantucket Community Preservation Committee, Massachusetts Coastal Zone Management Program, Osceola Foundation, and ReMain Nantucket.



29 June 2019



DISCLAIMER
The Resilient Nantucket data and visualizations illustrate the scale of potential sea level rise flooding at specific locations within the Town of Nantucket. Water levels represent Mean Higher High Water (MHHW), excluding wind driven tide, wave action, and other factors that influence flooding. The data and visualizations are without warranty to their performance or fitness for any particular purpose. The entire risk associated with the results and performance of this data and visualizations are assumed by the user. This data and visualizations should be used strictly as a planning reference and not for permitting or other legal purposes.

EXECUTIVE SUMMARY

Approximately 17,000 people live on the island of Nantucket year round with more than 11,000 residing here seasonally. In 2017, there were some 500,000 visitor trips to the island.^[1] Many of these residents and visitors choose Nantucket because of its unique physical environment. Approximately 48 square miles in size with 88 miles of coastline, the island is one of the United States' largest National Historic Landmark Districts with over 800 pre-1860s structures contributing to its historical, cultural, and architectural significance. Approximately one-third of Nantucket is protected open space with an array of distinct ecological systems and habitats. The economy is largely dependent upon visitors coming to experience the island's historical places and natural environment. These irreplaceable resources are increasingly threatened by short-term flooding and sea level rise.

The Town of Nantucket is working to understand these threats, identify vulnerable areas, raise awareness, and engage residents and stakeholders in the process of adapting and enhancing resiliency. As part of updating the Hazard Mitigation Plan (completed in March 2019), ten areas were identified as vulnerable including "Downtown and Brant Point."^[2]

Resilient Nantucket: 3D Digital Documentation and Sea Level Rise Visualization is an initiative to digitally document the core of historic Nantucket Town, its waterfront, and Brant Point (Resilient Nantucket Study Area Map) and to prepare 3D visualizations of sea level rise projections. The digital data and other products generated by this initiative are being used in a variety of ways:

§ Precise building elevation measurements and other data (foundation and structural system, materials, age, condition, etc.) to inform the development and implementation of adaptation strategies;

§ Vulnerability assessment of some 300 individual buildings that make up the Nantucket Town and Waterfront study area;

§ Informed by case studies of programs and projects in other historic coastal communities, considerations for integrating resiliency and adaptation measures into existing historic preservation guidelines including *Building with Nantucket in Mind: Guideline for Protecting the Historic Architecture and Landscape of Nantucket*;

§ 3D visualizations and other materials that help communicate sea level rise projections and impacts and raise awareness of threats and resiliency measures among residents and stakeholders;

§ Public workshop, *Keeping History Above Water Nantucket*, that brings together the community and experts from Massachusetts and around the country to address the impacts of short- and long-term flooding on the historical, cultural, and architectural resources of Nantucket Town. Keeping History Above Water is a program of the Newport Restoration Foundation: <http://historyabovewater.org/>; and

§ The Resilient Nantucket approach is intended to serve as a model for other historic coastal communities in Massachusetts and across the country that are working to enhance resiliency while maintaining historical and architectural character and sense of place.

[1] Information on the number of Nantucket residents and visitors comes from the Nantucket Data Platform: www.nantucketdataplatfrom.com.

[2] Town of Nantucket Natural Hazard Mitigation Plan, March 2019: www.nantucket-ma.gov/1373/Hazard-Mitigation-Plan

PROJECT BACKGROUND

Originally occupied by two Wampanoag Native American tribes, the island of Nantucket was settled by the English in 1659. After early, mostly unsuccessful attempts to establish an agrarian economy, the English settlers, initially instructed by the Native Americans, began to hunt Right, then Sperm whales. The whale oil was processed as fuel for lamps or made into candles in factories established along Nantucket's urban waterfront. By the early nineteenth century, the island, then a community of some 10,000 residents, was the whaling capitol of the world, with local captains and crews making three- to five-year voyages to the Pacific to hunt whales, returning to Nantucket to process the oil, and deliver it to Europe and elsewhere. The wealth and cultural-exchange made possible by the whaling industry, coupled with a strong social influence exerted by the Quaker religion, helped shape a distinct society and culture.^[1] Despite some success in promoting the island as a tourist destination to replace whaling beginning as early as the 1860s, Nantucket remained in a period of economic and population decline until the mid-twentieth century when cultural heritage conservation and tourism were used as tools to revitalize the historic environment and economy of the island and presumably, improve the quality of life for its residents.

Nantucket's local historic district was established in 1955. With Beacon Hill in Boston, it was among the first historic districts in Massachusetts. The Town of Nantucket and Village of Sconset on the eastern end of the island were made National Historic Landmark Districts in 1966 following the passage of the U.S. National Preservation Act. The district was expanded to include the entire island in 197. The historic preservation focus that pervades the island is described in the introduction of *Building with Nantucket in Mind: Guidelines for Protecting the Historic Architecture and Landscape of Nantucket Island*:

From the moment it was rediscovered as a haven for tourists at the turn of the century, Nantucket was a preservation movement in progress. It continues, with only additional fervor and professionalism, to this day. Because of this, when a building is acquired or a plan for new construction is made, the builder/buyer is automatically a part of a preservation continuum. Here, where the island is both viable community and dynamic museum, there is no such thing as building without Nantucket in mind.^[2]

Resilient Nantucket: 3D Digital Documentation and Sea Level Rise Visualization is helping inform and advance Community Resiliency Planning being undertaken by the Town of Nantucket.

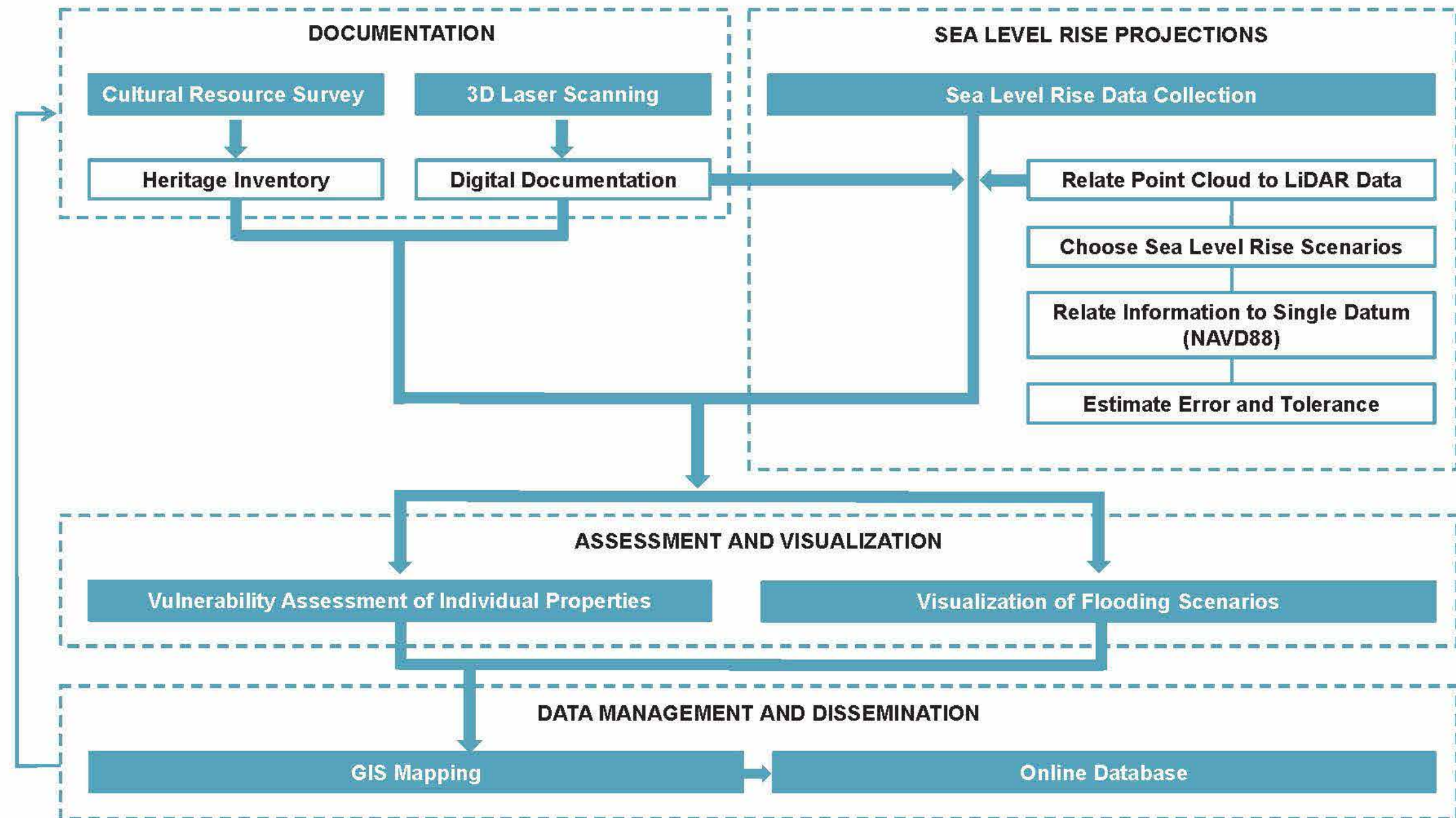
[1] Nathaniel Philbrick, *Away Off Shore: Nantucket Island and Its People*. (Nantucket, Massachusetts: Mill Hill Press, 1993).

[2] *Building with Nantucket in Mind: Guidelines for Protecting the Historic Architecture and Landscape of Nantucket Island* by J. Christopher Lang and Kate Stout, 1995 edition.



The Resilient Nantucket study area focused on the core of historic Nantucket Town, its waterfront, and Brant Point. The study area encompasses a range of historical, cultural, and architectural resource types. Prominent buildings include the Pacific Club (right image), Whaling Museum, Thomas Macy Warehouse, Brant Point Lighthouse (left image), the Dreamland, and the wharves (Old North Wharf is center image).

PROJECT METHODOLOGY



PROJECT METHODOLOGY

DOCUMENTATION

TASK 1: Cultural Resource Survey

- Background research, field survey, data organization, and inventory development
- Some 300 historic buildings in Nantucket Town and Brant Point
- Photographs, structural information, conditions, and archival data

TASK 2: 3D Laser Scanning

3D point clouds captured from 532 positions of terrestrial laser scanning provide:

- Accurate measurements for architectural heritage documentation
- 3D imagery and information for flood visualization and vulnerability assessment

SEA LEVEL RISE PROJECTIONS

Step 1: Relate Point Cloud to LiDAR Data

Ground elevations from airborne LiDAR data from the Massachusetts GIS archive

Step 2: Choosing Sea Level Rise Scenarios

NOAA Intermediate-High scenarios for the years of 2040, 2060, 2080, and 2100

Step 3: Relating Information to a Single Datum (NAVD88)

Datum chart of NAVD88 and tidal elevations for the community

Step 4: Estimate Error and Tolerance

Verification of the accuracy of data from airborne LiDAR and terrestrial laser scanning

Step 5: Identifying Vulnerable Heritage

Cultural and geospatial understanding through field observation and digital analysis

Step 6: Flooding Scenarios Visualization

Bathtub approach where a digital water level is raised and rendered with the point cloud to represent the selected scenarios in eight vulnerable locations in Nantucket

FLOOD VULNERABILITY ASSESSMENT AND GIS MAPPING

Step 1: Measuring First Floor Elevations

Levels of living space measured to door threshold of the main entrances of each building

Step 2: Generating GIS Attribute Table and Study Area Map

Historical and architectural information as well as measured floor levels and other factors

Step 3: Identifying Filtering Factors and Creating Analytical Layers

Mapping of historic spaces inundated under NOAA Intermediate-High scenarios

Step 4: Populating Detailed Survey Dataset

Historic resource survey as well as measured documentation for individual properties

Step 5: Disseminating and Managing GIS Maps and Information

Data shared with the public and continuously updated with refined research and assessment

RESILIENT NANTUCKET STUDY AREA MAP



SEA LEVEL RISE VISUALIZATION LOCATOR MAP



Visualaization Locations

1. Easy & Broad Streets
2. Old North Wharf
3. Pacific Club & Lower Main Street
4. Macy Warehouse at Lower Main Street
5. Wave Shuttle Terminal

Benchmark Elevations Relative to NAVD88

- A. 2.40ft
- B. 5.90ft

STUDY AREA 1



EASY & BROAD STREETS

NOAA Intermediate - High Sea Level Rise Projection
2019



EASY & BROAD STREETS

NOAA Intermediate - High Sea Level Rise Projection
2040 Water Level = 3.25 feet (above NAVD88)



EASY & BROAD STREETS

NOAA Intermediate - High Sea Level Rise Projection
2060 Water Level = 4.54 feet (above NAVD88)



EASY & BROAD STREETS

NOAA Intermediate - High Sea Level Rise Projection
2080 Water Level = 6.14 feet (above NAVD88)



EASY & BROAD STREETS

NOAA Intermediate - High Sea Level Rise Projection
2100 Water Level = 8.04 feet (above NAVD88)



OLD NORTH WHARF

NOAA Intermediate - High Sea Level Rise Projection
2019



OLD NORTH WHARF

NOAA Intermediate - High Sea Level Rise Projection
2060 Water Level = 4.54 feet (above NAVD88)



OLD NORTH WHARF

NOAA Intermediate - High Sea Level Rise Projection
2080 Water Level = 6.14 feet (above NAVD88)



OLD NORTH WHARF

NOAA Intermediate - High Sea Level Rise Projection
2100 Water Level = 8.04 feet (above NAVD88)



PACIFIC CLUB & LOWER MAIN STREET

NOAA Intermediate - High Sea Level Rise Projection
2019



PACIFIC CLUB & LOWER MAIN STREET

NOAA Intermediate - High Sea Level Rise Projection
2080 Water Level = 6.14 feet (above NAVD88)



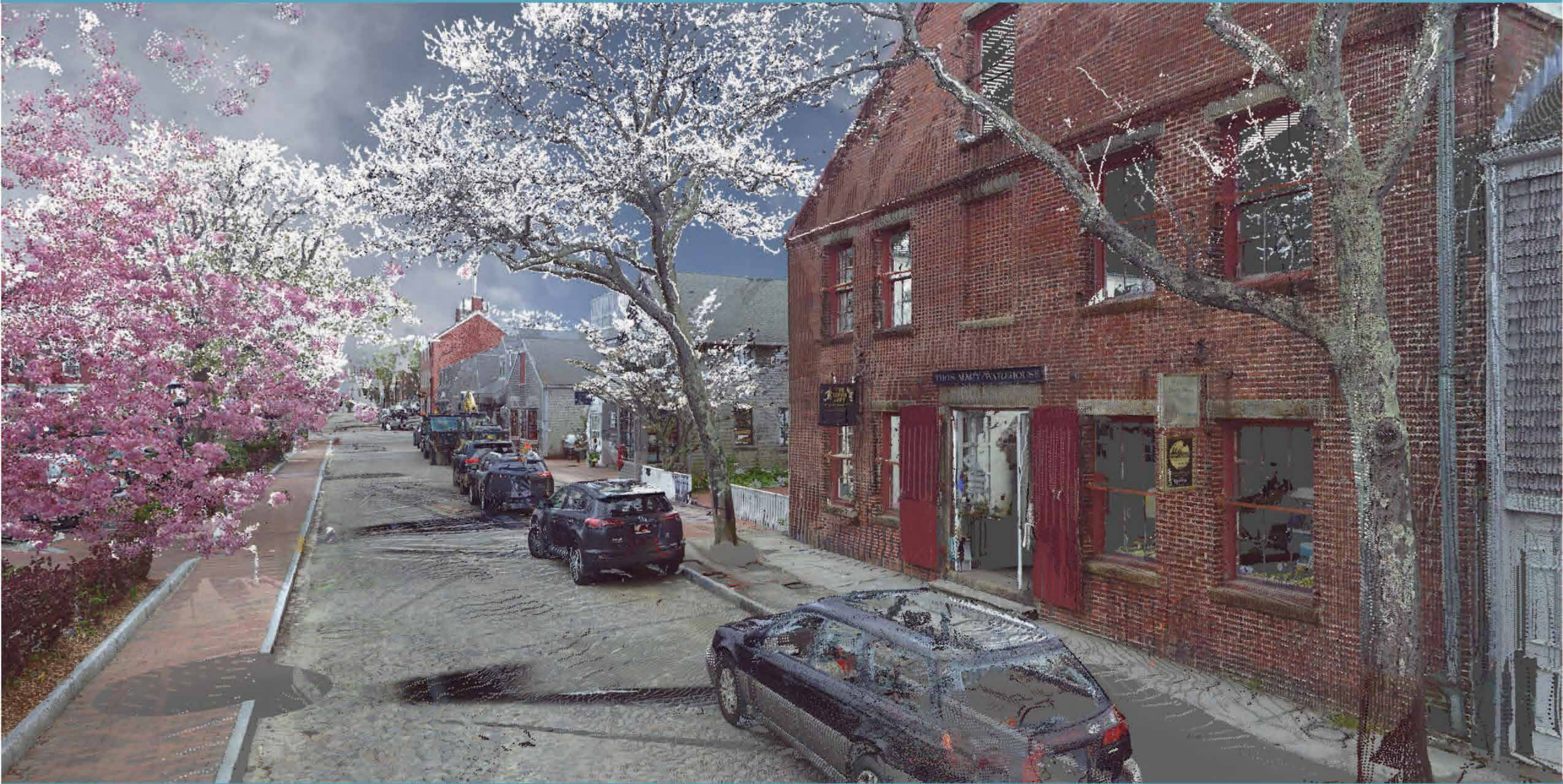
PACIFIC CLUB & LOWER MAIN STREET

NOAA Intermediate - High Sea Level Rise Projection
2100 Water Level = 8.04 feet (above NAVD88)



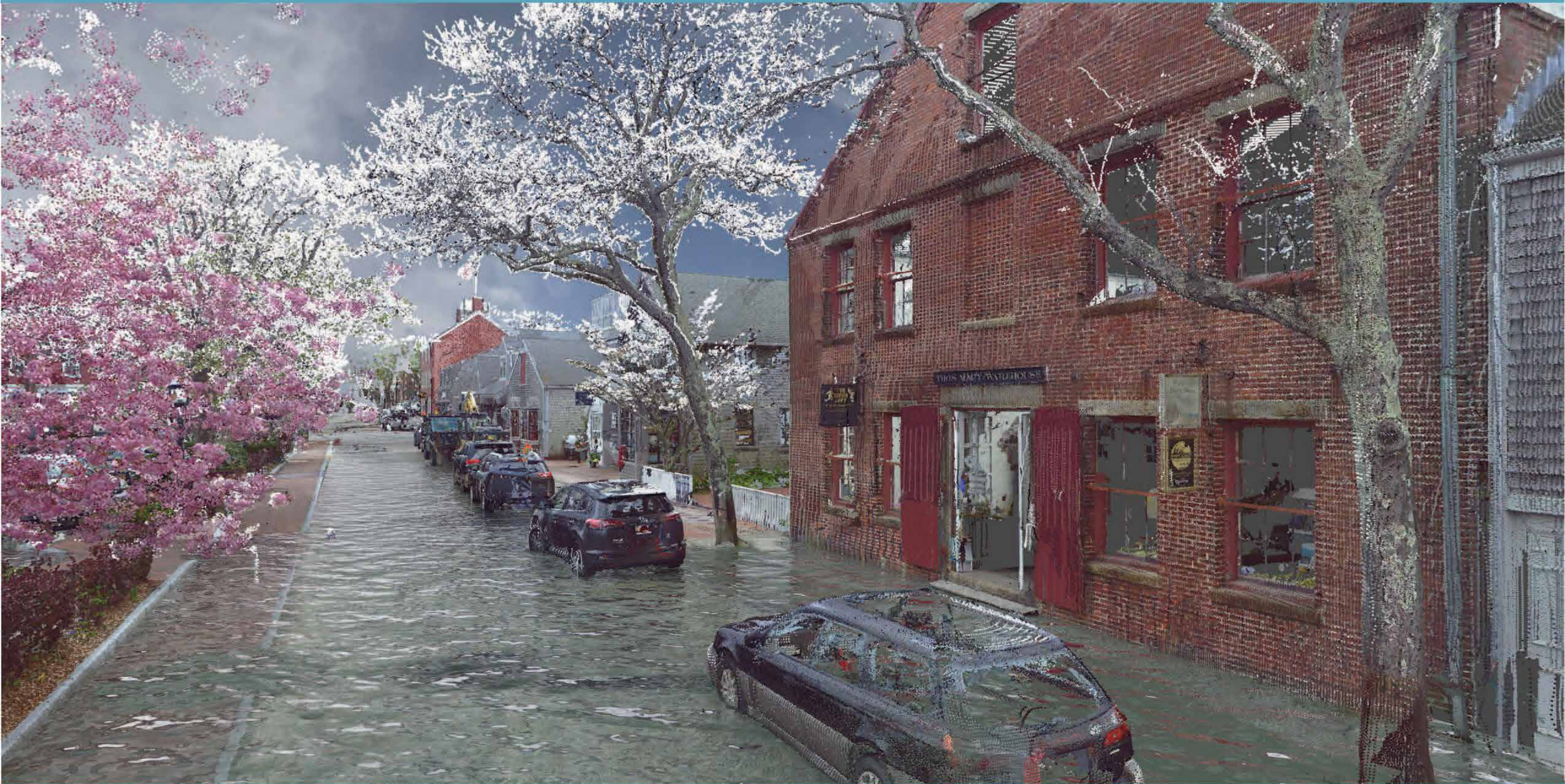
MACY WAREHOUSE at LOWER MAIN STREET

NOAA Intermediate - High Sea Level Rise Projection
2019



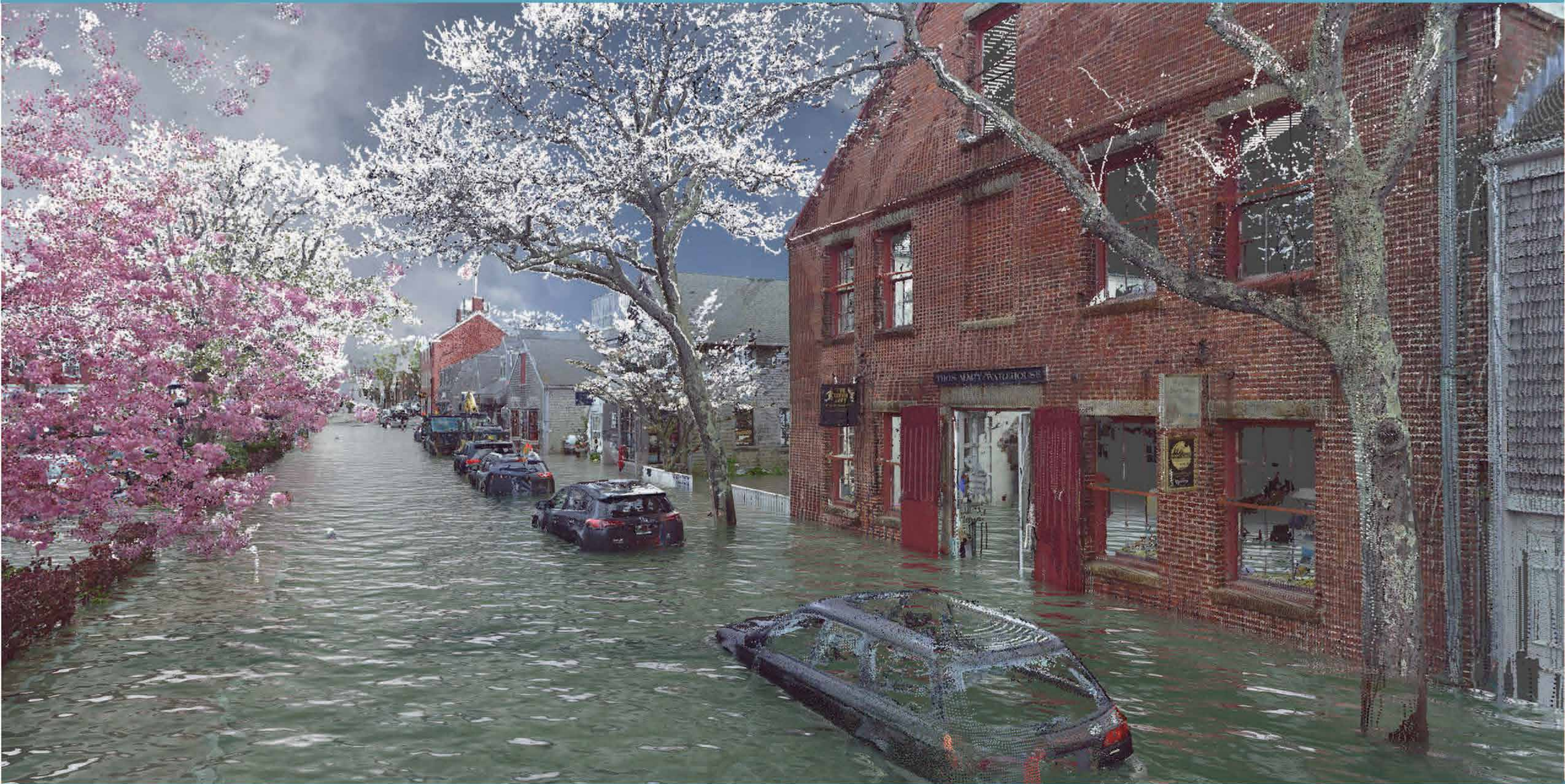
MACY WAREHOUSE at LOWER MAIN STREET

NOAA Intermediate - High Sea Level Rise Projection
2060 Water Level = 4.54 feet (above NAVD88)



MACY WAREHOUSE at LOWER MAIN STREET

NOAA Intermediate - High Sea Level Rise Projection
2080 Water Level = 6.14 feet (above NAVD88)



MACY WAREHOUSE at LOWER MAIN STREET

NOAA Intermediate - High Sea Level Rise Projection
2100 Water Level = 8.04 feet (above NAVD88)



WAVE SHUTTLE TERMINAL

NOAA Intermediate - High Sea Level Rise Projection
2019



WAVE SHUTTLE TERMINAL

NOAA Intermediate - High Sea Level Rise Projection
2080 Water Level = 6.14 feet (above NAVD88)

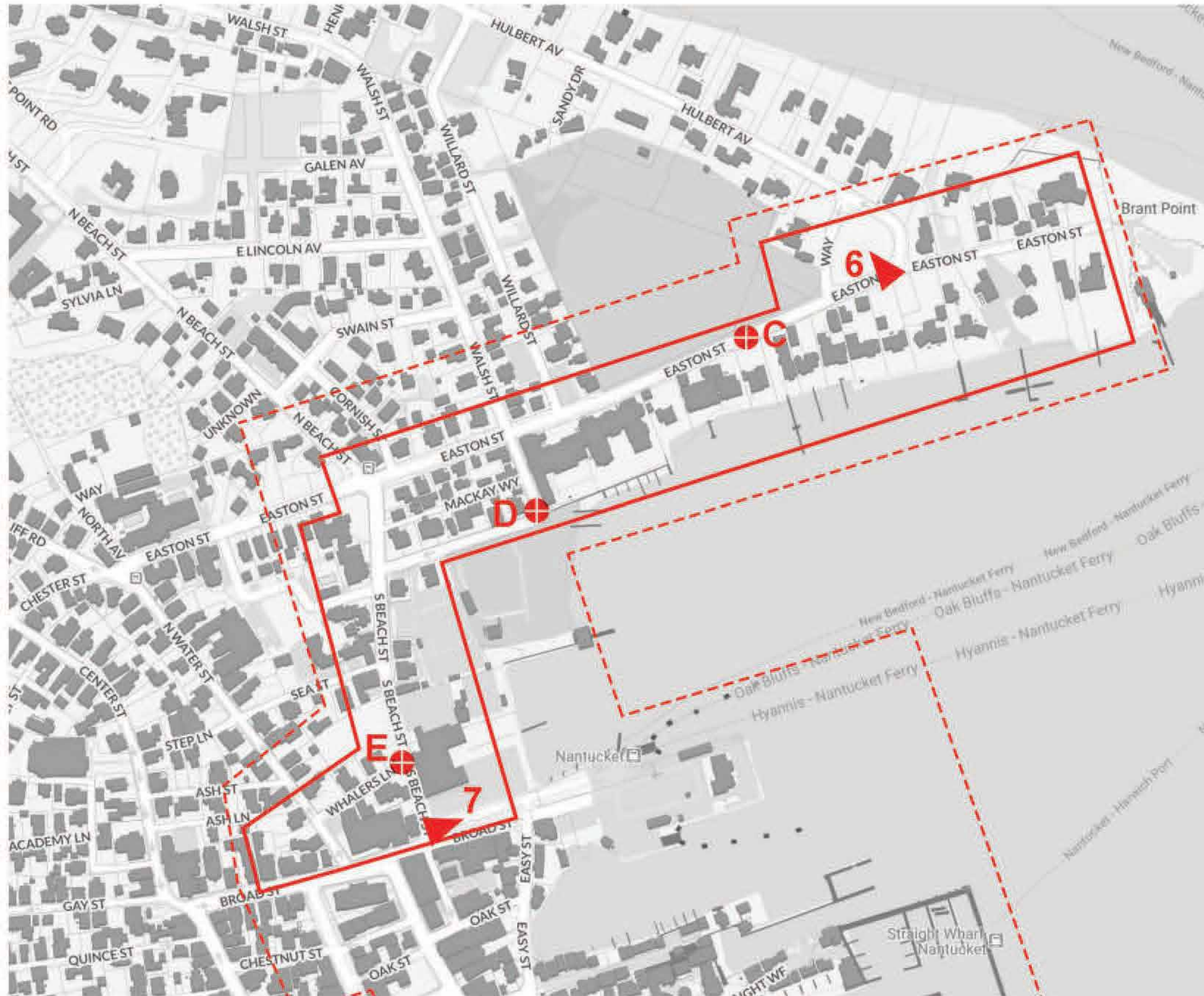


WAVE SHUTTLE TERMINAL

NOAA Intermediate - High Sea Level Rise Projection
2100 Water Level = 8.04 feet (above NAVD88)



SEA LEVEL RISE VISUALIZATION LOCATOR MAP



Visualization Locations

- 6. Brant Point at Easton Street
- 7. Broad & S Beach Streets

Benchmark Elevations Relative to NAVD88

- C. 2.40ft
- D. 2.92ft
- E. 3.90ft

STUDY AREA 2.A



BRANT POINT at EASTON STREET

NOAA Intermediate - High Sea Level Rise Projection
2019



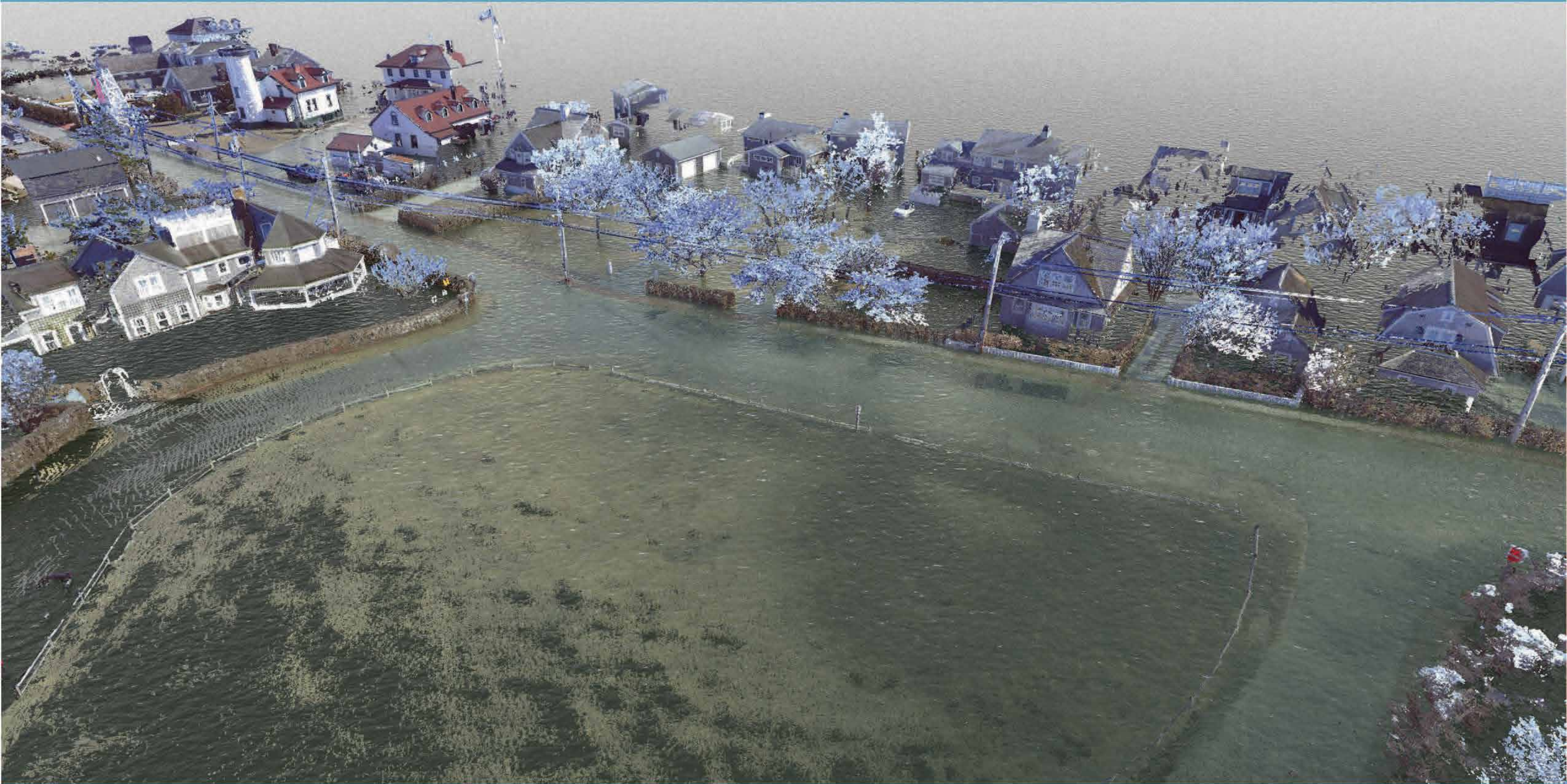
BRANT POINT at EASTON STREET

NOAA Intermediate - High Sea Level Rise Projection
2040 Water Level = 3.25 feet (above NAVD88)



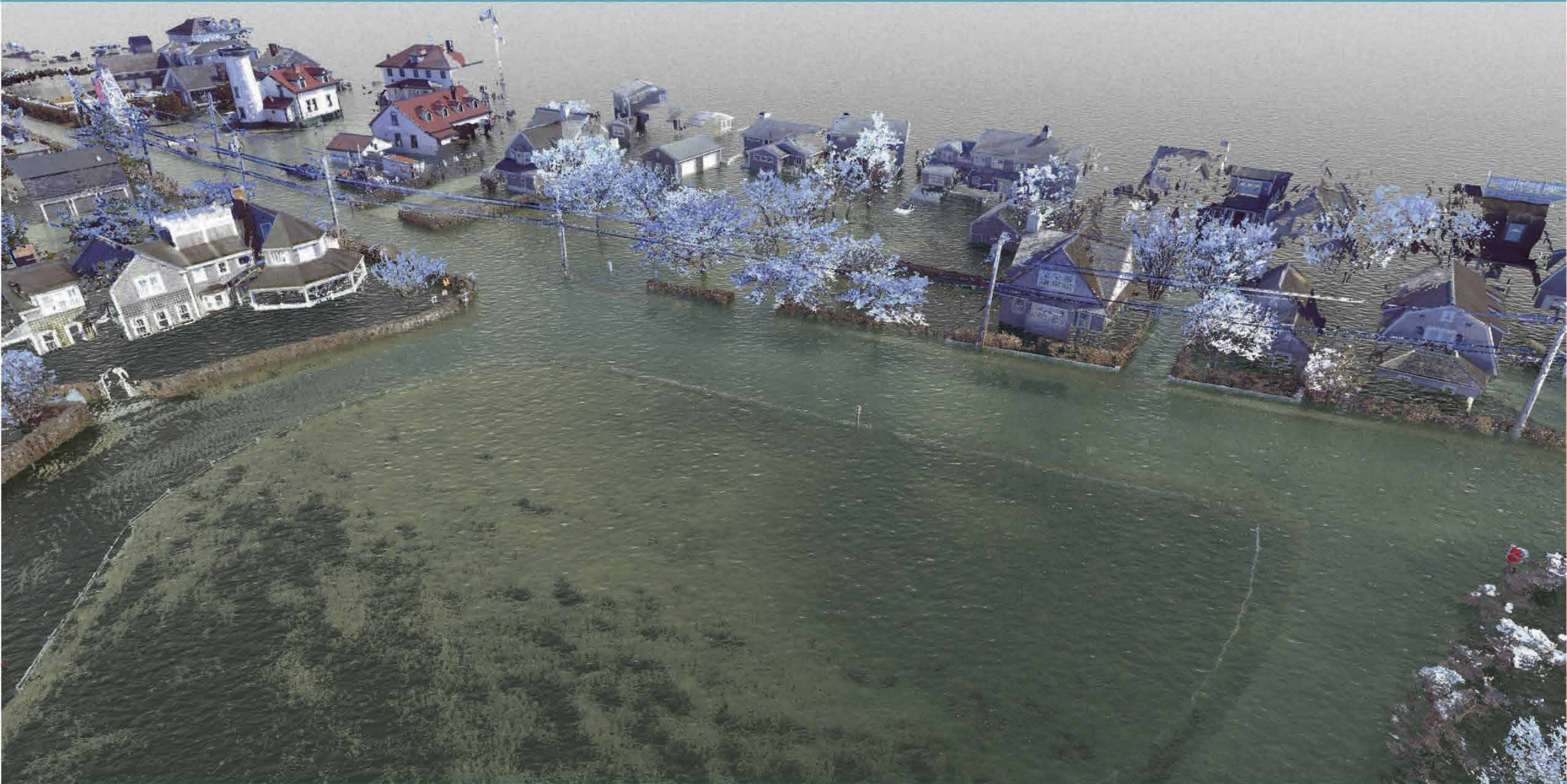
BRANT POINT at EASTON STREET

NOAA Intermediate - High Sea Level Rise Projection
2060 Water Level = 4.54 feet (above NAVD88)



BRANT POINT at EASTON STREET

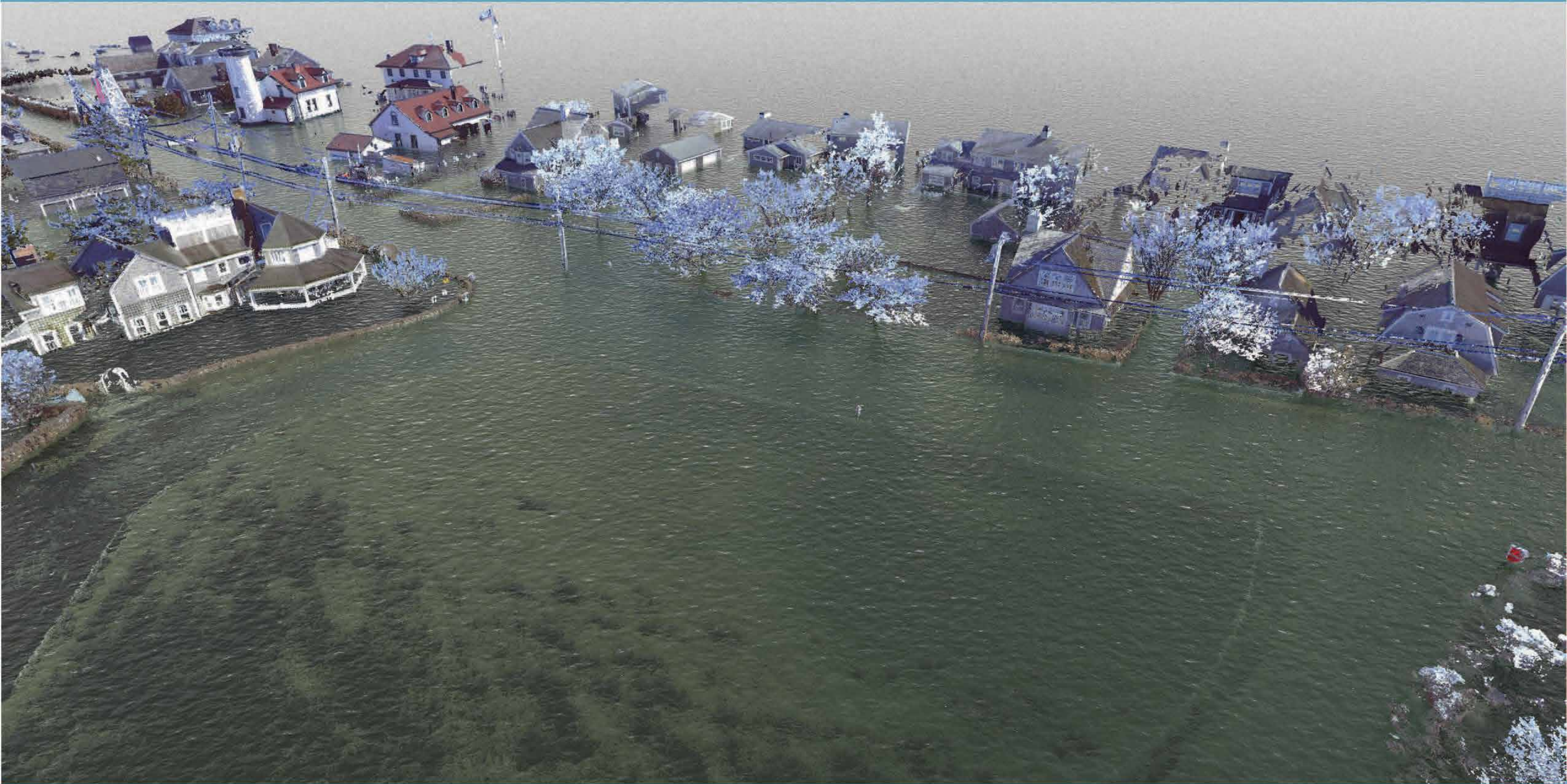
NOAA Intermediate - High Sea Level Rise Projection
2080 Water Level = 6.14 feet (above NAVD88)



BRANT POINT at EASTON STREET

NOAA Intermediate - High Sea Level Rise Projection

2100 Water Level = 8.04 feet (above NAVD88)



BROAD & S BEACH STREETS

NOAA Intermediate - High Sea Level Rise Projection
2019



BROAD & S BEACH STREETS

NOAA Intermediate - High Sea Level Rise Projection
2060 Water Level = 4.54 feet (above NAVD88)



BROAD & S BEACH STREETS

NOAA Intermediate - High Sea Level Rise Projection
2080 Water Level = 6.14 feet (above NAVD88)

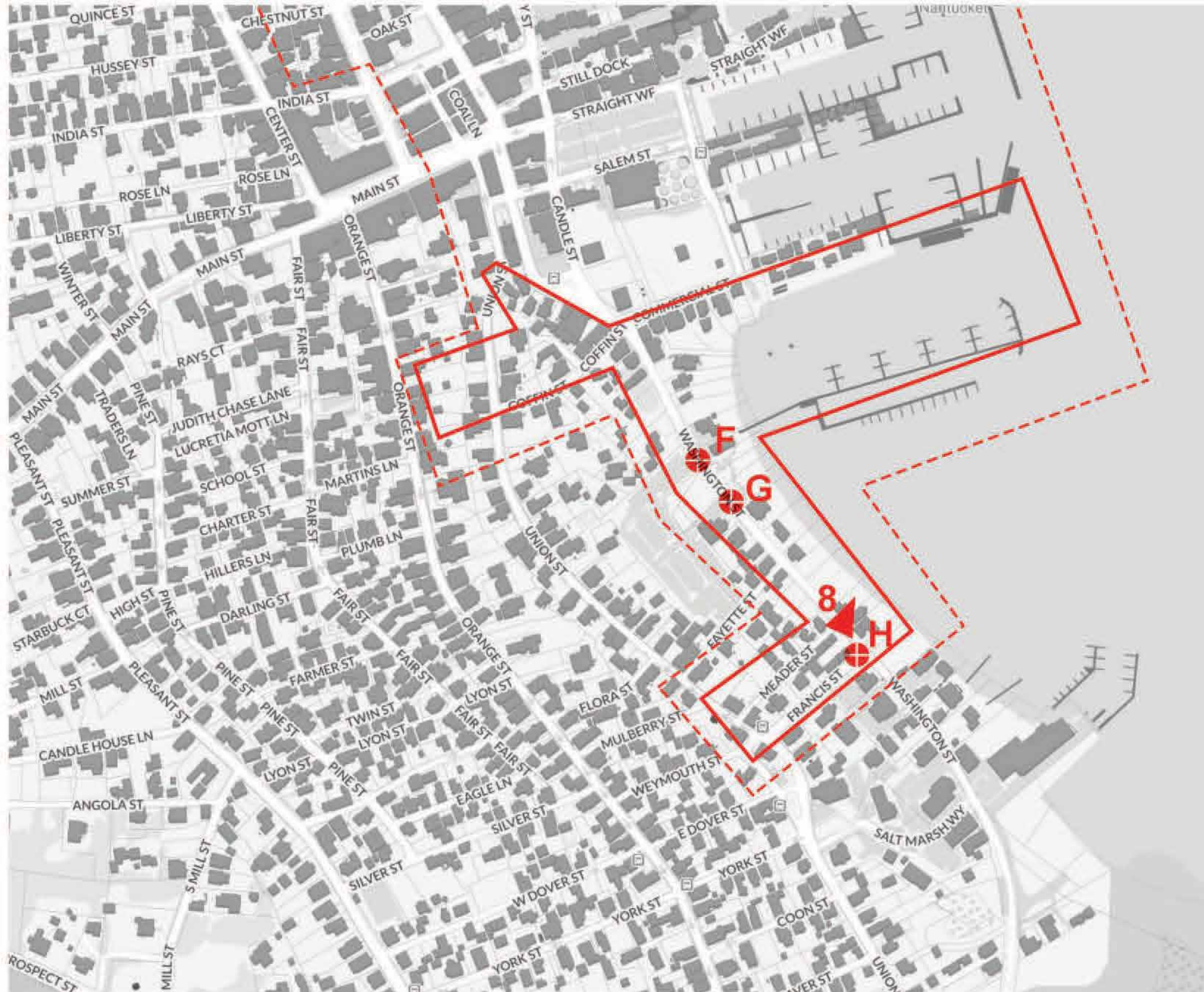



BROAD & S BEACH STREETS

NOAA Intermediate - High Sea Level Rise Projection
2100 Water Level = 8.04 feet (above NAVD88)



SEA LEVEL RISE VISUALIZATION LOCATOR MAP



 Visualization Locations

8. Harbor Cottages at Francis Street

 Benchmark Elevations
Relative to NAVD88

F. 3.93ft
G. 3.90ft
H. 4.03ft

STUDY AREA 2.B



HARBOR COTTAGES at FRANCIS STREET

NOAA Intermediate - High Sea Level Rise Projection
2019



HARBOR COTTAGES at FRANCIS STREET

NOAA Intermediate - High Sea Level Rise Projection
2060 Water Level = 4.54 feet (above NAVD88)



HARBOR COTTAGES at FRANCIS STREET

NOAA Intermediate - High Sea Level Rise Projection
2080 Water Level = 6.14 feet (above NAVD88)



HARBOR COTTAGES at FRANCIS STREET

NOAA Intermediate - High Sea Level Rise Projection
2100 Water Level = 8.04 feet (above NAVD88)

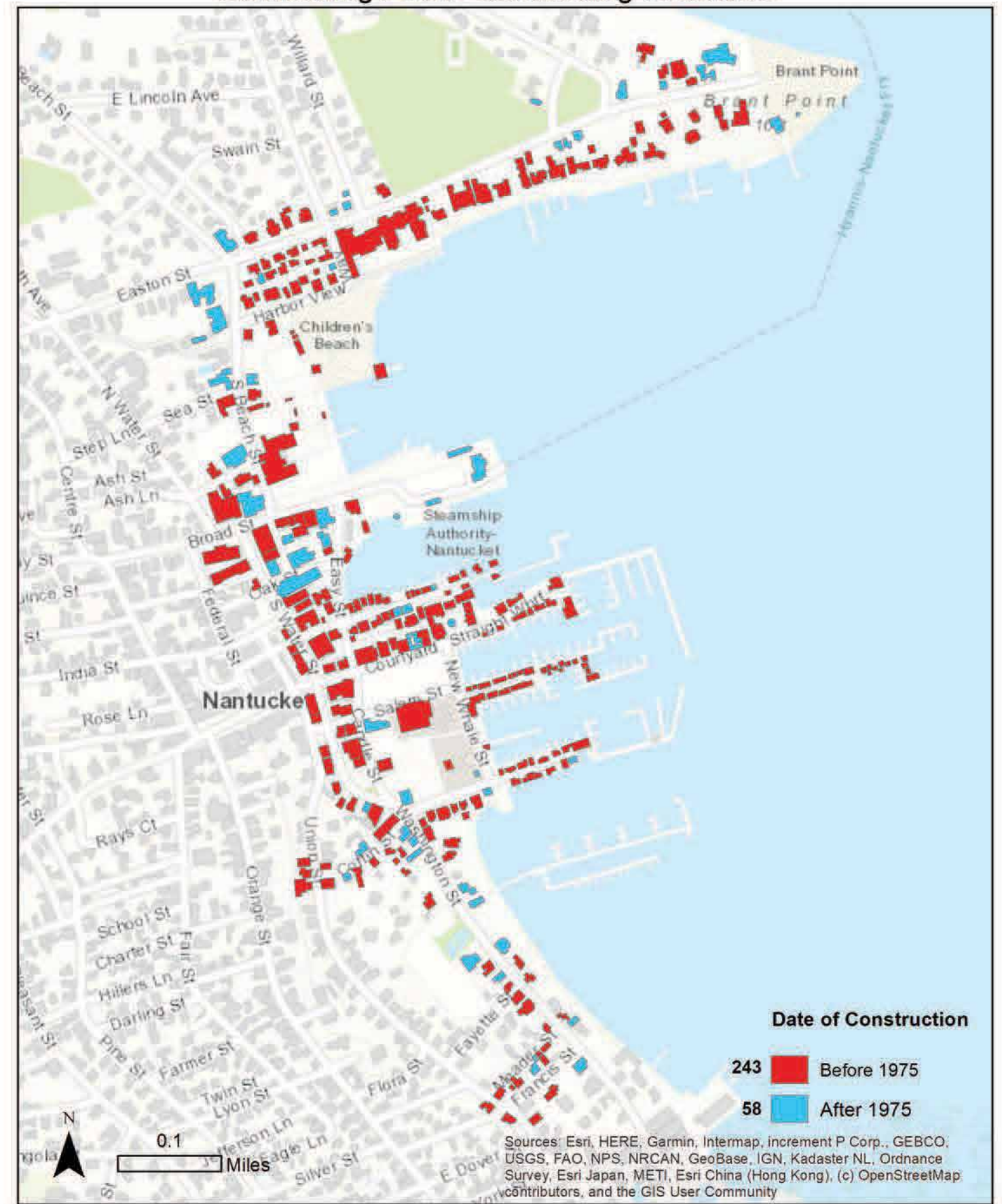


FLOOD VULNERABILITY ASSESSMENT FOR TOWN OF NANTUCKET

Study Area

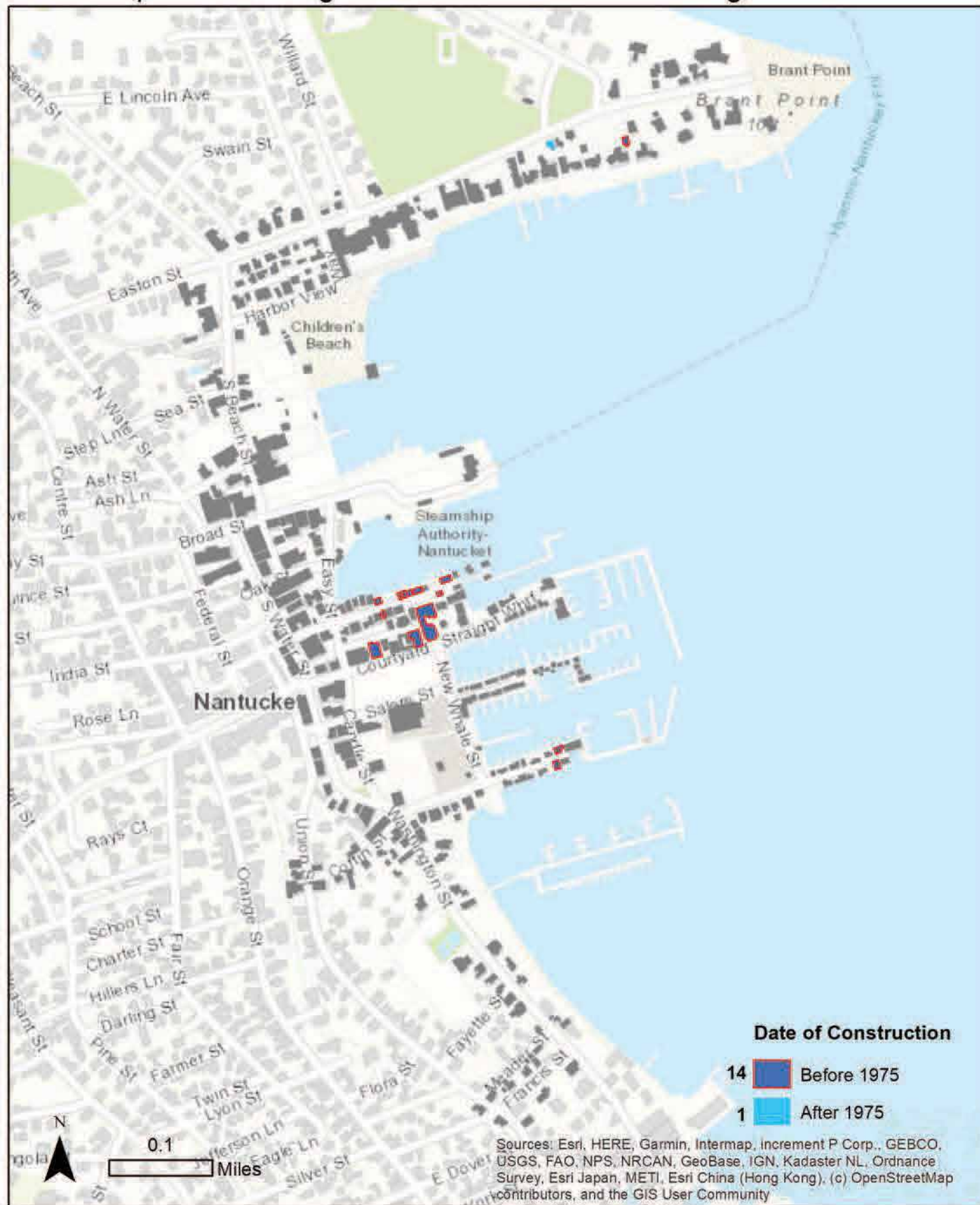


Contributing / Non - Contributing Structures



FLOOD VULNERABILITY ASSESSMENT FOR TOWN OF NANTUCKET 2040

Impacted Buildings under NOAA Intermediate High Scenario

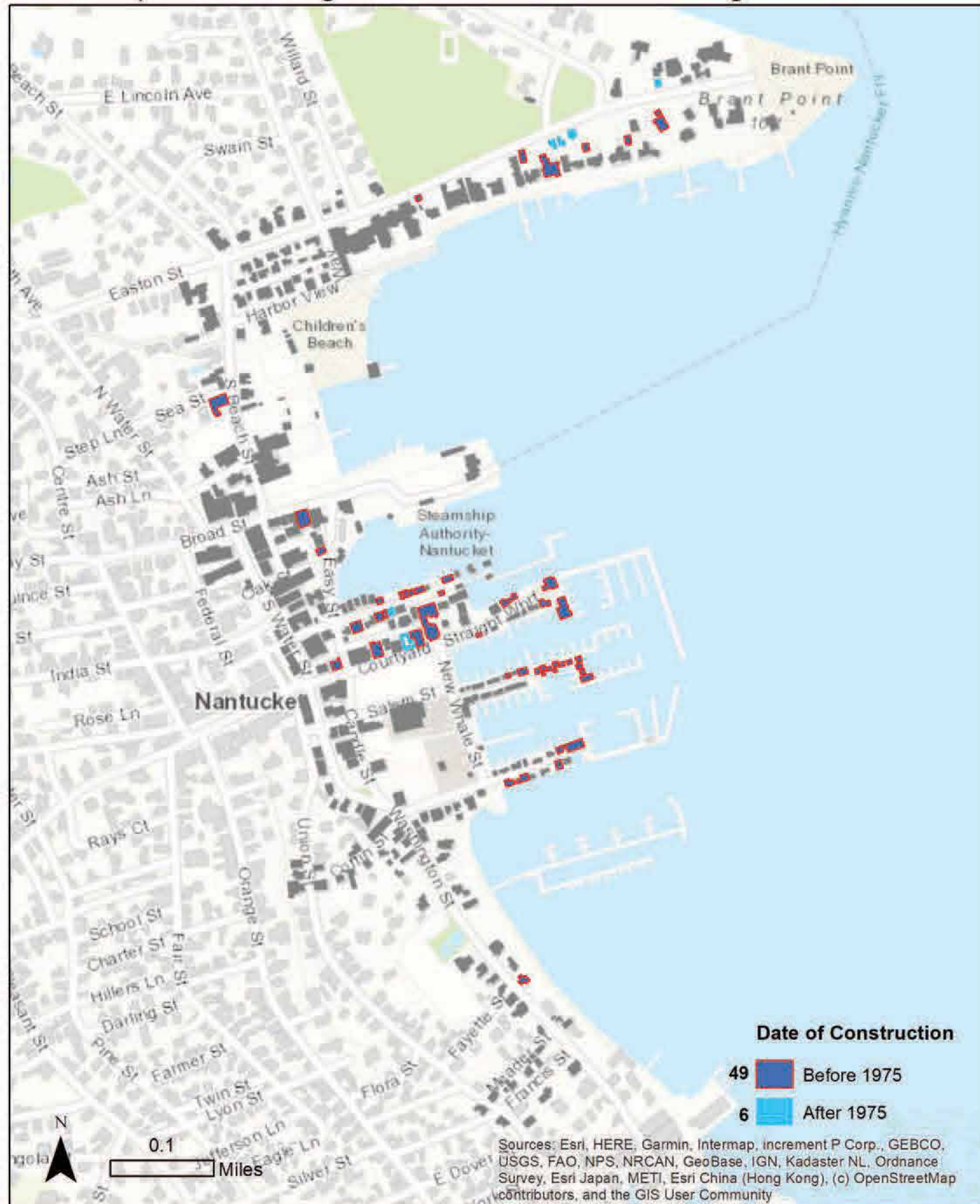


Structural Types of Impacted Historic Buildings

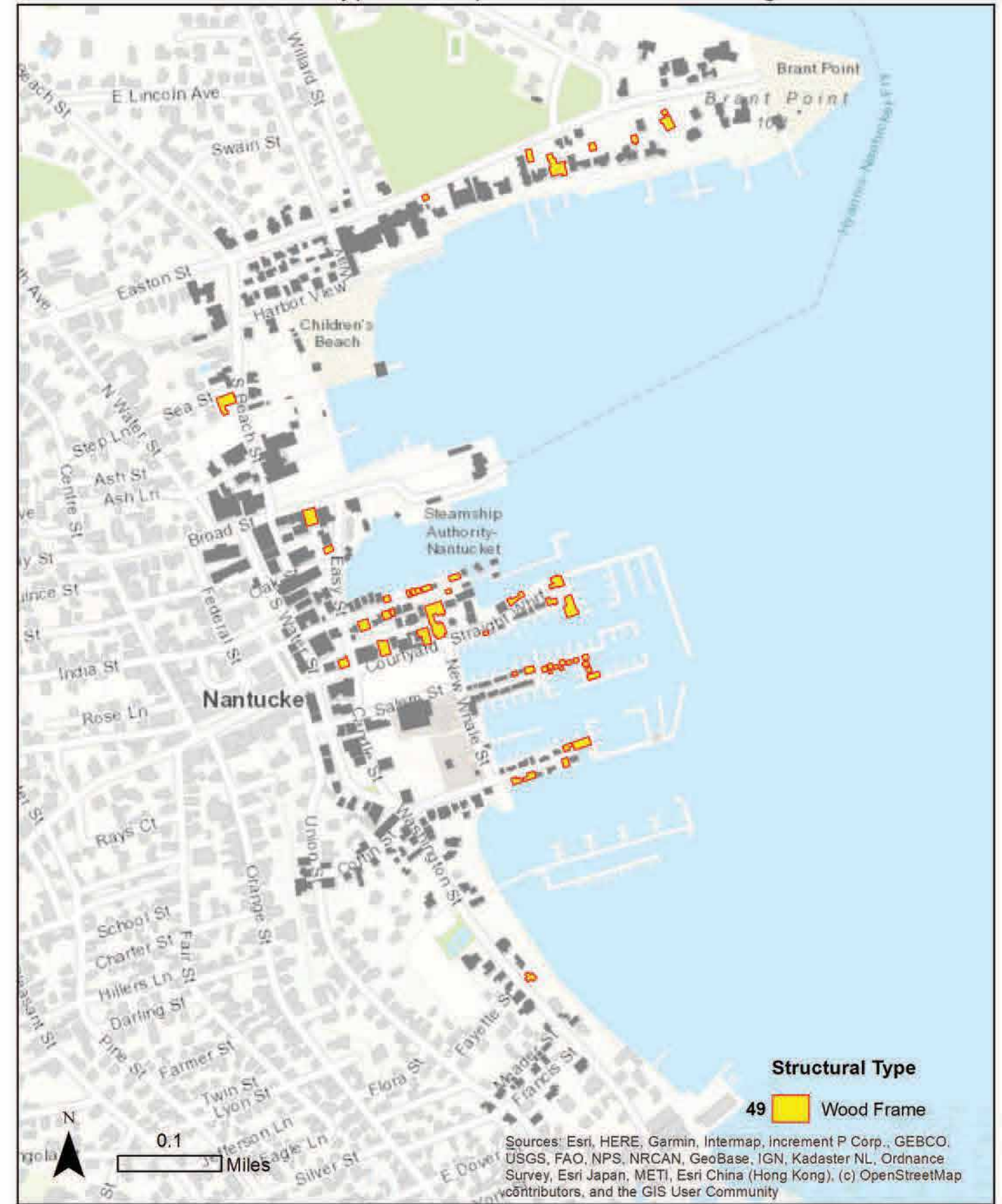


FLOOD VULNERABILITY ASSESSMENT FOR TOWN OF NANTUCKET 2060

Impacted Buildings under NOAA Intermediate High Scenario

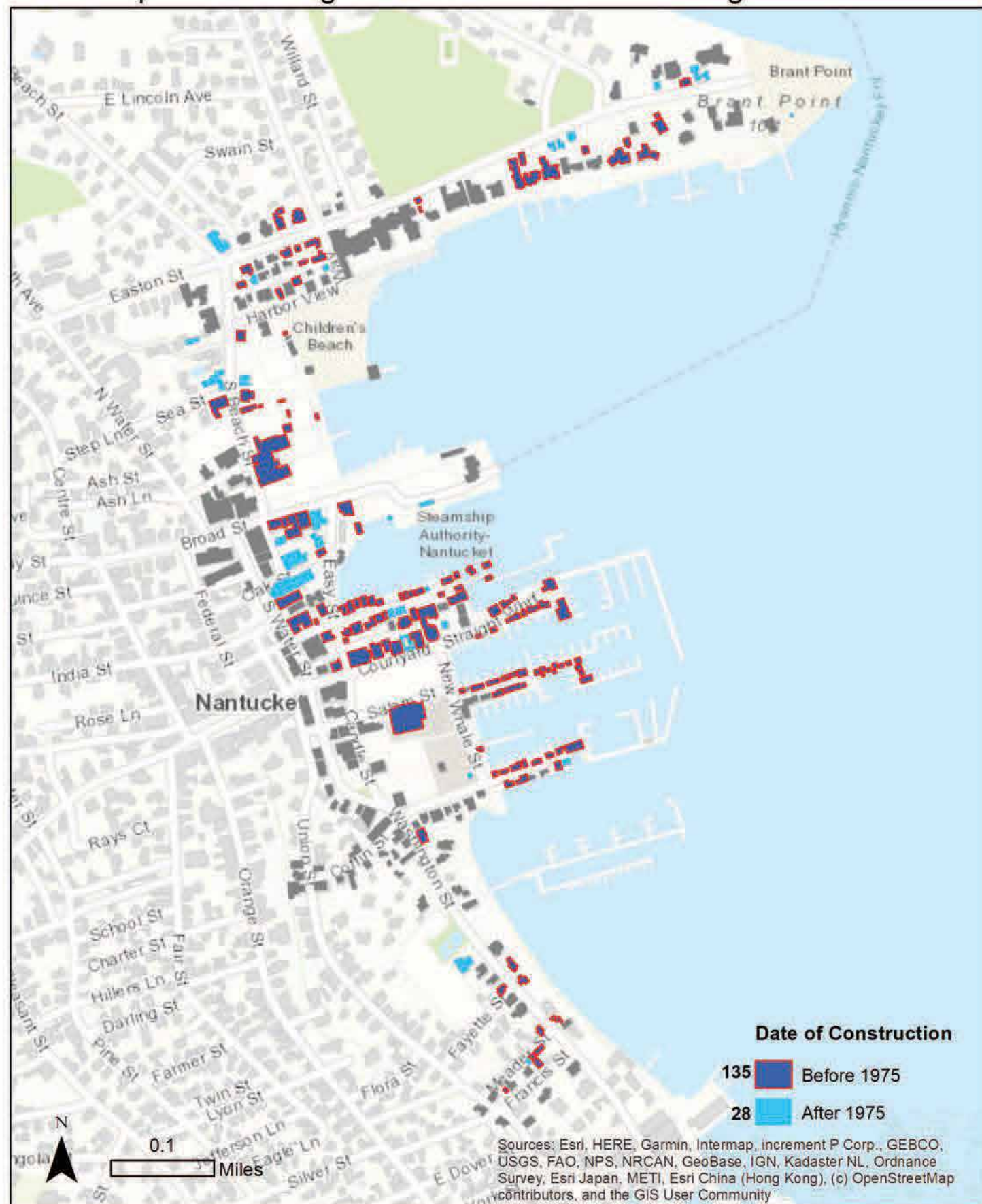


Structural Types of Impacted Historic Buildings

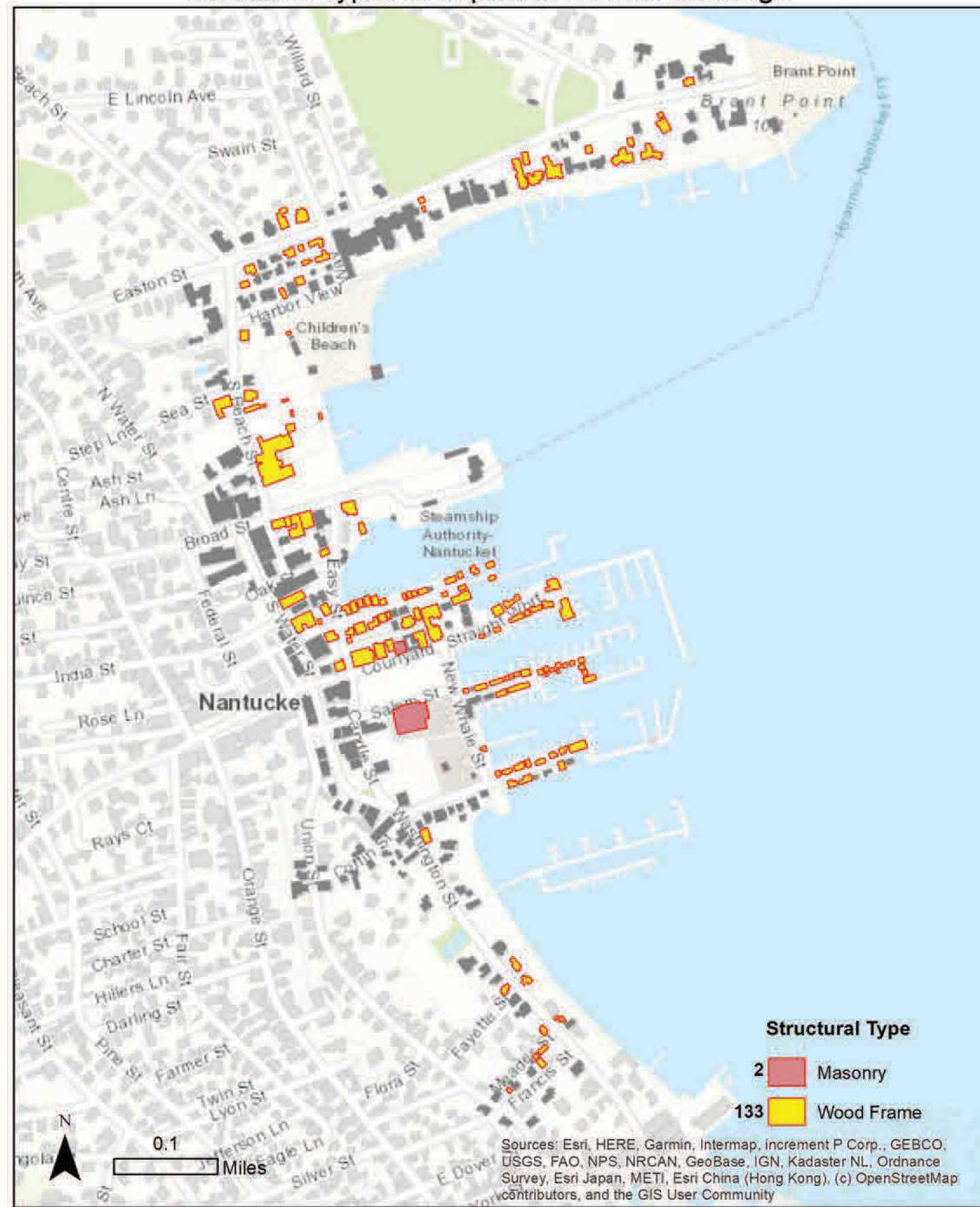


FLOOD VULNERABILITY ASSESSMENT FOR TOWN OF NANTUCKET 2080

Impacted Buildings under NOAA Intermediate High Scenario



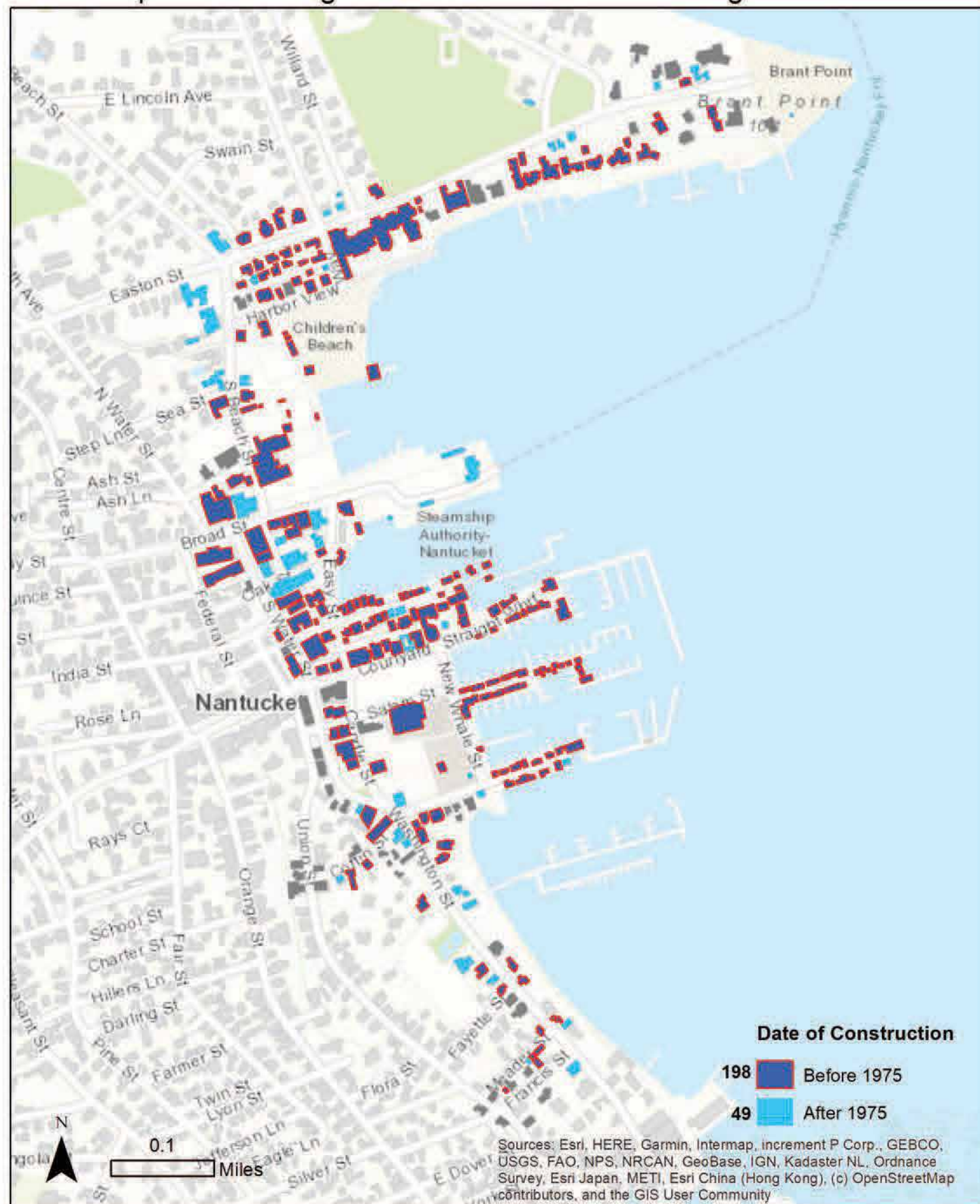
Structural Types of Impacted Historic Buildings



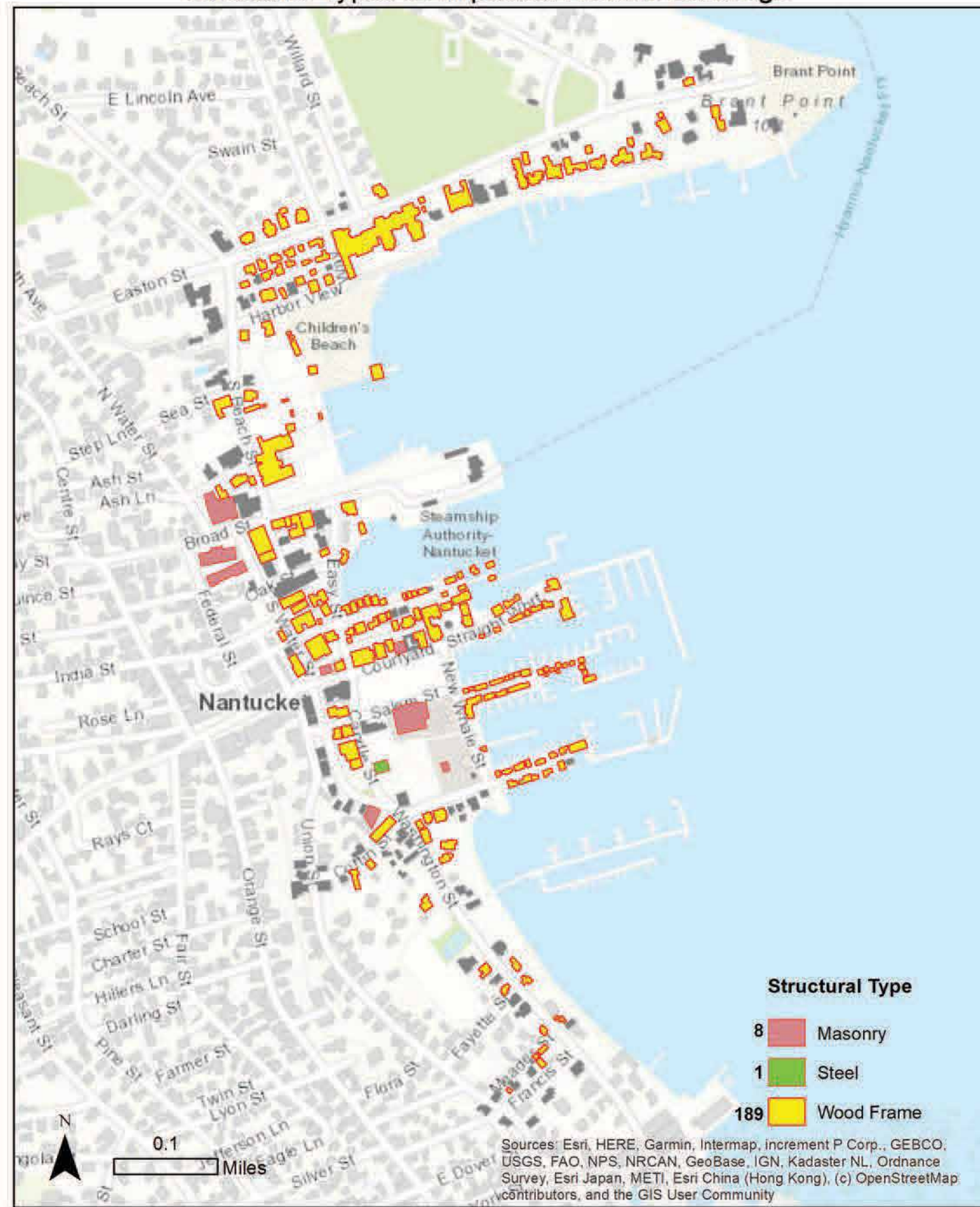
FLOOD VULNERABILITY ASSESSMENT FOR TOWN OF NANTUCKET

2100

Impacted Buildings under NOAA Intermediate High Scenario



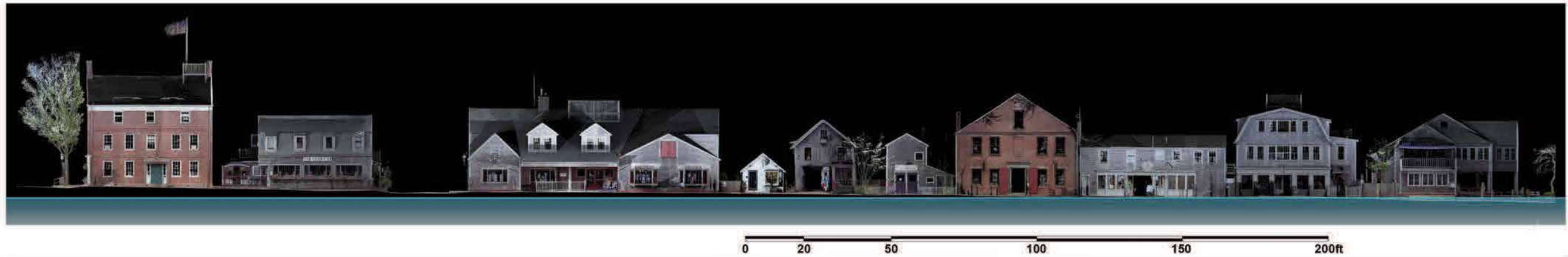
Structural Types of Impacted Historic Buildings



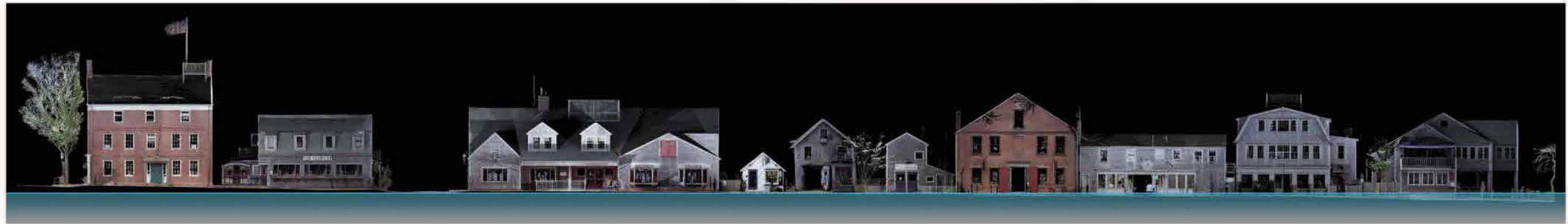
LOWER MAIN STREET
NANTUCKET, MA

NOAA INTERMEDIATE HIGH
SEA LEVEL RISE PROJECTION

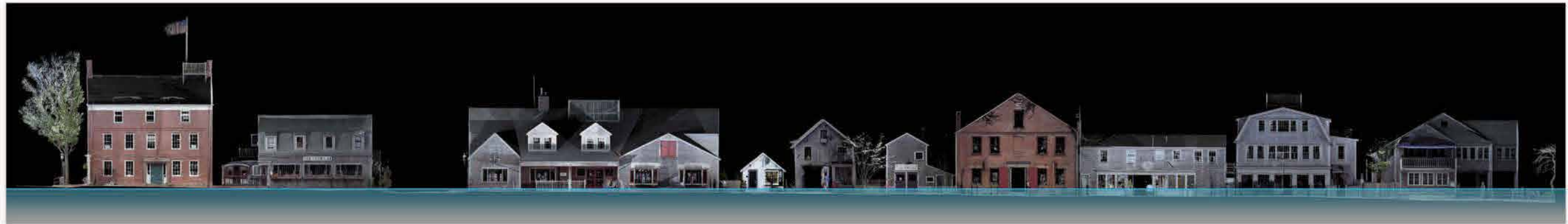
MHHW RELATIVE TO NAVD88
2040 - 3.25ft



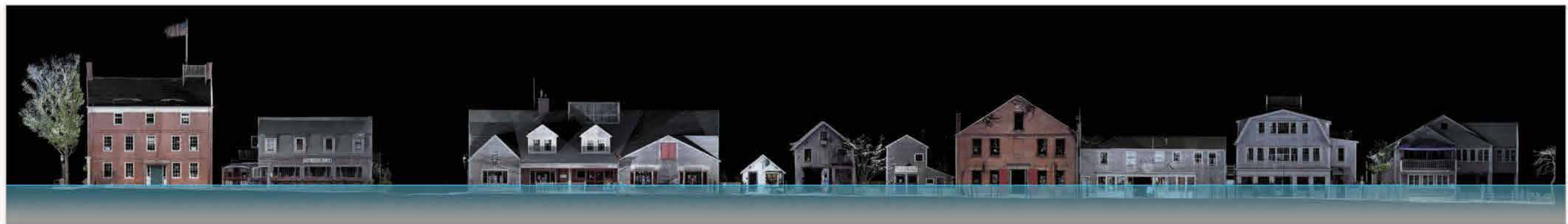
2060 - 4.54ft



2080 - 6.14ft



2100 - 8.04ft



BROAD STREET
NANTUCKET, MA

NOAA INTERMEDIATE HIGH
SEA LEVEL RISE PROJECTION

MHHW RELATIVE TO NAVD88
2040 - 3.25ft



0 20 50 100 150 200ft

2060 - 4.54ft



2080 - 6.14ft



2100 - 8.04ft

