Preparing Portsmouth's Historic District for Sea Level Rise

Portsmouth, New Hampshire

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August 28, 2018
Project 1702439

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Executive Summary

The City of Portsmouth has completed a historic resources climate change vulnerability assessment and adaptation planning effort. The project incorporates results of the 2013 Coastal Resilience Initiative newly adopted 2016 Downtown Historic Register District, along with the City's a 3-0 Massing Model and updated property valuation database, to develop 1) an economic and cultural valuation of its historic properties; 2) adaptation action recommendations for specific parcels and planning approaches in the City; and 3) greater understanding of groundwater issues likely to emerge as sea level continues to rise.

A Local Adaptation Committee of stakeholders concerned about historic assets in Portsmouth was central to development of the methods, results, and recommendation in the project. The valuation methodology uses economic, historic, cultural and flood water vulnerability measurements to characterize, risk-assess and prioritize key historic assets in the City. The project focuses on four strategy area to evaluate economic impact of flooding and sea-level rise in a variety of land uses and settings. Areas including Strawbery Banke, a national historic monument representing early colonial settlement in northern New England, were carefully evaluated for both sea-level change and rising groundwater or seepage impacts to historic structures. Other areas evaluated include a section of the South End neighborhood containing private, historically significant homes; a first-period cemetery; and the culturally significant Prescott Park.

Candidate adaptation actions were evaluated for 18 sites representative of historically significant neighborhoods in the four strategy areas. For each action or set of actions on these sites, the report discusses potential feasibility, effectiveness, cost, and implications for historic character if the actions are taken. An online Story Map was created to allow stakeholders an interactive means of visualizing sites evaluated and the candidate adaptation actions under consideration. Review is provided of recent research on groundwater trends and projections in the region given different sea level rise scenarios. Hydrologic modeling was conducted to visualize extents of surface water flooding under different tidal, surge, and sea level rise scenarios in Portsmouth. Recommendations are made for actions to update planning and emergency management documents in light of results from the study, and options are articulated for a network of groundwater monitoring wells and other collaborative monitoring activity that could be undertaken in the near future. In combination the approaches developed for the project have broad-based applicability for other coastal communities aiming to enhance resiliency.

1. Context

The City of Portsmouth, population 23,500, is a thriving coastal community with a robust tourist economy based on its rich architectural history with the State's only deep water port it has a unique location along a scenic tidal river mouth. Also situated along the waterfront is the historic Portsmouth Naval Shipyard.

Supported by funding from the National Park Service (NPS) under the Hurricane Sandy Pre-Disaster Mitigation grant program through the State of New Hampshire Division of Historic Resources, the City of Portsmouth initiated this project to create a Historic Resources Climate Change Vulnerability Assessment and Adaptation Plan. Following on a Coastal Resilience Initiative in which the City mapped areas most vulnerable to sea level rise and severe coastal storms (City of Portsmouth, 2013), this effort incorporates results of the newly adopted 2016 Downtown National Historic Register District with the City's Local Historic District, its 3-D Massing Model and the City's property valuation database to develop a historic, economic and cultural valuation of properties within the Historic Districts. The valuation methodology uses economic, historic, cultural and flood water vulnerability measurements to characterize, risk-assess and prioritize key historic assets in the City. A Local Adaptation Committee of over ten Historic District stakeholders met monthly through 2017 to help structure the approach to historic assets in the District and guide project decisions.

The project focused on four strategy areas to evaluate the impact of flooding and sea-level rise on historic assets in a variety of land uses and settings. These areas encompassed Strawbery Banke, a national historic monument representing early colonial settlement in northern New England; an older section of the South End neighborhood including private, historically significant homes; a first-period cemetery; and the culturally significant Prescott Park. In the downtown, the study evaluated impacts of sea-level rise for structures on the working waterfront, where both commercial and industrial uses continue to operate and depend on land-side support services.

The study included a multidisciplinary team of local and regional practitioners integrating a variety of economic, environmental, cultural, historic, and engineering factors. Using online visualization tools, field surveys of the historic structures, and current valuation data, the methods combine value scores with flood risk scores. These results were used to identify and evaluate candidate adaptation actions in each strategy area. Recommendations are provided for planning and code revision; emergency management; and collaborative monitoring to enhance resiliency of the historic resources in Portsmouth.

2. Vulnerability Assessment Methods

2.1 Scenario Models

To assess vulnerability of historic buildings and land, the project team used a flood of 11.2 ft that represents a 100-year flood (the "base flood elevation") at Mean Higher High Water (MHHW) in 2013 conditions and added water depth to reflect that floods of this size will be made worse by sea level rise over time. The water surface elevation for this modeled event was 13.5 ft NAVD88 and represents a merging of water surface elevations from 1) a 100-year flood (11.2 ft); 2) sea level rise amounts from a High Emissions scenario by 2050 (totaling 12.9 ft, 1.7 ft of which is from sea level rise); and 3) sea level rise amounts from a Low Emissions scenario by 2100 (13.7 ft, 2.5 ft of which is from sea level rise). These parameters were developed through the City of Portsmouth's Community Resilience Initiative (City of Portsmouth, 2013). Using this 13.5 ft flood boundary, GEI created a depth grid representing depths of water from a 13.5 ft flood on the surrounding land using a Digital Elevation Model (DEM) from a LiDAR (Light Detection and Ranging) survey. The flooding boundary and depth grids were used to identify buildings and landscapes from the registry of historic places in Portsmouth.

2.2 Local Adaptation Committee

City staff selected members of the Local Adaptation Committee (LAC) to represent diverse interests in Portsmouth's historic assets. Membership included representatives from City Council, the Historic District Commission, the Conservation Commission, managers of Strawbery Banke, interested historic preservation experts, residents of the study area, local businesses, and City Staff representing the Department of Public Works and Prescott Park and serving as liaison for the Conservation Commission and the Historic District Commission. Five meetings were held to 1) brief participants on project progress to date, 2) solicit input and help make decisions on data collection and interpretation, 3) discuss project recommendations, and 4) discuss how to effectively continue developing momentum created through the project, including with a large public presentation on the overall project.

2.3 Value and Risk Mapping

2.3.1 Historic value scoring

Methodology

To complete the historic value scoring component of the assessment, SEARCH Inc. of Portsmouth, New Hampshire used two previous surveys to guide the work: the 2016 National Register Nomination of the Portsmouth Downtown Historic District (PAL 2016) and a survey of historic resources within Portsmouth completed in 1986 (Portsmouth Advocates). SEARCH then conducted a field survey of those properties within the 13.5 ft and 11.5 ft flood zones that were also located in both the national and local historic districts. Historic resources included private residences, municipal buildings, commercial and retail buildings, bridges, cemeteries, and designed landscapes. A total of 418 historic resources are located within the flood zones and the Portsmouth Downtown Historic District. There were an additional 85 historic resources that were part of local historic district but not located within the flood zones, totaling 503 properties and structures in this historic value assessment.[1]

Field Survey

SEARCH architectural historian, Jenna Dunham, MS completed the historic value scoring assessment by conducting a field survey from July through September 2017. She was assisted in the field by SEARCH historian, Tricia Peone, PhD. Historic value scoring survey for the project used standard procedures for the location, investigation, and recording of historic properties. SEARCH and the City of Portsmouth provided field maps to identify each of the 503 historic resources within the study area. These maps were cross referenced with GIS data, location address, and date of construction provided by the City of Portsmouth Assessor's database. Additional information including the historic name of the resource, whether it was contributing or non-contributing, and type of resource was obtained through the 2016 Portsmouth Downtown Historic District National Register Nomination and the 1986 survey performed by the Portsmouth Advocates.

During the field survey, the location of a historic resource was confirmed through data provided by the assessor's database and/or the survey information for the historic districts. Identified historic resources were photographed with a digital camera and all pertinent information regarding architectural style, distinguishing characteristics, and present condition was recorded in field notes and photo-log. The historic value assessment was then completed through field examination and background information known about the resource from the 1986 and 2016 surveys. Date of construction, design, architectural features, condition, and integrity of the structure, as well as how the resources relate to the surrounding landscape, were carefully considered. Upon completion of fieldwork, the historic value score and photographs were returned to the SEARCH offices for analysis. This information was then compiled into Microsoft Excel format and exported into a GIS for creation of the historic value map.

The *Secretary of the Interior's Standards for Evaluating the Integrity of a Property* was used in assigning the historic value score. This is a standard evaluation procedure used by architectural historians, preservation planners, historians, and other individuals when

[1] Note that many other structures (both historic and non-historic) are located outside the historic districts but within the 13.5 storm-surge/sea-level rise zone. Note that the data used in this study does not include an assessment of accessory buildings and does not include flooding impacts to the basements of abutting structures or buildings.

assessing the historic integrity of a resource for National Register of Historic Places eligibility. The Secretary of the Interior's Standards identify seven aspects of integrity: location, design, setting, materials, workmanship, feeling, and association. Each is described in further detail below from an excerpt from *National Register Bulletin #15: How to Apply the National Register Criteria for Evaluation* (Andrus 1990):

> **Location**
>
> **Location is the place where the historic property was constructed or the place where the historic event occurred.** The relationship between the property and its location is often important to understanding why the property was created or why something happened. The actual location of a historic property, complemented by its setting, is particularly important in recapturing the sense of historic events and persons. Except in rare cases, the relationship between a property and its historic associations is destroyed if the property is moved.
>
> **Design**
>
> **Design is the combination of elements that create the form, plan, space, structure, and style of a property.** It results from conscious decisions made during the original conception and planning of a property (or its significant alteration) and applies to activities as diverse as community planning, engineering, architecture, and landscape architecture. Design includes such elements as organization of space, proportion, scale, technology, ornamentation, and materials.
>
> A property's design reflects historic functions and technologies as well as aesthetics. It includes such considerations as the structural system; massing; arrangement of spaces; pattern of fenestration; textures and colors of surface materials; type, amount, and style of ornamental detailing; and arrangement and type of plantings in a designed landscape.
>
> Design can also apply to districts, whether they are important primarily for historic association, architectural value, information potential, or a combination thereof. For districts significant primarily for historic association or architectural value, design concerns more than just the individual buildings or structures located within the boundaries. It also applies to the way in which buildings, sites, or structures are related: for example, spatial relationships between major features; visual rhythms in a streetscape or landscape plantings; the layout and materials of walkways and roads; and the relationship of other features, such as statues, water fountains, and archeological sites.

Setting

Setting is the physical environment of a historic property. Whereas location refers to the specific place where a property was built or an event occurred, setting refers to the *character* of the place in which the property played its historical role. It involves *how*, not just where, the property is situated and its relationship to surrounding features and open space.

Setting often reflects the basic physical conditions under which a property was built and the functions it was intended to serve. In addition, the way in which a property is positioned in its environment can reflect the designer's concept of nature and aesthetic preferences.

The physical features that constitute the setting of a historic property can be either natural or manmade, including such elements as:

- Topographic features (a gorge or the crest of a hill);
- Vegetation;
- Simple manmade features (paths or fences); and
- Relationships between buildings and other features or open space.

These features and their relationships should be examined not only within the exact boundaries of the property, but also between the property and its *surroundings*. This is particularly important for districts.

Materials

Materials are the physical elements that were combined or deposited during a particular period of time and in a particular pattern or configuration to form a historic property. The choice and combination of materials reveal the preferences of those who created the property and indicate the availability of particular types of materials and technologies. Indigenous materials are often the focus of regional building traditions and thereby help define an area's sense of time and place.

A property must retain the key exterior materials dating from the period of its historic significance. If the property has been rehabilitated, the historic materials and significant features must have been preserved.

Workmanship

Workmanship is the physical evidence of the crafts of a particular culture or people during any given period in history or prehistory. It is the evidence of artisans' labor and skill in constructing or altering a building, structure, object, or site. Workmanship can apply to the property as a whole or to its individual components. It can be expressed in vernacular methods of construction and plain finishes or in highly sophisticated configurations and ornamental detailing. It can be based on common traditions or innovative period techniques.

Feeling

Feeling is a property's expression of the aesthetic or historic sense of a particular period of time. It results from the presence of physical features that, taken together, convey the property's historic character. For example, a rural historic district retaining original design, materials, workmanship, and setting will relate the feeling of agricultural life in the 19th century. A grouping of prehistoric petroglyphs, unmarred by graffiti and intrusions and located on its original isolated bluff, can evoke a sense of tribal spiritual life.

Association

Association is the direct link between an important historic event or person and a historic property. A property retains association if it is the place where the event or activity occurred and is sufficiently intact to convey that relationship to an observer. Like feeling, association requires the presence of physical features that convey a property's historic character. For example, a Revolutionary War battlefield whose natural and manmade elements have remained intact since the 18th century will retain its quality of association with the battle.

Historic Value Assessment Scoring

In addition to historic integrity, the historic properties were also assessed for their historical significance. In most cases, this has previously been established by the previous surveys, particularly the 2016 National Register Nomination of the Portsmouth Downtown Historic District. In the National Register Nomination, each property was assessed for its status as contributing or non-contributing status within the district. Those historic resources that were previously defined as contributing to the historic district were presumed to retain their historic significance, unless major alterations had been made since the 2016 survey.

Finally, each property was assessed for its retention of essential physical features. It is presumed all buildings and historic resources will encounter change over time. According to the Secretary of the Interior's Standards, it is not necessary for a property to retain all of its historic physical features or characteristics. However, the property must retain the essential physical features in order to convey its historical identity (NPS Bulletin #15).

Historic value scores were assigned in a range from 1 – 5. During the field survey and historic value scoring, those properties that retain a high degree of integrity, as well as character-defining physical features, earned a higher value score (4 or 5). Buildings or resources that had lost not only their integrity but also key physical attributes were assigned a lower score (2 or 3), and properties that did not retain any aspects of integrity or had not yet met the 50-year age criteria for the National Register were assigned the lowest score (1).

Historic Value Score – 5

Resources with a score of 5 retained a high degree if not all aspects of the Secretary of the Interior's Standards of Integrity (location, design, setting, materials, workmanship, feeling, and association). In addition, few modern materials were used on the building or landscape. Any alterations were minor or not visible on the main façade or from the public right-of-way. Renovations or restoration work, if present, had been completed in a historically sensitive manner. Many buildings that received a historic value score of 5 were located in the Strawbery Banke and South End Neighborhoods.

Historic Value Score – 4

Resources with a value score of 4 retained the majority, or nearly all, aspects of integrity with very few visible alterations. These buildings only had minor use of modern building materials, such as replacement windows, or a small addition on the rear or side elevation. Any renovation work was also completed historically sensitively, where original materials were reused rather than replaced. Buildings and landscapes that received this score were located in Strawbery Banke, the South End Neighborhood, South Mill Pond, and Prescott Park.

Historic Value Score – 3

Resources that received a historic value score of 3 were noted as having a medium level of historic integrity. These resources have retained some aspects of historic integrity but also have substantial alterations such as large additions visible from the public right-of-way and/or altered window and door openings. In addition these properties incorporated modern building materials such as vinyl siding to replace original wood clapboard or shingle siding, resulting in partial loss of most original building material. However, the resources still retained some defining historic characteristics such as corner boards, sidelights around the main entry, or exposed granite foundation. Examples of resources that received a historic value score of 3 were seen in the North and South Mill Pond areas, Market Street, and the South End Neighborhood.

Historic Value Score – 2

Resources with a score of 2 retained very few aspects of historic integrity. In addition, these buildings would have significant alterations, particularly on the main façade. Examples include a large enclosed porch added to the primary façade or demolition of a portion of the original structure. Resources with a score of 2 had also lost of the majority of original materials and retained few of their historic features. Examples were seen in the North and South Mill Pond strategy areas as well as Market Street and the South End Neighborhood.

Historic Value Score – 1

Resources with a score of 1 were either not of historic age (the National Register criteria state a resource must be over 50 years old to qualify) or because it retained almost no historic or original building materials, had lost essentially all aspects of historic integrity, and no longer exhibited defining historic features. Properties with a historic value score of 1 were found in all neighborhoods of the study area.

Not Visible

A small number of resources were not visible during the field survey. These were primarily ancillary buildings such as sheds or garages, which were set behind the main structure and were surrounded by a fence or otherwise not visible from the public right-of-way.

2.3.2 Cultural value scoring

As a supplement to the historic value of the individual properties within the study area, the properties were also assessed for their cultural significance. The importance to cultural value areas relates to the concept of the whole being greater than the sum of the parts and that some areas, like Strawbery Banke, represent much greater assets to the community than any of the individual properties or structures within Strawbery Banke. Thus, staff initially identified seven cultural value areas (Figure 1) and include the working waterfront, downtown waterfront, Prescott Park, Strawbery Banke, Peirce Island, the civic campus along the south mill pond and the South End Neighborhood. The local advisory committee was asked to rate each area for the following five criteria and then develop a composite score in order to assign a weight or cultural value score.

1. Public Use and Access: The level and frequency of public use and enjoyment of the area.
2. Aesthetic Value: The degree to which the landscape or historic properties provide a coherent expression of history.
3. Economic Value: The direct, indirect and induced spending levels and relationship to the city's cultural heritage and tourism economy.
4. Educational Value: The degree of educational utility to tell the story of the city's historical development.
5. Symbolic Value: The level of symbolism that the area represents as a character-defining aspect of Portsmouth.

Cultural value scores were assigned for each criterion in a range from 1 – 5. Those area that retain a high degree of value from the committee earned a higher value score (4 or 5). After scoring each area based on the five criteria the scores were totaled in order to assign an aggregate score and ranking for each area. The cultural value rankings were as follows:

Cultural Value Score – 5

The only cultural value area with a score of more than 26 was Strawbery Banke with had the highest ranking across all five criteria. Not surprisingly, Strawbery Banke represents the primary historical resource for the city.

Cultural Value Score – 4

The Downtown Waterfront, Prescott Park and the South End Neighborhood all scored high with respect to their public use and access, aesthetic and economic values.

Cultural Value Score – 3

The Working Waterfront, comprising of the area along Market, Bow and Ceres Street, scored high on its economic and symbolic value but lower on public use, aesthetic and educational value. Similarly, Pierce Island scored high for public use and access but low for its educational value. Finally, the Civic Campus along the South Mill Pond scored high for its public use and access and aesthetic value and lower for economic and symbolic value.

2.3.3 Tax value scoring

As a final supplement to the historic value of the individual properties within the study area, the properties were also assessed for their economic or asset value. The importance to economic value areas relates to both the direct value to the city's tax base as well as the direct costs associated with a loss of value relating to a major storm event. Values were derived from the city's assessment records and only included the principal structures – including non-historic properties within the target area – a pro-rated figure of land value lost to sea-level rise. Replacement cost of the principal structure was used a general proxy for loss in the event of the major stormwater event. Importantly, the indirect costs relating to cultural heritage or tourism impacts were not included in the data or the analysis. Further, assessment of public- or non-profit-owned properties and structures (e.g., cemeteries, municipal buildings, religious facilities, parks) are suspected of being undervalued given their tax-exempt status. Thus, further research is needed to refine the figures for these property types.

In summary, in a major storm event or sea-level rise to 11.5 ft., the economic value assessment identified a potential direct loss of nearly $1 billion of property within the target area. With an overall tax base of $5.4 billion dollars this figure represents nearly 20% of the city tax base. Using the assessment data for replacement cost and apportioning the land area impacted by sea-level rise, each of the properties was scored and ranked from 1 through 5 and a weight of .25 was then applied to the score. Thus, the range of values was from 0.25 (for a score of 1) to 1.25 (for a score of 5).

2.3.4 Composite value scoring

Historic values were ranked 1 through 5, with each score being weighted by 1. Cultural values were ranked 1 through 5 with each score being weighted by 0.5. Tax values were ranked 1 through 5 with each score being weighted by 0.25. Note that for historic and cultural values, a score of 0 was also possible for 85 of the 503 parcels in the historic survey. This is because only 418 of these parcels were both in the historic survey and within the flood zones (see methods section). For tax values, however, all parcels had a score from 1 to 5. Composite values were simply the sum of the weighted historic, cultural, and tax value scores, and had a possible range of 0.25 – 8.75.

2.3.5 Risk mapping

Building footprint and landscape boundary polygons were analyzed in relation to the depth of flooding from a 13.5 ft flood to produce a Risk Map. Note that depths at each location are relative to MHHW, and have had the ground elevation of each location, as indicated by LiDAR data, subtracted from 13.5 ft. Flood depths across the study area in this data layer ranged from 0.01 ft to 11.26 ft. This range was used to create five equally spaced intervals of 2.25 ft so that each building or landscape received a score of 1 through 5, depending on the deepest flood depth at each polygon. For example, buildings and landscapes that received a 5 had depths ranging from 9.02 ft to 11.26 ft. Note also that only surface flooding is reflected in these calculations; basement or other subsurface flooding is not reflected in the maps or analysis.

2.3.6 Combined value and risk mapping

The composite value score was then combined with the risk score, where risk was given twice the weight of composite value. For example, if the composite value score was 5 and the risk score was 4, the combined value and risk score was $5 + 4*2 = 13$. This weighting of risk was determined through discussion and agreement by members of the LAC.

3. Vulnerability Assessment Results

3.1 Maps and Considerations

3.1.1 Historic Value

Once the historic value assessment scores were assigned, they were completed in a Microsoft Excel document. This value was then converted into GIS so that it could be plotted on the historic value maps for buildings and sites (Figures 2 and 3). A summary of historic value scores by the National Register District, the 1986 survey, and the entire study area within the flood zone are included in the table below.

Historic Value Score	National Register Portsmouth Downtown Historic District (2016)	1986 Historic Resource Survey	Total in 2017 Historic District Sea Level Rise Study Area	Total Percentage (%) in 2017 Historic District Sea Level Rise Study Area
1	54	16	70	14%
2	38	19	57	11%
3	104	23	127	25%
4	154	20	174	35%
5	62	7	69	14%
Not Visible	6	0	6	1%
Totals	418	85	503	100%

Each historic value score was assigned a color value on the historic value map to provide a visual aid. Historic value of 5 was assigned red, 4 was assigned orange, 3 was assigned yellow, 2 was assigned green, and 1 was assigned blue.

Based on the historic value map, the areas with the highest assessed historic value scores are: Strawbery Banke, South End/Working Waterfront, and South Mill Pond Neighborhoods. These geographic areas displayed the greatest majority of buildings that received a historic value score ranging from 3 to 5. Buildings in these areas retained a moderate to very high degree of integrity, with few alterations or modern materials observed on the majority of structures. Designed landscapes such as Prescott Park, Pierce Island, South Mill Playground, and the Governor John Langdon Mansion Landscape retained much of their original layout, featured designed landscaping or planned gardens, and overall retained most aspects of integrity. Cemeteries in these areas also retain a high degree of integrity, with their original layout intact, little signs of vandalism, period examples of funerary art and/or architecture, and modern intrusions visually screened by stone walls, fencing, or vegetation.

Areas with lower assessed historic value scores include the Downtown Working Waterfront, primarily due to modern construction in these areas, with buildings less than 50 years old receiving a historic value score of 1, and other historic buildings that have been so significantly altered they were assigned a historic value score of 2 or 3. However, there are notable historic resources in these areas as well, including the Market Street warehouses and rowhouses. This landscape, although located adjacent to a major road in downtown Portsmouth, and across from modern developments, retains a high degree of integrity with its historic markers and landscaping features intact. Its raised landscape also provides a visual screen from traffic and the contemporary surroundings, while still providing accessibility for visitors. Some buildings in the North Mill Pond / Christian Shore area also have a high degree of integrity, with historic value scores ranging from 3 through 5. Many private residences retain much of their historic materials, with only minor additions or alterations visible from the public right-of-way.

3.1.2 Cultural Value

Cultural value maps for buildings and sites are shown in Figures 4 and 5.

3.1.3 Tax Value

Tax value maps for buildings and sites are shown in Figures 6 and 7.

3.1.4 Composite Value

The composite value maps for buildings and sites (Figures 8 and 9) show a wide range of composite value scores (0.25 – 8.75) spread across the historic district. Highest scores are generally clustered in the historic downtown and along the southern working waterfront coastline, and lower scores are generally clustered in the newer and more industrial North Mill Pond area.

3.1.5 Risk

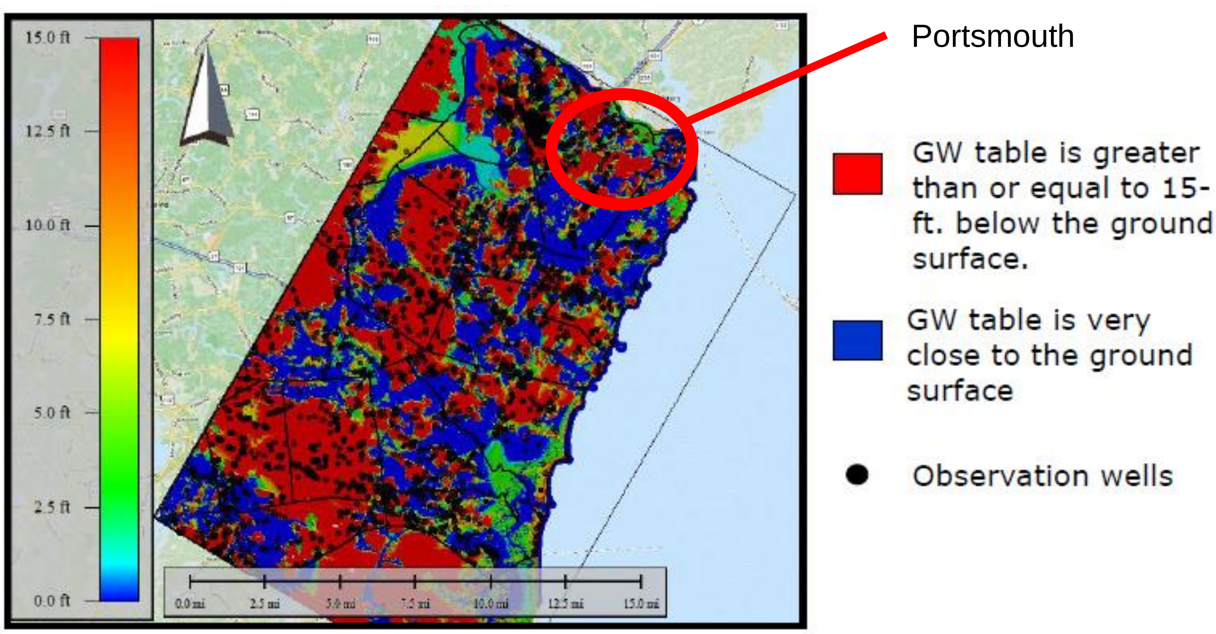
The risk maps for buildings and sites (Figures 10 and 11) show a wide range of flood depths throughout the study area, from a 13.5 ft flood (0.01 ft to 11.26 ft). Of the 503 polygons representing historic buildings and landscapes, 157 had a score of 1, 139 had a score of 2, 143 had a score of 3, 40 had a score of 4, and 24 had a score of 5. Risk scores did not appear to be clustered in any notable way, as the spatial distribution of scores was variable through the study area.

3.1.6 Composite Value and Risk

Combining composite value and risk, maps were produced with overall scores for each structure or landscape feature in the historic inventory (Figures 12 and 13). Within each of the four strategy areas (Figure 1) there was a wide range of scores spanning age of the structure, types of construction, proximity to water, degree of historic significance, and other parcel characteristics. No clear patterns emerged about clusters of characteristics within these groups – for example there was no obvious association between high tax value parcels and proximity to water, as is the case in some coastal cities.

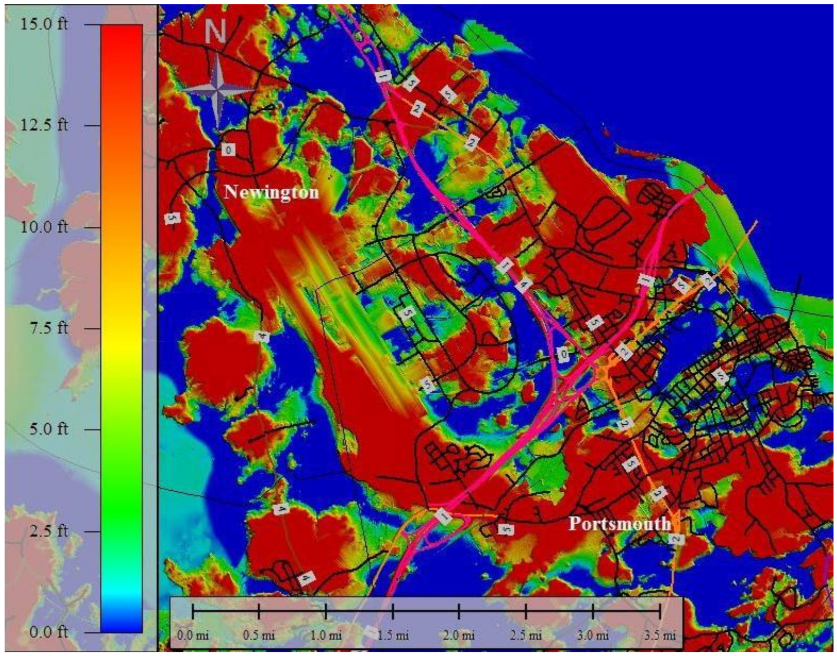
3.2 Assessment of groundwater vulnerability factors

Besides threats of flooding from sea level rise, storm surge, and runoff from extreme precipitation events, structural and landscape assets in Portsmouth's Historic District may also be vulnerable to groundwater issues that can be exacerbated by sea level rise. As in the image below, depth to groundwater has been documented throughout the Spaulding Turnpike area using data from observation wells from 1960 – 2015 (Portsmouth is in the upper right corner):



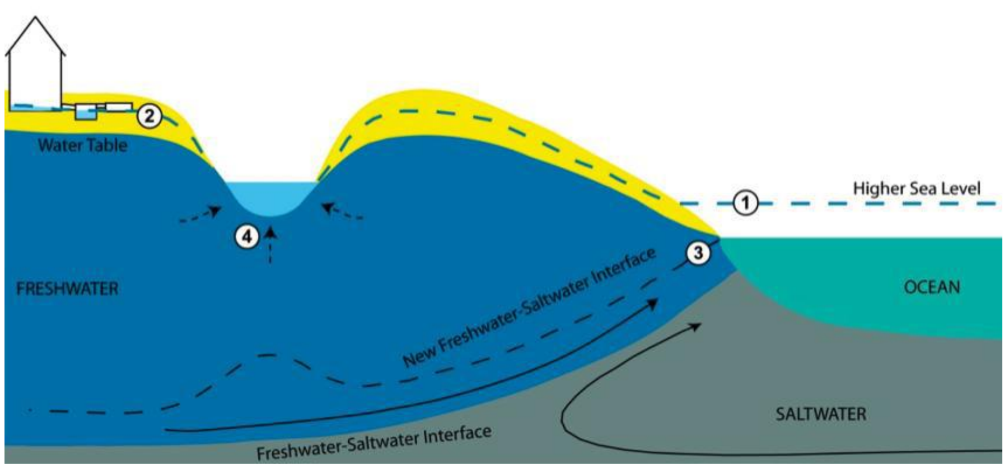
Source: Jacobs et al. 2017

More refined estimates have been provided within Portsmouth itself as in this image:



Source: Jacobs et al. 2017

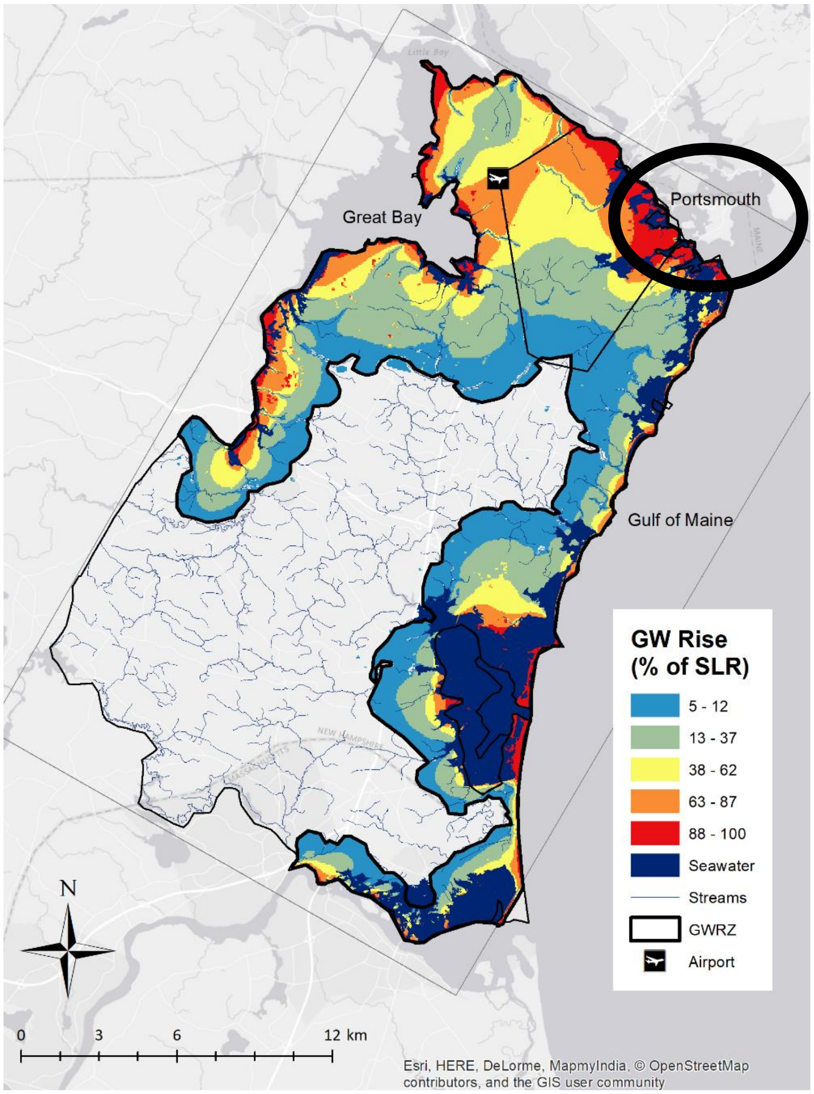
Importantly, sea level rise is expected to influence these groundwater levels due largely to hydrostatic pressure from rising sea levels and taking into account the nature of the geological materials, surrounding groundwater connectivity, and other physical parameters. As in the following image, the boundary between saltwater-based and freshwater-based groundwater is a dynamic and shifting interface. As sea level rises this interface may shift inland and upward in elevation, depending on the degree to which streams and groundwater pumping dampen this effect.



Source: water.usgs.gov

In many places this rise in groundwater levels will extend farther inland than the effects of surface flooding. For example, in a recent study Knott et al. (2017) modified an existing USGS groundwater flow model (Mack 2009) to investigate the effect of sea level rise on groundwater levels in the Portsmouth region of coastal New Hampshire. Versus current groundwater levels in the area of Middle Street in Portsmouth (around 3.8 ft below ground) the model predicted that with 1.0 ft of sea level rise the groundwater level might be expected to rise to 2.5 ft below ground, and with 2.7 ft of sea level rise it might be expected to rise to 1.5 ft below ground (for comparison, the present project used 2.5 ft of sea level rise). The study examined potential of this groundwater rise to impact roads through weakening the base and subbase layers on which these roads were built, but for historic structures and sites in the Historic District the implications appear to be similar (i.e., subsurface flooding may become common long before surface flooding does).

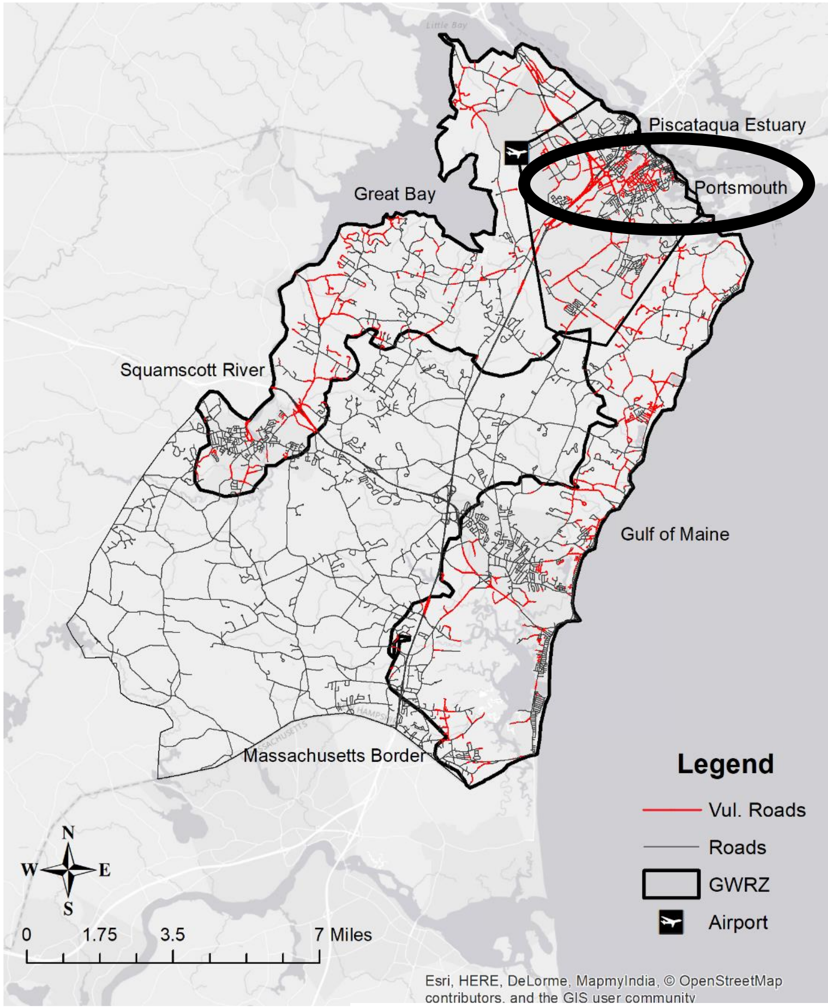
Similarly, in areas with shallower groundwater, sea level rise is more likely to begin to cause moisture problems in basements and foundations, and could begin corroding the bottoms of septic tanks. Knott et al. (2018a) evaluated the amount of groundwater rise that might be expected with sea level rise in different parts of the Spaulding Turnpike region. As in the figure below, results suggest that in Portsmouth, groundwater rise could be 88 – 100% of the amount of sea level rise.



Source: Knott et al. (2018b)

The Assumptions and Limitations section in Knott et al. (2018a) is a useful guide to interpreting the groundwater modeling results. In general, regional data sets point to averages and trends. These results should be used with caution for site-specific purposes due to uncertainties associated with heterogeneous sediments (sand, silt, and clay), fractured bedrock, seasonal variations in groundwater levels, and data-collection limitations and variability. At the same time, amounts of groundwater rise in different portions of the Historic District will not be uniform or linear. They will depend on immediate proximity of groundwater discharge areas, distance from the coast and other variables. Mack (2009) provides a good overview of these influences and their dynamics in coastal New Hampshire.

Knott et al. (2018a) then evaluated roads vulnerable to rising groundwater, depicted in red in the below image:



Source: Knott et al. (2018a)

Depending on presence or absence of a basement, historic structures along these roads would likely experience substantial moisture problems. Moisture problems can be expected to increase for at least some if not many structures in the Historic District. Unfortunately, the historic structure database used in this project did not have information on presence or absence of basements, basement depth, or foundation type for each structure. However it is known that in some portions of the Historic District nearly all historic structures have basements.

A recommendation from this study is thus to complete a foundation inventory and use it to help track emerging groundwater-related impacts on the Historic District. Especially given that significant surface-water flooding may continue to be infrequent for several decades, these monitoring efforts can become an early warning system indicating when new actions may become immediately necessary. The work would aim to secure permission to reference GIS layers produced through the above cited works, which also modeled locations in the region where rising groundwater might come into contact with underground storage tanks and hazardous waste, where impacts might be seen in marine and freshwater wetlands, and other impacts.

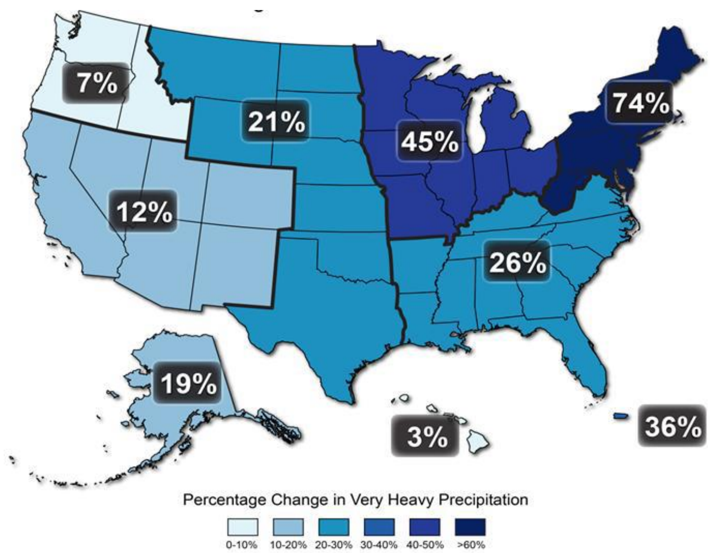
Such a monitoring effort would be an especially meaningful contribution to the emerging science in this area. For example groundwater levels projected at the Middle Street site in Knott et al. 2017 are outside interquartile range of the overall data set, and the Assumptions and Limitation section of Knott et al. (2018a) clarify that adaptation planning for specific sites will need more detailed site specific data such as the long-term groundwater monitoring program suggested here.

Additional factors also contribute to groundwater-related vulnerability of structures in the Historic District. As managers and owners of historic structures in Portsmouth may know, uncontrolled moisture is the often the most prevalent cause of deterioration in historic buildings. It leads to erosion, corrosion, rot, and destruction of materials, finishes, and structural components. A variety of conditions contribute to these moisture problems in old buildings, including type of construction materials, amounts of building usage, atmospheric changes (e.g. sun, temperature, prevailing winds, relative humidity), adjacent plants and landscaping materials, and the amount of air infiltration. Seasonal and tidal variations in groundwater levels are also key factors (Park 1996).

A related set of influences is soil type and depth in each part of the historic district, which will affect flow of fresh ground water and the potential for the salt/freshwater interface to move landward. Some historic building materials are not salt tolerant: salt can cause surface deterioration of bricks and mortar, and wall ties and other metal materials are prone to rusting and deterioration from contact with ground water, the impact of which increases significantly with wetting and drying of saline water induced by tidal action. In combination with the recommended basement inventory, therefore, overlay analysis could be conducted that compares soil thickness in the location of each vulnerable structure or landscape feature with current depth to groundwater. It would be a useful tool for tracking how these vulnerabilities might change differently within the Historic District given both different amounts of sea level rise and presence or absence of a basement.

Additional consideration should be given to possible changes in precipitation that could increase infiltration raising groundwater levels, potentially compromising significant structures and landscapes in the Historic District. This is an area of active research, however; it is also possible that an increase in extreme precipitation events could result in more runoff and less aquifer recharge. Note also that the in three recent studies described here (Knott et al. 2017, Knott et al. 2018a, and Knott et al. 2018b), stationarity is assumed in aquifer recharge and groundwater withdrawals; the analyses considered sea level rise-induced groundwater rise only.

Substantial increases in heavy precipitation events that have occurred in the northeast during the last half century are depicted below as change in 1% rainfall events from 1958 – 2012:



Source: National Climate Assessment 2014

While these trends are dramatic, this record is not specific to New Hampshire and reflects the past, so may be an unreliable guide for the estimating future trends in coastal New Hampshire. Numerous new tools such as Atlas 14 (NOAA 2017) have been produced to estimate future frequencies of precipitation events of various intensities, including for coastal New Hampshire. With consideration of the suite of available tools and data sets, in 2016 the New Hampshire Coastal Risk and Hazards Commission made the general recommendation that infrastructure design and upgrades in coastal New Hampshire should be undertaken with an expectation of 15% increase in frequency of extreme precipitation events after 2050 (NH CRHC 2016).

Even if this 15% increase is used as an estimate, however, groundwater levels will not necessarily increase by similar amounts with each precipitation event, the collection of events of different sizes in a given year, or the cumulative volume of precipitation over many years. Groundwater levels are influenced by many factors besides precipitation, such as drawdown from water uses. These influences have been modeled in detail for coastal New Hampshire (Mack 2009), which found that groundwater levels in coastal New Hampshire may actually decrease slightly under some future scenarios. Although this work was conducted before the studies cited above regarding sea level rise-associated groundwater increases, the important point for planning purposes in Portsmouth is that current understanding of relationships between precipitation, sea level rise, and groundwater levels continues to evolve. For future estimates of likely groundwater changes in the Historic District, the most recent studies should be used and strong effort should be made to incorporate both a range of sea level rise scenarios, possible changes in precipitation over time, and interactions between ocean and groundwater dynamics.

4. Adaptation Considerations

4.1 Context

In this section each of 16 candidate adaptation actions is evaluated for feasibility, cost, and potential effectiveness in making Portsmouth's Historic District more resilient to the threats of storm surge and sea level rise. The degree to which each would impact historic character of the asset or neighborhood is also evaluated. The goals are to 1) provide a non-exhaustive visual sampler of possible actions and their advantages and disadvantages, and 2) help foster ideas for further exploration of actions to protect vulnerable assets in the Historic District.

Actions were selected by the project team to capture historic places and features such as cemeteries; to encompass residential, commercial, non-profit, and governmental holdings; to provide a diversity of techniques within the categories of fortify, accommodate, and relocate; to span structure-specific techniques such as floodproofing and non-structure specific techniques such as seawalls; and to examine a range of types of vulnerability such as waterfront structures on piers or cemetery sites adjacent to the inland side of a bridge across North Mill Pond.

The actions are grouped in four strategy areas determined through discussions with the LAC: North Mill Pond, South Mill Pond, South End/Strawbery Banke/Working Waterfront, and Downtown Working Waterfront (Figure 1). There is some overlap between sites in these areas, especially between the South End/Strawbery Banke/Working Waterfront and the Downtown Working Waterfront. The descriptions should help decide which categories of activity might be appropriate to pursue further, whether within a given strategy area or with similar types of resources in other strategy areas or in the remainder of Portsmouth.

Each strategy area has four candidate actions: the first two are structure-specific and the second two are not. Structure-specific actions include wet and dry floodproofing and elevation or relocation of particular buildings, and non structure-specific actions include actions that would benefit larger numbers of structures or historic assets at once such as a seawall or voluntary buyout program. The LAC reviewed an earlier version of this list and made substitutions based on historic features they were familiar with and particularly concerned about. Importantly, proper interpretation of these examples requires understanding the following limitations:

- Each example represents cursory and introductory considerations of possible actions. Site specific field and office work should be pursued in each case to further evaluate whether the mentioned actions may be effective or desirable.

- Cost estimations are particularly introductory because immediately upon becoming more specific about any of the potential actions, entire categories of cost will need to be created or excluded for that action.
- In developing these candidate actions, no consideration was given to local hydrology other than generic overlaps with the 13.5' flooding polygon. The examples simply illustrate some categories of action that, if carefully coordinated with a broad range of other activities to address local hydrological nuances in an integrated fashion, may contribute to an overall effort to prevent losses of historic, cultural, and economic value in the District.
- Neither the actions by themselves nor the entire set of actions if taken together would render the individual structures or the whole Historic District completely resilient to the range of types of flooding to which the District is vulnerable.
- All potential actions should be integrated into a coordinated stormwater management plan and set of stormwater infrastructure upgrades, in a manner that encompasses the multi-directional threats from sea level rise, storm surge, and upland runoff.

These examples were provided to the LAC in an online ESRI Story Map format, where photographs of each site or portion of the City were uploaded for viewing on an interactive map along with summary text excerpted from the below action descriptions. This method of graphic visualization of candidate adaptation actions was an important part of the outreach strategy used on the project and can contribute to stakeholder engagement opportunities beyond the project.

The sixteen evaluations are followed by two with more detail: the Point of Graves Burial Ground, next to Prescott Park, and residential structures at 35 and 41 Salter Street. They provide further site-specific examples of what adaptation action could look like and might cost, along with photographs and additional interpretation of strengths and weaknesses of some candidate actions. The intent is to 1) prepare current or future owners of these assets to make decisions about which actions they will implement and 2) serve to illustrate types of research and action and that can enhance adaptation decision-making for similarly-situated properties elsewhere in Portsmouth.

4.2 Adaptation Examples

North Mill Pond (1)
230 Maplewood Avenue (Christian Shores area)

Candidate Actions
Structural elevation integrated with
likely bridge redesign
Wet floodproof
Buyout program

Potential Feasibility
Each of these three actions is likely to be feasible on their own but integrating them could be a challenge. Sequencing may be an option; in some adaptation situations, it is fine to take one action when others may follow. However, because buyout programs are generally used to help owners of a structure move out of harm's way without losing their real estate value, the assumption is usually that the structure will be relocated or abandoned through the buyout – in which case elevation and/or wet floodproofing the structure may not be necessary. Similarly, wet floodproofing may not be necessary if the structure is elevated. Sequenced activities of this type can be effective if careful attention is paid to when each might occur. For example, if it may be decades before the bridge is elevated, wet floodproofing in the near term may still increase resiliency during this period and possibly after (depending on height of the elevation). Also, if a buyout program were implemented it could potentially be timed to coincide with a possible bridge elevation. Firm conclusions about feasibility would need to be further evaluated through additional engineering analyses and conversations with the property owner.

Potential Effectiveness
Wet floodproofing or elevation of the house and bridge would likely reduce damage from storm surge or extreme rainfall events. A buyout program could remove the house from exposure to risk from flooding. If the bridge is elevated and the house is not, there may be some reduction in flooding risk to the house (and nearby houses in the Christian Shores neighborhood) because of changes in hydrological dynamics around the bridge. It may also be helpful to integrate a tide gate into the approach. Prior to reaching firm conclusions about likely effectiveness of any combination of engineering activities, these possibilities would need to be carefully evaluated using hydrologic models and other investigations.

Preliminary Cost Estimate
- Cost of wet floodproofing the house depends on how aggressive the actions would be. Raising an electrical outlet is considered wet floodproofing and would cost little (but do little) and taking all possible steps to wet floodproof the house would represent many actions each with large possible cost ranges. To estimate the cost of a wet floodproofing project once the specific steps are identified, examples of general estimates are included in FEMA 312, *Homeowner's Guide to Retrofitting: Six Ways*

to Protect Your House From Flooding and FEMA 259, *Engineering Principles and Practices of Retrofitting Floodprone Residential Structures*. Appendix C of FEMA 551, *Selecting Appropriate Mitigation Measures for Floodprone Structures*, provides guidance and references for conducting more detailed cost estimates. Additional cost estimates can be obtained from R.S. Means' *Contractor's Pricing Guide*.

- Cost of a possible voluntary buyout of the house would be determined by how large a portion of the value of the structure the program is intended to cover and market values at the time.
- Cost of elevating the wood frame house on piers would likely be in the range of $36/sf (FEMA 551, *Selecting Appropriate Mitigation Measures for Floodprone Structures*). Costs of permitting, utility interconnect modifications, right of way acquisitions, or other expense categories would be additional and would require separate estimation.
- Cost of elevating the bridge would involve a wide range of engineering and other design categories and is unknown at this time.

Potential Impact on Historic Character

Structural elevation of buildings may diminish integrity of design, materials, and workmanship, particularly in cases where original granite block or fieldstone foundations are intact. However, some historic structures may be able to be raised by 1 or 2 ft without having a substantial adverse impact on integrity or character; these will need to be evaluated on a case-specific basis. It is presumed that character defining features of a building, such as interior woodwork, exterior original siding, and original windows (if present) would be preserved from future flood damage with structural elevation. Wet floodproofing would likely have minimal effect on the interior of a foundation, and the integrity of the building would remain largely intact. With wet floodproofing measures made on the interior of the building, few alterations to the exterior (such as vents at the basement level) would be visible. Alterations such as flow-through vents in the foundation would have a minor impact on integrity of design, materials and workmanship. A buyout program where a building is relocated would result in a loss of integrity of location, and possibly feeling and association. If a contributing building to the Portsmouth Downtown Historic District were removed from the district, it would likely no longer be a part of the district, resulting in a loss of National Register eligibility for that building.

North Mill Pond (2)
333 Vaughan St (3S Artspace Building)

Candidate Actions
Dry floodproof

Potential Feasibility
Dry floodproofing is a standard approach used in many commercial and residential coastal settings that involves keeping water out of the structure and away from its contents. It comprises a diverse set of possible activities including sealing exterior brick and concrete, closing basement openings, and arranging for immediate availability of temporary flood barriers over doors and windows. This building of masonry construction is a good candidate for dry floodproofing. There is no basement so there is less total area to be concerned about. There are few openings around the entire perimeter and these can be protected with removable flood coverings over doors and windows, which can be stored when flood conditions are not present. The first several feet of brick can be sealed with impermeable coating and re-covered with false brick covering to eliminate the appearance of a modified structure. Feasibility is often determined by cost, who would pay, and public or private acceptance of possible aesthetic changes. Firm conclusions about feasibility would need to be further evaluated through additional engineering analyses and conversations with the property owner.

Potential Effectiveness
Dry floodproofing this structure could significantly reduce potential damages to the structure and contents of the building from flooding caused by storm surge or extreme rainfall events. The techniques will not effectively protect the structure if sea level rises to the point where high tide reaches the building openings. Prior to reaching firm conclusions about likely effectiveness, these possibilities would need to be carefully evaluated using hydrologic models and other engineering investigations.

Preliminary Cost Estimate
Dry floodproofing a concrete block or brick-faced wall by applying a polyethylene sheet or other impervious material and covering it with a facing material such as brick would likely cost around $3.50/sf. An acrylic latex wall coating would likely cost around $3.00/sf. A high performance urethane sealant would additionally cost around $2.50/sf (FEMA 551, *Selecting Appropriate Mitigation Measures for Floodprone Structures*). Removable flood walls range widely in cost depending on manufacturer and style and these would need to be estimated for each specific project.

Potential Impact on Historic Character
Dry floodproofing would have minimal effect on the building's integrity of materials, design, workmanship, location, feeling, or association. Temporary flood barriers over doors and/or

windows, because they are removable, would not impose a lasting effect on the integrity or historic characteristics of the building.

North Mill Pond (3)
North Mill Pond and Union Cemeteries

Candidate Action
Construct flood wall

Potential Feasibility
It may be possible to protect this pair of cemeteries from storm surge-related flooding from the North Mill Pond side via construction of a 3' tall flood wall along the pond shore. Because flood waters could go around the edges of a constructed barrier of these types, it would need to be constructed to hook up to the left and right of the site (this image). Firm conclusions about feasibility would need to be further evaluated through additional engineering analyses.

Potential Effectiveness
However, because the flooding polygon of concern (13.5') indicates water is also likely to enter from the opposite side of the site, this potential action has low potential effectiveness of keeping floodwaters off the cemeteries. To be effective the fortification structures would likely need to be constructed all the way around the site. Prior to reaching firm conclusions about likely effectiveness, however, these possibilities would need to be carefully evaluated using hydrologic models and other engineering investigations.

Preliminary Cost Estimate
For roughly 250' lineal feet of 3' flood wall along the shore of North Mill Pond that hooks up to the left and right of the site in the image, cost of materials and construction would likely range from $300 to $400/lf, depending on the degree to which ornamentation or other customized materials were to be incorporated in the design (source: GEI Consultants). Costs of permitting, lane closures, or other expense categories would be additional and would require separate estimation.

Potential Impact on Historic Character
Fortification would not influence the cemeteries' integrity of design, materials, workmanship, feeling, location, or association. It may diminish the integrity of setting and feeling, depending upon the location of the wall and its proximity to the cemetery. Character defining features of the Old North Cemetery are its design, examples of eighteenth and nineteenth century funerary art, and its location in downtown Portsmouth. These features would not be affected by the fortification construction, and would be preserved in the event of flooding.

North Mill Pond (4)
500 Market Street (Nobles Island)

Candidate Action
Construct revetment

Potential Feasibility
This action would benefit multiple structures including the Greater Portsmouth Chamber, the New Hampshire State Port Authority, and Noble's Island. It would likely be possible to construct a revetment, riprap, or a seawall around the cluster of buildings, creating a protected enclosure up against the inland side of Market Street. Firm conclusions about feasibility would need to be further evaluated through additional engineering analyses.

Potential Effectiveness
This action would not protect the structures from flooding from the opposite direction across Market Street. Because the flooding polygon of concern (13.5') indicates water is also likely to enter from this side of the site, by itself this potential action has low potential effectiveness of keeping all types of floodwaters off the properties. Market Street may also need to be elevated for this action to be effective. Prior to reaching firm conclusions about likely effectiveness, however, these possibilities would need to be carefully evaluated using hydrologic models and other engineering investigations.

Preliminary Cost Estimate
For the roughly 500 lineal feet of revetment along the shore of Nobles Island that connects with Marcy Street on either side, cost of materials and construction would be around $250 to $300/lf (source: GEI Consultants). Costs of permitting, lane closures, road elevation, or other expense categories would be additional and would require separate estimation.

Potential Impact on Historic Character
Fortification would not impose a lasting effect on the integrity of the buildings' design, materials, workmanship, or location. The key characteristics of the historic buildings would be retained and not affected by the construction of a revetment.

South Mill Pond (5)
359 Marcy Street (Sanders Fish Market)

Candidate Action
Elevate structure

Potential Feasibility
Structural elevation is a standard approach used in many commercial and residential coastal settings. Feasibility is often determined by cost and who would pay; complications of making changes to existing utility connections; public perception of the proposed elevation; road and parking access that may need to be reconfigured; or rights of way that may be compromised. With proper planning and attention at this site few of these constraints are likely to be impossible to address, but there may need to be a substantial and coordinated effort to increase public acceptance and address legal and regulatory issues invoked by the effort. Although a subset of these actions may be feasible for this structure, firm conclusions would need to be further evaluated through additional engineering and conversations with the property owner.

Potential Effectiveness
When structures and their contents are entirely elevated above where flood waters are likely to pass, they are less likely to be damaged – so with proper construction this action has strong potential to protect the structure from damages from sea level rise, storm surge, and extreme rainfall events. Prior to reaching firm conclusions about likely effectiveness, however, these possibilities would need to be carefully evaluated using hydrologic models and other engineering investigations.

Preliminary Cost Estimate
Cost of elevating the wood frame structure on piers would likely be in the range of $36/sf (FEMA 551, *Selecting Appropriate Mitigation Measures for Floodprone Structures*). Costs of permitting, utility interconnect modifications, right of way acquisitions, or other expense categories would be additional and would require separate estimation.

Potential Impact on Historic Character
Elevating this structure would compromise the building's integrity of design, materials and workmanship. This building, however, has already lost integrity of design, materials, and workmanship due to the altered window and door openings on the main façade. The piers that the building's addition rest upon do not appear original to the building. Raising the elevation of this building would thus result in a loss of some aspects of integrity, but other aspects of integrity such as location, feeling, setting, and association would be retained.

South Mill Pond (6)
Parrott Avenue Corridor

Candidate Actions
Dry floodproof

Potential Feasibility
Dry floodproofing is a standard approach used in many commercial and residential coastal settings that involves keeping water out of the structure and away from its contents. It comprises a diverse set of possible activities including sealing exterior brick and concrete, closing basement openings, and arranging for immediate availability of temporary flood barriers over doors and windows. These buildings of masonry construction are good candidates for dry floodproofing. Openings around the perimeter of the buildings can be protected with removable flood coverings over doors and windows, which can be stored when flood conditions are not present. The first several feet of brick can be sealed with impermeable coating and re-covered with false brick covering to eliminate the appearance of a modified structure. Feasibility is often determined by cost, who would pay, and public or private acceptance of possible aesthetic changes. Actions to protect this area could additionally include upgrading the tide gate at the opposite end of South Mill Pond to increase its ability to handle extreme flows. Although these actions may be feasible in this location, firm conclusions would need to be further evaluated through additional engineering and conversations with property owners.

Potential Effectiveness
Both dry floodproofing along the corridor and upgrading the tide gate have the potential to substantially reduce potential for flood-related losses in this location. Prior to reaching firm conclusions about likely effectiveness, however, these possibilities would need to be carefully evaluated using hydrologic models and other engineering investigations.

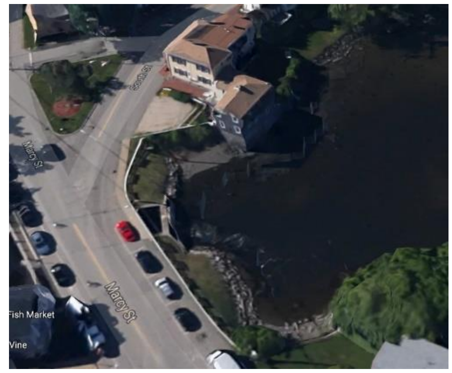
Preliminary Cost Estimate
Dry floodproofing a concrete block or brick-faced wall by applying a polyethylene sheet or other impervious material and covering it with a facing material such as brick would likely cost around $3.50/sf. An acrylic latex wall coating would likely cost around $3.00/sf. A high performance urethane sealant would additionally cost around $2.50/sf (FEMA 551, *Selecting Appropriate Mitigation Measures for Floodprone Structures*). Removable flood walls range widely in cost depending on manufacturer and style and these would need to be estimated for each specific project.

Potential Impact on Historic Character
Dry floodproofing would have minimal effect on the buildings' integrity of materials, design, workmanship, location, feeling, or association. Temporary flood barriers over doors and/or windows, because they are removable, would not impose a lasting effect on integrity or the

historic characteristics of the building. Dry floodproofing would likely result in the retention of the character defining features of these buildings.

South Mill Pond (7)
South Mill Pond tide gate area

Candidate Actions
Construct revetment, upgrade existing tide gate



Potential Feasibility
In addition to modifying the tide gate at the south end of South Mill Pond (action 6), additional actions to consider in this strategy area include raising existing fortification along the south edge of South Mill Pond and extending exiting fortification in this location farther along the shore of the Pond. Feasibility of these actions would likely be determined by cost and public or private acceptance of the visual changes, but firm conclusions would need to be further evaluated through additional engineering and other analyses.

Potential Effectiveness
Residences and businesses along the entire perimeter of South Mill Pond could experience substantially reduced risk of flood-related losses if these actions are taken in this location. Prior to reaching firm conclusions about likely effectiveness, however, these possibilities would need to be carefully evaluated using hydrologic models and other engineering investigations.

Preliminary Cost Estimate
For upgrading/elevating the roughly 250' lineal feet of revetment along the east corner of South Mill Pond abutting South Street, cost of materials and construction would likely range from $300 to $400/lf, depending on the degree to which ornamentation or other customized materials were to be incorporated in the design (source: GEI Consultants). Modifying or upgrading the existing tide gate would likely require significant engineering inputs and possibly digging down to accommodate a larger structure. Cost would likely range from $500,000 - $750,000 depending on site-specific conditions (source: GEI Consultants), and may be far more costly if cofferdams are needed for water diversion. Costs of permitting, lane closures, road elevation, or other expense categories would be additional and would require separate estimation.

Potential Impact on Historic Character
Fortification would help preserve the South Mill Pond landscape and surrounding historic buildings. Key historic characteristics, such as the design of the playground and the architecture of surrounding municipal and residential buildings would also be retained.

South Mill Pond (8)
Richards Avenue area

Candidate Action
Flood district designation, residential floodproofing rebate program

Potential Feasibility
The row of residences along Richards avenue has a relatively high composite value and risk score (Figure 12). One option that may benefit structures throughout the South Mill Pond strategy area or the whole City is creation of a flood district where a rebate program that covers part of the cost of implementation of floodproofing techniques would be offered for owners of residential property. Programs of this type resemble rebate programs that many municipalities offer for installing solar panels. Feasibility would likely be determined by political will to support the financial commitment to be made by the City, however firm conclusions would need to be developed through careful evaluation of social, political, and financial capacity for broad-based programs of this type in the City.

Potential Effectiveness
Depending on degree of participation in such a program, it could substantially reduce potential for flood-related losses throughout a designated flood district. Prior to reaching firm conclusions about likely effectiveness, however, these possibilities would need to be carefully evaluated using hydrologic models to confirm amounts of protection each type of floodproofing under consideration might convey to structures in the district.

Preliminary Cost Estimate
Cost of the program would be determined by how aggressive the City chooses to be in providing subsidies of this nature. This involves choices about how geographically broad the district would be, how many structures of what types would be in the program, which types of floodproofing activities would be covered under the program, and the percentage of any floodproofing cost the city chooses to subsidize.

Potential Impact on Historic Character
A flood rebate program that would reimburse home and business owners for wet or dry floodproofing efforts in their buildings would substantially increase the amount of historic integrity that can be retained in this area. These buildings retain a fair amount of historic value, and floodproofing measures would ensure that most aspects of integrity are retained, as well as reducing the effect of future flood damage.

South End Neighborhood/
Strawbery Banke/Working Waterfront *(9)*
55 Puddle Dock Lane (Sherburne House)

Candidate Action
Wet floodproof structure

Potential Feasibility
Wet floodproofing is a standard approach used in many commercial and residential coastal settings that allows water to pass through the structure and protects the contents water may touch. It comprises a diverse set of possible activities including installing pass-through vents at ground level (note: Sherburne House has no cellar); encasing plumbing and electrical equipment with flood-resistant coatings, raising electrical outlets; raising equipment and valuable objects to higher floors in the structure or removing them altogether; and switching to flood-resistant carpet and other materials. Feasibility is often determined by cost, who would pay, and public or private acceptance of possible aesthetic changes. Although a subset of these actions may be feasible for this structure, firm conclusions would need to be further evaluated through additional engineering and conversations with the property owner.

Potential Effectiveness
Wet floodproofing is generally more appropriate and effective than dry floodproofing for older and wooden structures such as the Sherburne House. This is because of hydrostatic pressure during flood conditions (a flood of 2 ft elevation is enough to cause most wood construction to buckle). With proper installation, wet floodproofing techniques have the potential to substantially reduce flood-related losses for this structure, however this would need to be carefully evaluated using additional site-specific and structural evaluation.

Preliminary Cost Estimate
Cost of wet floodproofing the house depends on how aggressive the actions would be. Raising an electrical outlet is considered wet floodproofing and would cost little (but do little) and taking all possible steps to wet floodproof the house would represent many actions each with large possible cost ranges. To estimate the cost of a wet floodproofing project once the specific steps are identified, examples of general estimates are included in FEMA 312, *Homeowner's Guide to Retrofitting: Six Ways to Protect Your House From Flooding* and FEMA 259, *Engineering Principles and Practices of Retrofitting Floodprone Residential Structures*. Appendix C of FEMA 551, *Selecting Appropriate Mitigation Measures for Floodprone Structures*, provides guidance and references for conducting more detailed cost estimates. Additional cost estimates can be obtained from R.S. Means' *Contractor's Pricing Guide*.

Potential Impact on Historic Character

Wet floodproofing would likely have minimal effect on historic characteristics on the building's interior, and the integrity of the building would remain largely intact. Key historic and architectural features of the Strawbery Banke area would be preserved and protected from loss due to flood damage. Alterations such as flow-through vents at ground level would have a minor impact on the overall integrity of design, materials and workmanship.

South End Neighborhood/
Strawbery Banke/Working Waterfront *(10)*
54 Pray Street (Sanders Lobster)

Candidate Action
Wet floodproof structure

Potential Feasibility
Wet floodproofing is a standard approach used in many commercial and residential coastal settings that allows water to pass through the structure and protects contents water may touch. It comprises diverse activities including installing pass-through vents at ground level; encasing plumbing and electrical equipment with flood-resistant coatings; raising electrical outlets; raising equipment and valuable objects out of the basement (note: Sanders Lobster has a foundation and basement), moving them to higher floors or removing them altogether; and switching to flood-resistant carpet and other materials. Feasibility is often determined by cost, who would pay, and public or private acceptance of possible aesthetic changes. Although a subset of these actions may be feasible for this structure, firm conclusions would need to be further evaluated through additional engineering analyses and conversations with the property owner.

Potential Effectiveness
Wet floodproofing is generally more appropriate and effective than dry floodproofing for older and wooden structures such as Sanders Lobster. This is because of hydrostatic pressure during flood conditions (a flood of 2 ft elevation is enough to cause most wood construction to buckle). With proper installation, wet floodproofing has the potential to substantially reduce flood-related losses for this structure, however this would need to be carefully evaluated using additional site-specific and structural evaluation.

Preliminary Cost Estimate
Cost of wet floodproofing the structure depends on how aggressive the actions would be. Raising an electrical outlet is considered wet floodproofing and would cost little (but do little) and taking all possible steps to wet floodproof the house would represent many actions each with large possible cost ranges. To estimate the cost of a wet floodproofing project once the specific steps are identified, examples of general estimates are included in FEMA 312, *Homeowner's Guide to Retrofitting: Six Ways to Protect Your House From Flooding* and FEMA 259, *Engineering Principles and Practices of Retrofitting Floodprone Residential Structures*. Appendix C of FEMA 551, *Selecting Appropriate Mitigation Measures for Floodprone Structures*, provides guidance and references for conducting more detailed cost estimates. Additional cost estimates can be obtained from R.S. Means' *Contractor's Pricing Guide*.

Potential Impact on Historic Character

Wet floodproofing would likely have minimal effect on the interior of a foundation, and the integrity of the building would remain largely intact. With wet floodproofing measures made on the building's main floor, few alterations to the exterior (such as vents at the basement level) would be visible. Alterations such as flow-through vents in the foundation would have a minor impact on the overall integrity of design, materials and workmanship.

South End Neighborhood/
Strawbery Banke/Working Waterfront *(11)*
Salter-Pray-Partridge Street area

Candidate Action
Voluntary buyout program

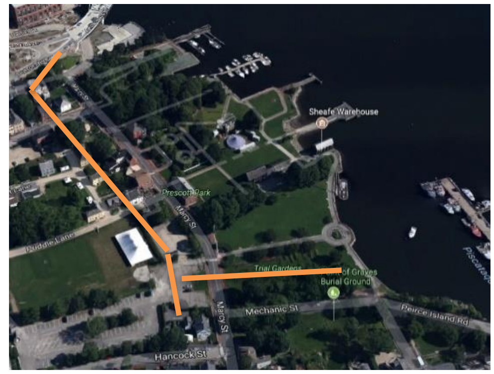
Potential Feasibility
Voluntary buyout programs are growing in popularity around the coastal US as a means to help property owners get out of harm's way without a financial loss. They usually use combinations of federal, state, and local funds to purchase all or parts of coastal parcels and the structures on them, relocate and/or demolish the structures, and allow the exposed real estate to convert to marsh and eventually open water. Because finances for these programs can be challenging to arrange, potential feasibility is somewhat determined by the ability to work proactively to integrate multiple sources of funds. Ability to develop local willingness to allocate funds is also a strong determinant of feasibility. A program of this type may be feasible in the Salter-Pray-Partridge Street area, but further evaluation is required, including an initial survey of residents and business owners to determine likelihood of participation. Results may indicate that for the time being local desire to relocate to less vulnerable areas is not strong enough to justify substantial investment in a program.

Potential Effectiveness
Successful programs of this type are growing in number (one example is Oakwood Beach, NY: http://www.wnyc.org/story/sandy-devastated-neighborhood-returns-nature/). They can help people move to less vulnerable land and help strategically guide conversion of shoreline to water over time. Some municipalities like East Hampton, NY now have a real estate transfer tax, a portion of which revenue is being used toward buyouts of vulnerable parcels. A program of this type either in the Salter-Pray-Partridge Street area or more broadly in Portsmouth has reasonable potential to effectively remove vulnerable assets from the threats of sea level rise and storm surge over time.

Preliminary Cost Estimate
Cost of a possible voluntary buyout of houses in the district would be determined by how many properties the City wishes to assist in this manner, the portion of the value of the structure the program would be intended to cover, and market values at the time.

Potential Impact on Historic Character
A buyout program where a building is relocated would result in a loss of integrity of location, and possibly feeling and association. If a building contributing to the Portsmouth Downtown Historic District were removed from the district, it would likely no longer be a part of the district, resulting in a loss of National Register eligibility.

South End Neighborhood/
Strawbery Banke/Working Waterfront *(12)*
Marcy Street Corridor



Candidate Action
Center road flood wall

Potential Feasibility
Center road flood walls are possible to erect in such a way that openings are left for pedestrians and cross traffic at key intersections. Stored panels (aluminum or steel) can be installed when storms are approaching, however because of these openings the walls do not address sea level rise. Conceptually, this idea could be feasible along Marcy Street and wrapping around on Mechanic Street as depicted with an orange line in this image. Obstacles to feasibility could include possible permitting issues, cost, and public acceptance of a visible structure of this type through the heart of the historic district.

Potential Effectiveness
Center road flood walls of this type can have the effect of sealing off portions of a city from flood waters from the ocean. They have been effectively used along the Rhine River in Cologne, Germany and other places. As with other options described in this collection, this is an introductory notion; potential effectiveness would need to be carefully evaluated thorough hydrologic and other analysis before considering it in greater detail.

Preliminary Cost Estimate
For the roughly 1,250 lineal feet of Marcy and Mechanic Streets where a 3 ft center road flood wall of this type may be able to be constructed, cost of materials and construction would likely range from $300 to $400/lf, depending on the degree to which ornamentation or other customized materials were to be incorporated in the design (source: GEI Consultants). Costs of permitting, lane closures, road elevation, or other expense categories would be additional and would require separate estimation.

Potential Impact on Historic Character
The installation of center road flood walls would have a temporary effect on the historic integrity of the area's setting and feeling. Overall, the majority of buildings in the Marcy and Mechanic Streets areas would retain their integrity of design, materials, workmanship, location, and association due to the protection from floodwaters the center road flood walls would provide. Key architectural features and historic characteristics would also be preserved via this method.

Downtown/Working Waterfront *(13)*
10 State Street (apartment complex)

Candidate Actions
Dry floodproof

Potential Feasibility
Dry floodproofing is a standard approach used in many commercial and residential coastal settings that involves keeping water out of the structure and away from its contents. It comprises a diverse set of possible activities including sealing exterior brick and concrete, closing basement openings, and arranging for immediate availability of temporary flood barriers over doors and windows. This building of masonry construction is a good candidate for dry floodproofing. There is no basement so there is less total area to be concerned about. Openings around the perimeter and these can be protected with removable flood coverings over doors and windows, which can be stored when flood conditions are not present. The first several feet of brick can be sealed with impermeable coating and re-covered with false brick covering to eliminate the appearance of a modified structure. Feasibility is often determined by cost, who would pay, and public or private acceptance of possible aesthetic changes. Firm conclusions about feasibility would need to be further evaluated through additional engineering analyses and conversations with the property owner.

Potential Effectiveness
Dry floodproofing this structure could significantly reduce potential damages to the structure and contents of the building from flooding caused by storm surge or extreme rainfall events. The techniques will not effectively protect the structure if sea level rises to the point where high tide reaches the building openings. Prior to reaching firm conclusions about likely effectiveness, these possibilities would need to be carefully evaluated using hydrologic models and other engineering investigations.

Preliminary Cost Estimate
Dry floodproofing a concrete block or brick-faced wall by applying a polyethylene sheet or other impervious material and covering it with a facing material such as brick would likely cost around $3.50/sf. An acrylic latex wall coating would likely cost around $3.00/sf. A high performance urethane sealant would additionally cost around $2.50/sf (FEMA 551, *Selecting Appropriate Mitigation Measures for Floodprone Structures*). Removable flood walls range widely in cost depending on manufacturer and style and these would need to be estimated for each specific project.

Potential Impact on Historic Character
The building at 10 State Street is not historic but this protective measure could be used for preserving the current condition of the building. Dry floodproofing would have minimal effect on the building's integrity of materials, design, workmanship, location, feeling, and

association. Temporary flood barriers over doors and/or windows, because they are removable, would not impose a lasting effect on historic integrity or characteristics of the building. Dry floodproofing and modification of the existing flood gate would likely result in the retention of the character defining features of these buildings.

Downtown/Working Waterfront *(14)*
34 Ceres Street (Moran Towing)

Candidate Actions
Wet floodproof

Potential Feasibility
Wet floodproofing is a standard approach used in many commercial and residential coastal settings that allows water to pass through the structure and protects contents water may touch. It comprises diverse activities including installing pass-through vents at ground level; encasing plumbing and electrical equipment with flood-resistant coatings; raising electrical outlets; raising equipment and valuable objects to higher floors or removing them altogether; and switching to flood-resistant carpet and other materials. Feasibility is often determined by cost, who would pay, and public or private acceptance of possible aesthetic changes. Although a subset of these actions may be feasible for this structure, firm conclusions would need to be further evaluated through additional engineering analyses and conversations with the property owner.

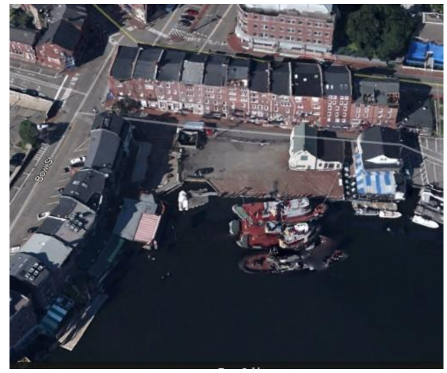
Potential Effectiveness
Wet floodproofing is generally more appropriate and effective than dry floodproofing for older and wooden structures such as Sanders Lobster. This is because of hydrostatic pressure during flood conditions (a flood of 2 ft elevation is enough to cause most wood construction to buckle). With proper installation, wet floodproofing has the potential to substantially reduce flood-related losses for this structure, however this would need to be carefully evaluated using additional site-specific and structural evaluation.

Preliminary Cost Estimate
Cost of wet floodproofing the structure depends on how aggressive the actions would be. Raising an electrical outlet is considered wet floodproofing and would cost little (but do little) and taking all possible steps to wet floodproof the house would represent many actions each with large possible cost ranges. To estimate the cost of a wet floodproofing project once the specific steps are identified, examples of general estimates are included in FEMA 312, *Homeowner's Guide to Retrofitting: Six Ways to Protect Your House From Flooding* and FEMA 259, *Engineering Principles and Practices of Retrofitting Floodprone Residential Structures*. Appendix C of FEMA 551, *Selecting Appropriate Mitigation Measures for Floodprone Structures*, provides guidance and references for conducting more detailed cost estimates. Additional cost estimates can be obtained from R.S. Means' *Contractor's Pricing Guide*.

Potential Impact on Historic Character

Wet floodproofing would likely have minimal effect on the historic integrity of the building. Alterations such as flow-through vents at ground level would have a minor impact on the overall integrity of design, materials and workmanship.

Downtown/Working Waterfront *(15)*
Market and Ceres Streets/Warehouses



Candidate Actions
Dry floodproof, abandon below grade space

Potential Feasibility
Dry floodproofing is a standard approach used in many commercial and residential coastal settings that involves keeping water out of the structure and away from its contents. It comprises a diverse set of possible activities including sealing exterior brick and concrete, closing basement openings, and arranging for immediate availability of temporary flood barriers over doors and windows. These buildings of masonry construction are good candidates for dry floodproofing. Openings around the perimeter of the buildings can be protected with removable flood coverings over doors and windows, which can be stored when flood conditions are not present. The first several feet of brick can be sealed with impermeable coating and re-covered with false brick covering to eliminate the appearance of a modified structure. An additional strategy to consider is providing incentives to encourage abandonment of below grade space, including providing incentives for termination of all business activity there and moving objects to higher floors. Feasibility of these actions is often determined by cost, who would pay, and public or private acceptance of both the possible aesthetic changes and the reduction in business activity that might accompany abandonment of commercial space currently in use. Although these actions may be feasible in this location, firm conclusions would need to be further evaluated through additional engineering, and conversations with property owners to identify appropriate incentives.

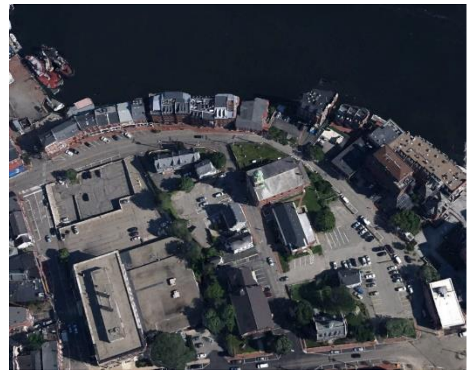
Potential Effectiveness
Both dry floodproofing along these streets abandoning below grade space could substantially reduce potential for flood-related losses in this location. Prior to reaching firm conclusions about likely effectiveness, however, these possibilities would need to be carefully evaluated using hydrologic models and other engineering investigations.

Preliminary Cost Estimate
Dry floodproofing a concrete block or brick-faced wall by applying a polyethylene sheet or other impervious material and covering it with a facing material such as brick would likely cost around \$3.50/sf. An acrylic latex wall coating would likely cost around \$3.00/sf. A high performance urethane sealant would additionally cost around \$2.50/sf (FEMA 551, *Selecting Appropriate Mitigation Measures for Floodprone Structures*). Removable flood walls range widely in cost depending on manufacturer and style and these would need to be estimated for each specific project.

Potential Impact on Historic Character

Dry floodproofing would have minimal effect on these historic buildings' integrity of materials, design, workmanship, location, feeling, or association. Temporary flood barriers over doors and/or windows, because they are removable, would not impose a lasting effect on the integrity or the historic characteristics of the building. Abandoning below grade space would not have a major impact on the buildings' key architectural and historic characteristics.

Downtown/Working Waterfront *(16)*
Bow Street



Candidate Actions
Designate a floodproofing retrofit district,
offer rebate program for commercial retrofits

Potential Feasibility
The row of structures along the water on Bow Street avenue has a relatively high composite value and risk score (Figure 12). One option that may benefit structures throughout the Downtown/Working Waterfront strategy area or the whole City is creation of a flood district where a rebate program that covers part of the cost of implementation of floodproofing techniques would be offered for businesses. Programs of this type resemble rebate programs that many municipalities offer for installing solar panels. Feasibility would likely be determined by political will to support the financial commitment to be made by the City, however firm conclusions would need to be developed through careful evaluation of social, political, and financial capacity for broad-based programs of this type in the City.

Potential Effectiveness
Depending on degree of participation in such a program, it could substantially reduce potential for flood-related losses throughout a designated flood district. Prior to reaching firm conclusions about likely effectiveness, however, these possibilities would need to be carefully evaluated using hydrologic models to confirm amounts of protection each type of floodproofing under consideration might convey to structures in the district.

Preliminary Cost Estimate
Cost of the program would be determined by how aggressive the City chooses to be in providing subsidies of this nature. This involves choices about how geographically broad the district would be, how many structures of what types would be in the program, which types of floodproofing activities would be covered under the program, and the percentage of any floodproofing cost the city chooses to subsidize.

Potential Impact on Historic Character
A flood rebate program that would reimburse home and business owners for wet or dry floodproofing efforts in their buildings would substantially increase the amount of historic integrity that can be retained in this area. These buildings retain a fair amount of historic value, and floodproofing measures would ensure that most aspects of integrity are retained and reduce the effect of future flood damage.

Point of Graves Burial Ground

Context

Historic preservation groups have begun to express serious concerns over the threat sea level rise poses to the to the archaeological record (e.g., Westley et al. 2011, Anderson et al. 2017). This is largely on account of scale of the vulnerability: tens of thousands of historic and prehistoric archaeological sites, and thousands of properties currently designated eligible for inclusion on the National Register of Historic Places, including archaeological sites, standing structures, and other cultural property types, will be submerged and hence lost or damaged (Reeder-Meyers 2015, Marzeion and Levermann 2014).

Portsmouth contains many significant historic resources and is part of this larger discussion and set of concerns. The Point of Graves Burial Ground is an acute representation of these challenges. The site was established in 1671 and contains graves of many of the earliest settlers and other important figures in the origins of Portsmouth. However, owing to its low-elevation location adjacent to the Atlantic Ocean, it is also extremely vulnerable to sea level rise and storm surge. The below images, with the Burial Ground indicated with a red outline, show an estimate of today's normal high tide (left) and a flooding polygon depicting a king tide the size observed in early January 2018 plus an additional 2.5 ft of sea level rise (right):

The question for this site (and many sites with significant archaeological resources in Portsmouth) is "What can be done to address these threats?" As with many coastal resources, options can be broadly grouped into "fortify, accommodate, and relocate." In the Point of Graves context these options can be characterized as follows:

Options

Fortify

The cemetery already has a wall curving around parts of two sides and all of one side. This structure may serve as an adequate protection against storm surge from those directions, although it would need to be evaluated for its structural integrity before this assumption can be made. Reinforcement or reconstruction of some sections of the wall may be necessary. Also, the wall is not equally high all the way around and is completely missing on the side where flooding might be most likely to occur (see right-hand aerial image above and the left side of the below image). In the lower left corner of the below image the wall is only a few inches tall, then 1-2 ft in height, then it gradually slopes up to 3-4 ft at the gate along the long side of the cemetery:

Following structural reinforcements if necessary, fortification of the site could thus additionally include raising height of the wall to a new elevation, all along its current extent and constructing a new wall along the long side of the cemetery where there is currently only a chain-link fence (left side in the above image). If a new 3 ft flood wall were constructed at this site, cost of materials and construction would likely range from $300 to $400/lf, depending on the degree to which ornamentation or other customized materials were to be incorporated in the design (source: GEI Consultants). Costs of permitting, lane closures, road elevation, or other expense categories would be additional and would require separate estimation.

Temporary flood barriers could also be purchased and stored, to be deployed across the main gate in the event of a surge event large enough to inundate the site, although given the low probability of events of this size, this action would appear to be a relatively low priority.

Accommodate

It would also be possible to simply allow high tides and flood waters to gradually overtake the site. If this course of action is taken, intermittent flooding from large storm surge events may cause some headstones to collapse over time and portions of the existing wall may deteriorate significantly. Flood waters would recede after each storm event, but with rising high tide levels these inundations would become more frequent over time. If this is to be the outcome, it may be preferable to have this be a deliberate choice that has been selected through a robust public process. The choice could also be part of efforts to evaluate whether the archaeological assets will in fact be completely lost when they are eventually inundated by high tides each day. For example, some shell middens dating to the Mid-Holocene have already witnessed episodes of submergence and exposure over vast periods, but remain partially intact in coastal marshlands of the Southeast (e.g., Thompson and Turck 2009), suggesting sea level rise does not necessary always equate with total destruction of all types of resources.

<u>Relocate</u>

Whether it is in one, three, or five decades, residents of Portsmouth and others concerned about archaeologically significant elements at Point of Graves may eventually wish to excavate some or all of the graves and relocate them to another site. Although not entirely impossible, this would be challenging for many reasons including that public funding for historic preservation efforts is often limited in quantity, difficult to acquire, and requires a high level of justification.

Whichever options are considered in more detail, it may also be advisable to enter data about Point of Graves (and Portsmouth's other vulnerable archaeologic resources) into a tracking database like the Digital Index of North American Archaeology (DINAA). DINAA is a publicly accessible compilation of existing archaeological site report data from multiple regional, state, and local repositories, linked with other archaeological databases as well as modern and paleoenvironmental data sets. It allows examination of relationships between environmental and cultural resources over large areas by rendering diverse heritage data sets interoperable and linking them with natural systems data sets encompassing physiography, biota, and climate in the past, present, and projected into the future (Anderson et al. 2017). Ideally, participating in such a system could provide concerned stakeholders in Portsmouth with knowledge of regional trends regarding gradual loss of other coastal archaeological resources in the region and help identify when different types of adaptation action could be most appropriate at the Point of Graves Burial Ground.

Residences at 35 and 41 Salter Street

Context

The two houses and associated garage at 35 and 41 Salter Street are good examples of structures that may be in need of adaptation action in the next several years. In fact threats from extremely high tides are already materializing, as with a king tide on January 5, 2018, where the river in the below photo crested its banks, inundated the garage up to a depth of over 1 ft and totaled a Porsche contained within.

The below images show an estimate of today's normal high tide (left) and a flooding polygon depicting a king tide the size observed in early January 2018 plus an additional 2.5 ft of sea level rise (right). The roof of the garage is visible under the flooding polygon:

Once the decision has been made to take adaptation action, questions need to be answered about which actions stand the best chance of being effective and affordable. Brief discussions are provided below for several candidate actions to protect the garage and houses at this location.

Options

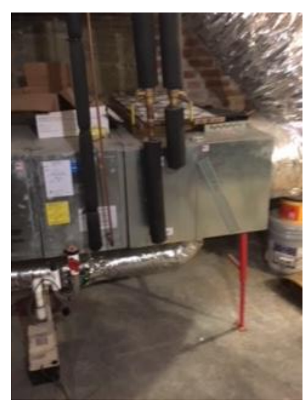
Garage: The below photo is looking towards the back of the two houses, with the garage on the right. The owner has indicated that one possibility is to relocate the garage to the top of the driveway, to the right of the houses in this image:

Because the garage is small, this action would likely be inexpensive compared to most relocations. However, note that once it is at the top of the driveway, the garage would be less vulnerable to king tides than at present but it would still be vulnerable to larger storm surge events. Whether it is moved or not, fortification of the garage may thus be a desirable option to protect both the garage and its contents.

One way to do this is with temporary barriers such as sandbags, deployed in the event of imminent flooding. These types of approaches tend to have many drawbacks, including weight and high storage space requirements. However, recent innovations in this arena make it possible to achieve the same level of flood protection relatively easily, for example with reusable bags that store flat and contain absorbent material so the bags fill with water as flooding occurs. An example product of this type is pictured (see www.miraclesandbag.com). Similar products are available at most building supply retailers. Cost is around $110 for 20 12" x 24" bags (creating roughly a 15 ft barrier if stacked as shown). For some properties, perhaps including the garage at 35/41 Salter St., this may be a cost-effective temporary flood protection solution.

Houses: Although more could be done, the current owners of these residential structures have already implemented several flood adaptation techniques such as installing a basement waterproofing system in 41 Salter St. and elevating the building by 1 ft (and they are considering elevating it an additional several feet). The choice has been made to adapt these structures through keeping the basements dry. In some of Portsmouth's older homes with wood frame construction, the best choice may be to use wet floodproofing techniques instead, where floodwaters are allowed pass through the structure. This can help avoid foundation cracks and other damage from hydrostatic pressure on the building during flood events. A diverse set of possible activities can constitute a wet floodproofing approach, including encasing plumbing and electrical equipment with flood-resistant coatings; raising equipment and valuable objects to higher floors in the structure or removing them altogether; raising electrical outlets; switching to flood-resistant carpet and other materials; and installing pass-through vents at ground level (an example is in the image at right; a sample vendor is at www.floodvent.com, and prices vary widely).

Similarly, some objects in the basement such as the water heater could be raised, perhaps to the same elevation as the furnace:



Staying with a dry floodproofing approach, however, several steps could still be taken for these structures. For example, brick is commonly thought to be an adequate moisture barrier, but in fact is somewhat permeable and can allow moisture to seep and cause corrosion and other damage over time, especially in older structures. Many types of wraps, shields, coatings, and sealants are available that could protect against this outcome, as are false brick panels to maintain visual character. Cost of these approaches varies widely, but in general the cost of dry floodproofing a structure to 3 ft above ground level, through an appropriate combination of techniques, is around $10 to $20 per square foot of enclosed area (Skinner et al. 2005). Dry floodproofing of both 35 and 41 Salter St. could also include fortification of the basement doors pictured below, using the self-filling temporary floodwall bags mentioned above.

In summary, actions like relocating the garage and deploying temporary flood barriers could have short term benefits of preventing future flooding damage at moderate cost. Additional actions to seal the foundations and raise equipment in the basements could provide further protection over time. In combination, these actions have a reasonable chance of protecting the structure, contents, and historic character of these buildings through the next several decades.

5. Implementation Strategies

To the extent there is interest in taking adaptation action in Portsmouth, questions will arise about implementation – Are there policy, zoning, or code changes that would need to happen before the actions become possible? Do the actions duplicate existing activities detailed in any existing emergency preparedness frameworks for the City? Where will the funding come from? What is the best way to know which actions are being effective on an ongoing basis? This section provides recommendations to address some of these challenges.

5.1 Recommended Policy, Zoning, and Code Changes

Maintaining the integrity of historic properties is important in maintaining Portsmouth's National Historic Landmark District designation, which ensures protection through the National Historic Preservation Act and makes historic property owners eligible for state and federal rehabilitation tax credits.

5.1.1 City of Portsmouth Master Plan

The City of Portsmouth's 2017 Master Plan – Vibrant, Authentic, Diverse, Connected and Resilient supports a coordinated approach to historic preservation and flood risk reduction. As a coastal community, Portsmouth will face significant and growing risks from coastal flooding and sea level rise accelerated due to climate change. Commercial areas and residential areas, including large parts of the historic district, are among the first areas vulnerable and likely to be impacted by sea level rise and coastal storm surges. Site plan review should be used to improve long-term preparedness of development, particularly in areas that are vulnerable to sea level rise.

> **Theme 2 Authentic:** A CITY THAT TREASURES ITS UNIQUE CHARACTER, NATURAL RESOURCES AND HISTORIC ASSETS - Action 2.1.1 Implement standards and guidelines to protect community character and assets, including factors such as mass, scale and resilience.

> **Theme 5 Resilient:** A CITY THAT CONSIDERS AND VALUES THE LONG-TERM HEALTH OF ITS NATURAL & BUILT ENVIRONMENT - Action 5.5.1 Incorporate sea level rise projections based on up-to-date state of the art dynamic models into adaptation planning and land use regulations.

5.1.2 Local Design and Guidelines

Flood Risk Assessment. When conducting shoreline planning or designing larger shoreline development projects, require preparation of a risk assessment based on the 100-year flood elevation with sea-level rise projections at 2100. The assessment should identify potential flooding, degrees of uncertainty, the consequences if flood protection devices fails, and the risk to existing habitat/environmental features and adjacent development and infrastructure from proposed flood protection devises.[1]

Resilient Design. Projects determined to be vulnerable to current or future shoreline flooding should be designed to be resilient to sea-level projections and other flooding at 2050. Projects intended to be in place longer than 2050 should prepare an adaptive management plan to manage sea-level projections and other flooding at 2100.[1]

Habitat and Shoreline Protection. Undeveloped shoreline areas that contain sensitive resources (e.g. salt marsh, habitat or natural vegetation) and provide ecosystem services such as flood storage should be preserved when shorelines are developed, redeveloped or for development expansion.[1] The City may consider adopting a "living shorelines" policy to guide preservation of natural shorelines and encourage establishment of living shorelines through restoration.

Property Buy-Out Program. Voluntary property buy-out programs have been proven to be an effective strategy for reducing risk, repetitive damage and costly repairs to property and resources. Often, the land is converted to open space, parks, or otherwise modified to provide flood storage, flood prevention or restored to a natural condition (e.g. living shoreline, sand dune restoration, etc). In advance of implementing such a program, the city should identify specific properties where buy-out may be the best or only option to address the flood risk. This "adaptive reuse" of reclaimed property can provide opportunities to comprehensively transform high risk coastal areas into resilient, adaptive landscapes.

The biggest hurdle to implementing a property buy-out program can be securing adequate funding, given the relatively high value of waterfront property. To be an effective adaptation strategy, a substantial and sustainable funding mechanism would need to be identified. Another caveat to implementing a buy-out program is the nature of its primary goal to remove structures from flood prone areas, many of which are located in the Historic District and are historic structures themselves. Removing historic structures, and those non-historic structures that contribute to a neighborhood, can unravel the fabric of what makes the Historic District a unique and valuable asset for the city.

5.1.3 Regulatory Standards

One issue to keep in mind when considering regulatory standards for historic structures is the unintended consequence of altering a structure to such a degree that it would likely be considered ineligible for the National Register of Historic Places. These standards may include flood adaptation strategies like wet and dry floodproofing, elevation, and replacement of original exterior materials and features. Incentivizing proactive adaptation of historic structures would allow more time for better design and planning compared with reactionary protective measures for flood protection after a structure has been damaged. Protecting historic structures with a regulatory overlay district may ensure their protection from insensitive alterations otherwise required by underlying zoning codes. Failure to implement adaptation measures could lead to a total loss of the structure over time, but in many cases protection of historic properties can be achieved by applying methods and approaches consistent with the property's historic character. Examples include removable barriers deployed before a flood event and removed afterward.

5.1.3.1 Portsmouth Zoning Ordinance Article 6 Overlay Districts

Following are recommendations for amendments to Zoning Ordinance Section 10.620 - Portsmouth's Flood Plain District and Section 10.630 - Portsmouth's Historic District.

Section 10.620 - Portsmouth's Flood Plain District

Height Limits. Amend the Flood Plain District and/or Historic District overlay(s) to accommodate the elevation of historic structures as a flood risk reduction measure in a manner in keeping with its surrounding neighborhood, and to the extent possible consistent with the Secretary of the Interior's *Standards for the Treatment of Historic Structures* and the 2015 International Codes/American Society of Civil Engineers' *Flood Resistant Design and Construction* (ASCE 24-14).[3]

Variances. When a variance is requested for a historic structure for which substantial exterior renovations are being made, require that the mechanical, electrical and plumbing systems be relocated to appropriate elevations (may be determined on a case by case based on flood depth maps) when interior renovations are being made.[3]

Variances. When a variance is requested for a historic structure for which substantial exterior renovations are being made, require (wet or dry) floodproofing to the extent practicable while preserving the exterior of the historic structure. Flood depths may be determined on a case by case based on flood depth maps.[3]

Section 10.630 - Portsmouth's Historic District

Section 10.635.70 Review Criteria. Add new criteria #5 To the extent possible, implement Flood Risk Reduction Measures: accommodate (wet floodproofing), fortify (barriers, dry floodproofing), and relocate. Add a definition of Flood Risk Reduction Measures to the ordinance.

Section 10.633.20 Exemptions From Certificate of Approval. The following exempted construction activities might benefit from flood risk reduction measures: #3, 6, 8, 9, 10, 12, 17, 18, 20, 21, 23, and 24. Requiring implement flood risk reduction measures when these improvements to architectural elements, features and utilities are proposed will begin the process of adaptation for historic structures in high-risk flood areas. Also refer to recommendations 4.1.1 and 4.1.2 above.

Temporary Measures. Amend the Historic District overlay to include language that addresses the installation of temporary storm protective measures (e.g. temporary floodwalls, storm shutters, and barriers).[3] Amend the Historic District Guidelines Manual to include preferred adaptation strategies for historic buildings.

5.1.3.2 Other Regulatory Standards

RSA 79-E:4-a Coastal Resilience Incentive Zone. Adopt the provisions of RSA 79-E:4-a that enables municipalities to use storm surge, sea-level rise and extreme precipitation projections in the 2016 NH Coastal Risk and Hazards Commission report to identify potentially impacted structures, and delineate a Coastal Resilience Incentive Zone(s) for the purpose of providing tax-based incentives for property owners to implement flood risk reduction measures.

Expedited Review. Adopt a post-disaster recovery review and permit procedure for expedited review of historic structures damaged during a disaster taking into account the City's disaster recovery process and how any alterations of the structure may affect federal recovery funding (FEMA, HUD). The policy should define what work is eligible for expedited review and conditions for permitting, and could limit expedited review to certain areas within the Historic District or Flood Plain District or only in the event of a Presidential Disaster Declaration and/or Governor's Declaration of a State of Emergency [3] Such a review and permit procedure might incentivize property owners to develop post-disaster recovery plans well in advance of a disaster laying the groundwork for the best possible outcome for historic preservation.

From Coastal Resilience Initiative Report (2013):

> ***Recommendation ZLU-16: Consider incorporating or providing incentives for new development and (significant) redevelopment to integrate adaptive management and reuse strategies into design plans for structures located or sited in highly vulnerable areas.***
>
> *Adapting existing buildings to mitigate climate change impacts is a viable alternative to demolition and replacement. Thus, designing for future buildings with embedded adaptive reuse potential is a defensible goal toward sustainability. Building adaptive reuse entails less energy and waste, protects a buildings' historic and cultural values- its socio-cultural and historic meanings embedded in the community - while giving them a renewed lifespan and purpose* (Conejos et al. 2011).

Shoreline Setbacks. Along natural undeveloped shorelines, establish setbacks for all new permanent structures, including walls, bulkheads and rip-rap, based on projected shoreline position assuming 2 feet of sea-level rise at 2050 and up to 6.6 feet of sea-level rise at 2100. Allow new structures for functionally water-dependent uses which can be adapted over time to accommodate sea-level rise inundation or be moved upland on the site (Conejos et al. 2011).

Non-Conforming Structures. Treat existing development in projected high-risk flood areas as non-conforming structures, and prohibit expansion or intensification of their use but allow ordinary maintenance and repair of damage up to no more than 50 percent of the building value. Options when damages amount to more than 50 percent of the building value may include: 1) Require removal or relocation of such non-conforming structures; or 2) Bring the structure into full compliance with floodplain development standards taking into account future sea-level rise projections (Conejos et al. 2011).

5.1.3.3 Recommendations from the Coastal Resilience Initiative Report (2013)

Recommendation ZLU-1: Evaluate the benefits and costs of adopting an Extended Flood Hazard Overlay District utilizing the flood elevation scenarios identified in the CRI Report. An extended Flood Hazard Overlay District would regulate these vulnerable areas by imposing special regulations aimed at:

- Incorporating phased adaptation actions for new development, redevelopment, and expansion of existing development;
- Protecting municipal infrastructure and private investments;
- Implementing sustainable and resilient development practices and infrastructure; and
- Protecting critical environmental resources.

Recommendation ZLU-6: Prepare a Historic District Flood Hazard Adaptation Plan which utilizes the results of an inventory to provides a long-term framework for floodproofing of structures, and opportunities for protection or relocation of structures.

The bulletin FEMA P-467-2 *Floodplain Management Bulletin Historic Structures (May 2008)* by the National Flood Insurance Program (NFIP) provides comprehensive guidance on how to minimize impacts to historic structures, and explains how the NFIP defines historic structure and gives relief to historic structures from floodplain management requirements (44 CFR §60.3).

Recommendation ZLU-8: Establish new road, street grade and structure/building first floor elevations and other infrastructure, covering the life-cycle of such construction based on the flood elevations projected in this study to 2050 and 2100 (i.e. preferably an elevation that exceeds current City, state and FEMA standards).

Knowing future elevations of supporting infrastructure will be important information for property owners to use in planning for renovations of existing historic structures, saving time and money, and enhancing historic preservation.

Recommendation ZLU-13: Consider initiating a cost/benefit study to determine the expected costs of maintenance and reinforcement of critical infrastructure and roads within highly vulnerable areas and to evaluate additional funding needs and sources.

Require additional fees from property owners and developers to pay for the costs of infrastructure services and maintenance, and emergency response in highly vulnerable areas. For example, only those property owners and developments located in an Extended Flood Hazard Area Overlay District would be assessed such fees. Fees may be structured to apply immediately to address ongoing impacts or phased in over time as specific flood elevation benchmarks occur in developed upland areas.

5.1.4 Policies and Practices

Interim Case-by-Case Assessment. In the interim, as new regulations are being developed, assess projects/applications/structures on a case-by-case basis to determine the public benefits, historic preservation opportunities, resilience to flooding, and capacity to adapt to flood projections at 2050 and 2100.[1] This assessment could yield valuable information to be provided as advisory guidance to the property owner/applicant.

Hazard Mitigation Plan. The City could adopt a policy to designate in its Hazard Mitigation Plan the high-risk flood area of the Historic District, as identified in this assessment, as a "special flood mitigation area" for the purpose of protecting against and mitigating flood impacts from sea-level rise and storm surge.

5.2 Emergency Preparedness and Evacuation Plans

Portsmouth's current Hazard Mitigation Plan was adopted in May 2017. Plan preparation includes a 10-step process (several are listed below) for identification of "critical facilities" including resources of historical, cultural and social value, and impacts from flooding, sea level rise, and coastal storms. A specific goal of the Plan is to "reduce the potential impact of natural and man-made disasters on Portsmouth's and the State's specific historic treasures and interests as well as other tangible and intangible characteristics that add to the quality of life to the citizens and guests of the State and the City."

Step 3 – Identify Critical Facilities and Areas of Concern
Step 4 – Identify Existing Mitigation Strategies
Step 5 – Identify the Gaps in Existing Mitigation Strategies

Step 6 – Identify Potential Mitigation Strategies
Step 7 – Prioritize and Develop the Action Plan
Step 8 - Determine Priorities
Step 9 - Develop Implementation Strategy

A good application of this assessment would be to elevate the importance of the City's historic and cultural resources in emergency planning and preparedness. Within the next Plan update cycle and using the results of the *Historic Properties Climate Change Vulnerability Assessment and Adaptation Plan*, historical and cultural resources in high-risk flood areas could be more thoroughly identified, prioritized, mitigation strategies developed, and recommendations placed in the implementation plan to protect them into the future.

In Chapter VIII Feasibility and Prioritization of Proposed Mitigation Strategies, the effectiveness of each mitigation action identified in the Plan is evaluated in a matrix with a series of questions about damages which are ranked from 1 (lowest) to 5 (highest). The question "Will historic structures be saved or protected?" ranked as follows for 7 relevant strategies (17 total):

Mitigation Strategy - Culvert Replacements = 3
Mitigation Strategy - Increase GIS Capacity = 2
Mitigation Strategy - Update GIS Imagery = 1
Mitigation Strategy – Building Code for Wind = 3
Mitigation Strategy – Evacuation route signs for parking lots and garage = 2
Mitigation Strategy – Downtown City stormwater management plan = 3
Mitigation Strategy – Flood Protection for wastewater pump station =2

Recommend that the City could adopt a policy to designate in its Hazard Mitigation Plan the high-risk flood area of the Historic District, as identified in this assessment, as a "special flood mitigation area" for the purpose of protecting against and mitigating flood impacts from sea-level rise and storm surge. Specific flood hazard mitigation strategies (such as those listed above) should describe specifically what historic resources in the designated area would be saved or protected.

The above recommendation and maps showing the extent of flood risk areas were presented to Portsmouth's Emergency Management Director Steve Achilles at a meeting with city staff on November 27, 2017. Achilles strongly supported the action to strengthen the focus on the Historic District and its resources in the city's Hazard Mitigation Plan. By elevating its importance, the Historic District will be considered a high priority with respect to implementation and prioritization of mitigation strategies that protect against or prevent flood impacts, and may enhance the District's ability to receive mitigation funding from federal agencies.

5.3 Collaborative Monitoring

Collaborative monitoring activities are steps taken by an organized group of stakeholders to track changes that could trigger actions in policy, finance, or other adaptation action. They could prepare Portsmouth to have programs in place and structures adapted before significant damage has occurred. For example, volunteers could check basements for humidity and standing water, possibly through checklists provided to homeowners with request for data submission. Data sheets could be posted next to the electrical panel for each structure and filled out and submitted annually to the City, which would track when trigger points were being reached in each strategy area.

Involved parties could include any stakeholders interested in preserving historic assets in Portsmouth – City staff, property owners, members of the Historic District Commission, or Strawbery Banke or other property managers. Monitoring could also be conducted not just on individual properties but in the public sphere, on historically important infrastructure, monuments, and parks. Next steps could include the basement inventory discussed elsewhere in this document; determining specific desired data inputs; identifying where responsibility would reside for tracking and responding to status changes; and choosing methods for maximizing participant engagement over time.

Importantly, volunteer efforts such as these should serve only as a supplement to a larger and coordinated effort to deploy a network of groundwater monitoring wells throughout the Historic District and possibly other portions of Portsmouth. Groundwater data obtained over time from a network of this type will create a more scientific basis on which to make management decisions and help avoid irregularities of participant turnover, whether from changes in ownership of a parcel or level of interest in participation. Next steps could include determining the appropriate density of wells in a network and the best locations in the City for these wells; research on cost to acquire and deploy the equipment; and clarifying how data collection, management, and interpretation will occur.

6. Conclusions

Conversations in the LAC meeting series clearly demonstrated a high degree of concern for the long-term viability of a range of structural and landscape assets in Portsmouth's iconic Historic District. There is significant interest in seeing the City initiate action in the categories described in this report. This includes support for efforts to 1) adapt existing buildings and landscape features to be more resilient to sea level rise and storm surge; 2) modify existing planning documents and emergency management protocols to support more resilient development; and 3) engage with stakeholders that can help implement the programs and continue to monitor changes over time.

Stakeholder activities could include continuation of the Local Adaptation Committee, expansion and continued use of the ESRI Story Map created through this project, and creation of a collaborative monitoring program. One recommendation is to complete such an inventory of basements, foundations, and foundation types, and use it to help track emerging groundwater-related impacts on the Historic District. The work would reference the publicly available GIS layers that were produced in works cited in this report. Inventory results would be linked to the new groundwater models and form the basis of a volunteer collaborative monitoring program that could support a new network of groundwater monitoring wells in the City. Data from these systems may be able to serve as an early warning system before surface flooding has become a significant problem for the Historic District, helping trigger municipal actions in policy or finance to would address the issues before they become more severe.

7. Limitation of Liability

This report should be used for general planning purposes only. Best available predictive information about future climatic conditions specific to sea level rise and storm surge were used in preparation of this report. That said, the vulnerability assessment performed for the project was limited by several factors including vertical accuracy of elevation data used and reliance on flooding models that do not consider wave action and other coastal dynamics. As climate projections and surge and elevation models are improved, this report and reports of this type will need to be updated to reflect the new information. Also, actions discussed in the report will not render the individual structures or sections of the Historic District completely resilient to the range of types of flooding to which it is vulnerable. In developing the candidate actions, no consideration was given to local hydrology other than overlaps with the 13.5' flooding polygon as indicated. The report simply provides examples of some categories of planning and other action that, if carefully coordinated with a broad range of other activities that address local hydrological nuances in an integrated fashion, may contribute to an overall effort to prevent losses of historic, cultural, and economic value in the District.

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Figures

Figure 1. Strategy Areas Map

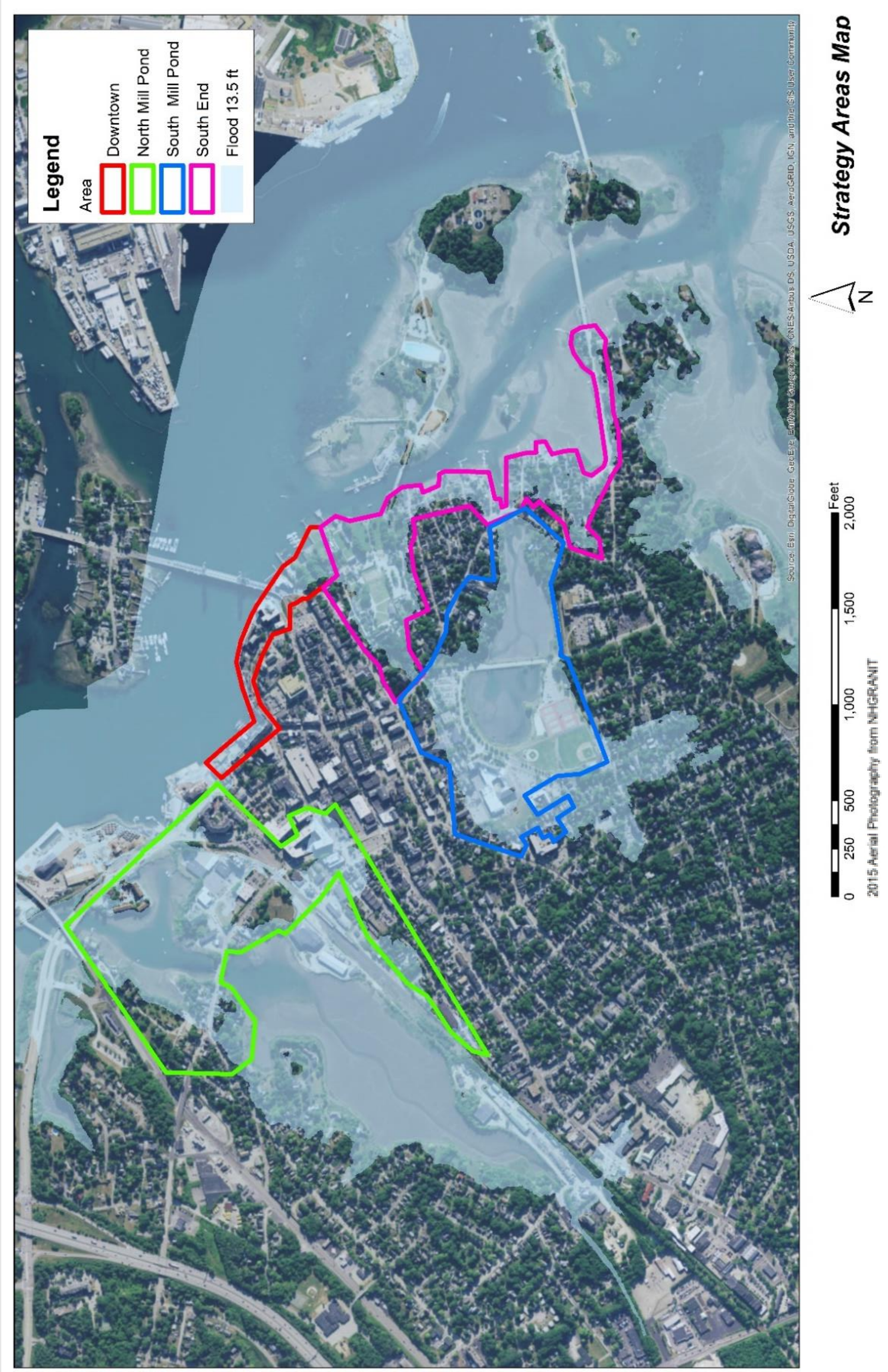


Figure 2. Historic Value Map: Buildings

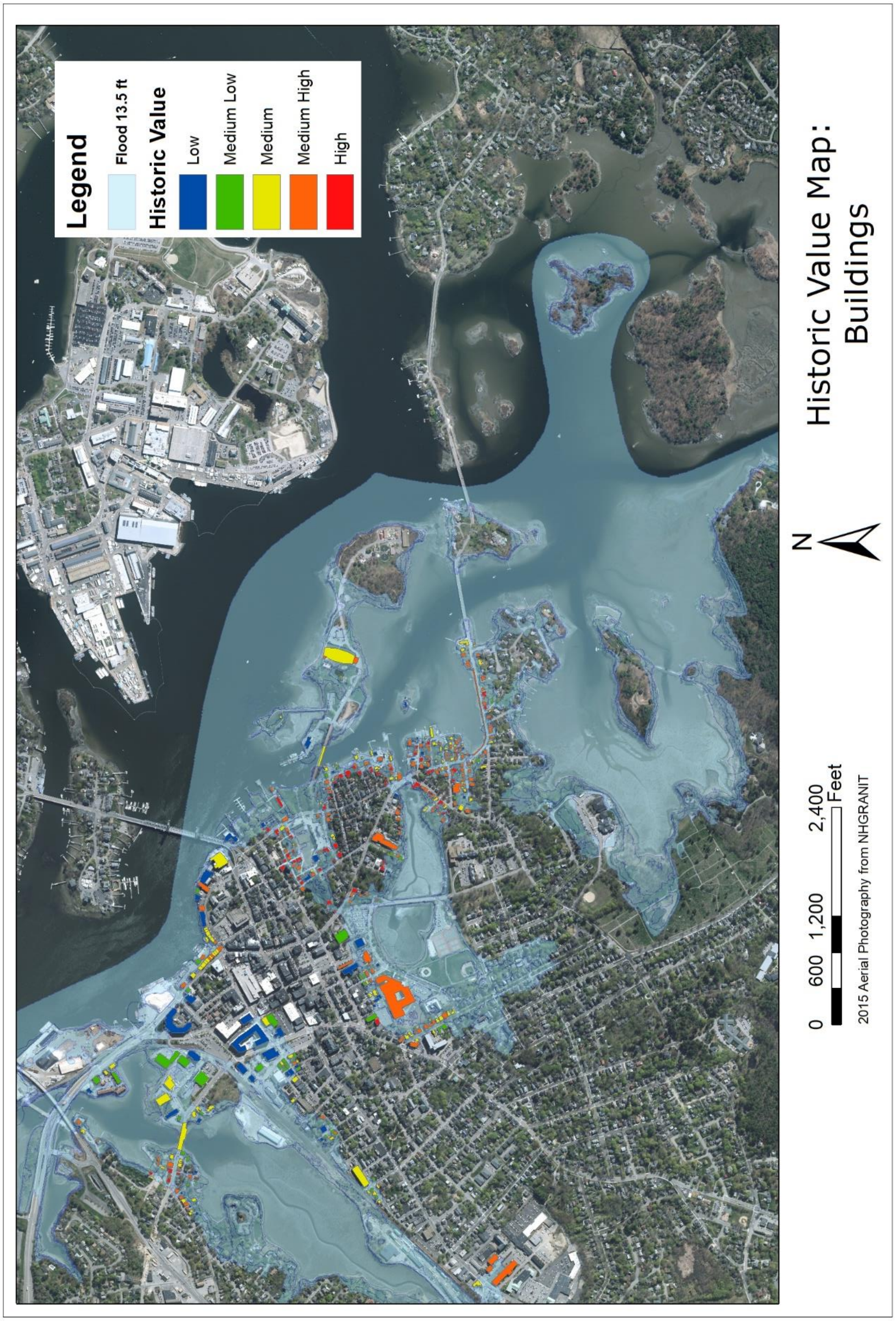


Figure 3. Historic Value Map: Sites

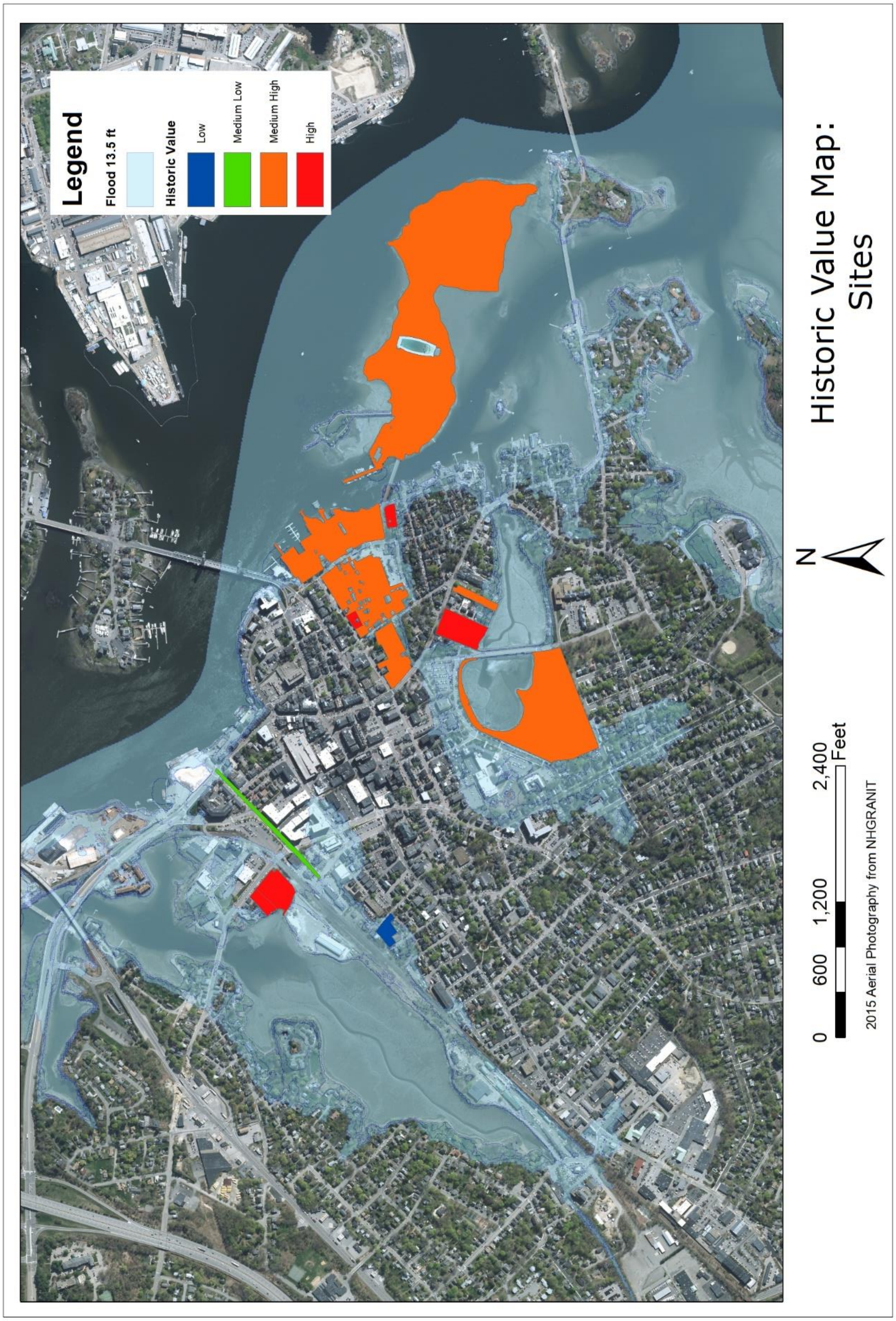


Figure 4. Cultural Value Map: Buildings

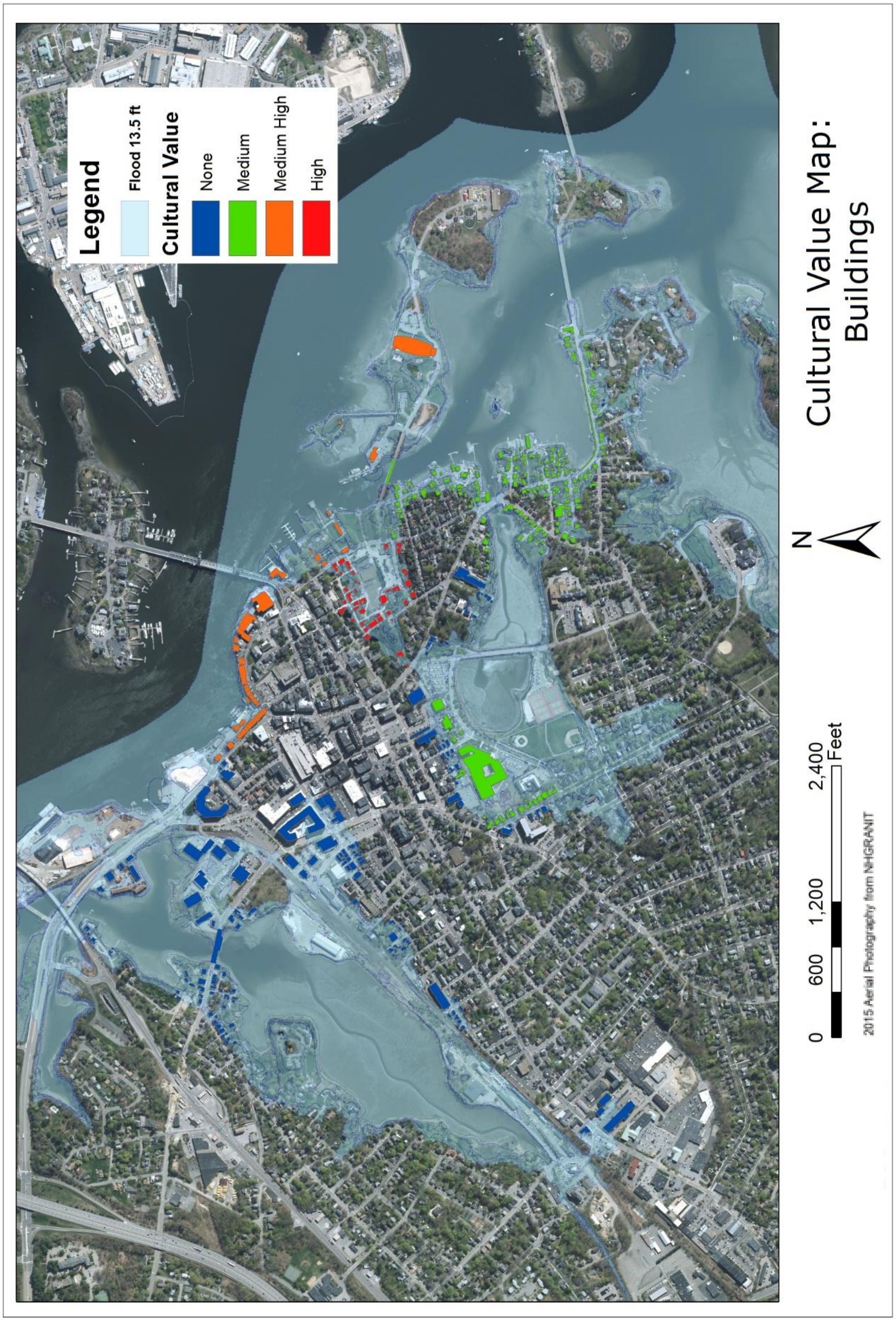


Figure 5. Cultural Value Map: Sites

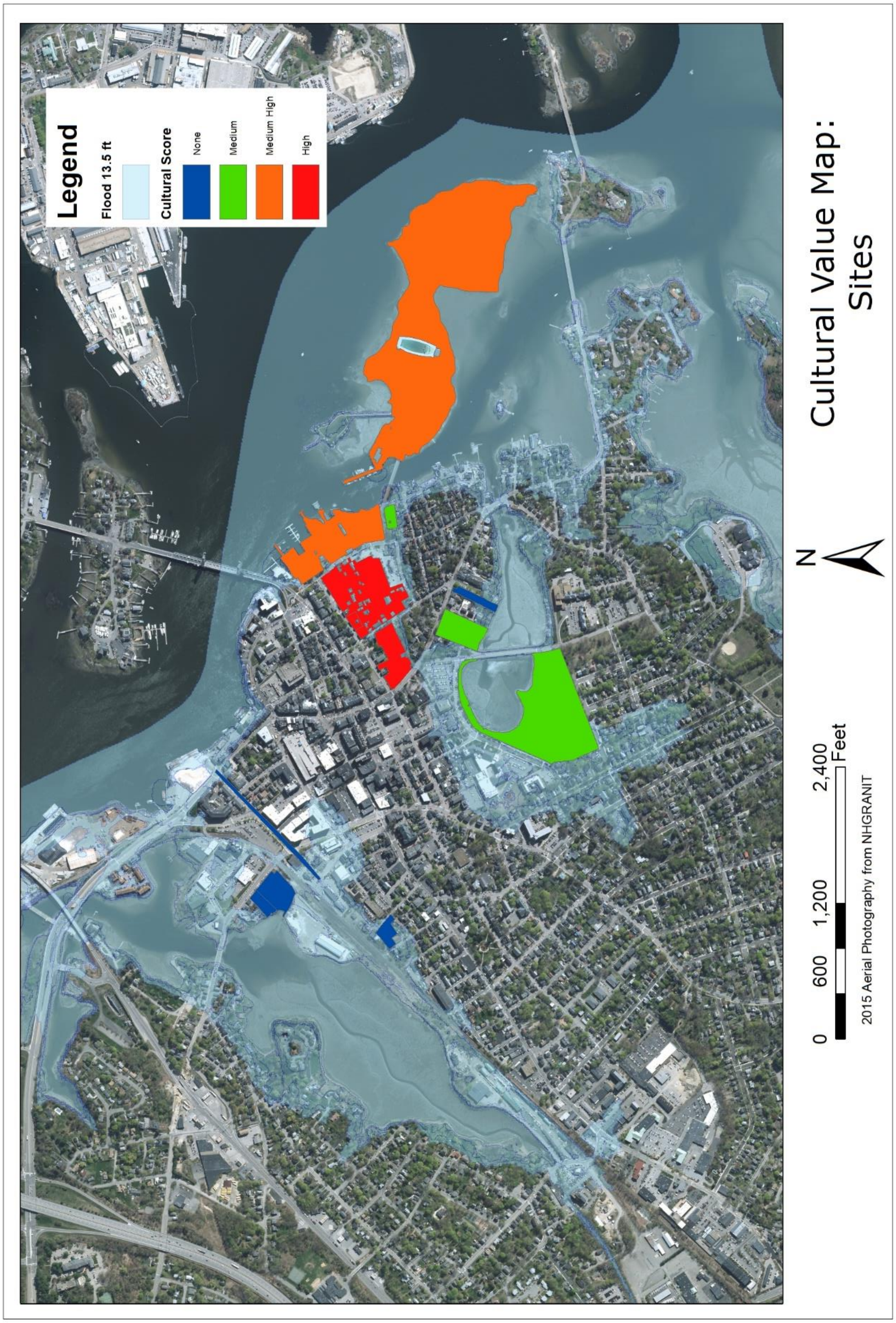


Figure 6. Tax Value Map: Buildings

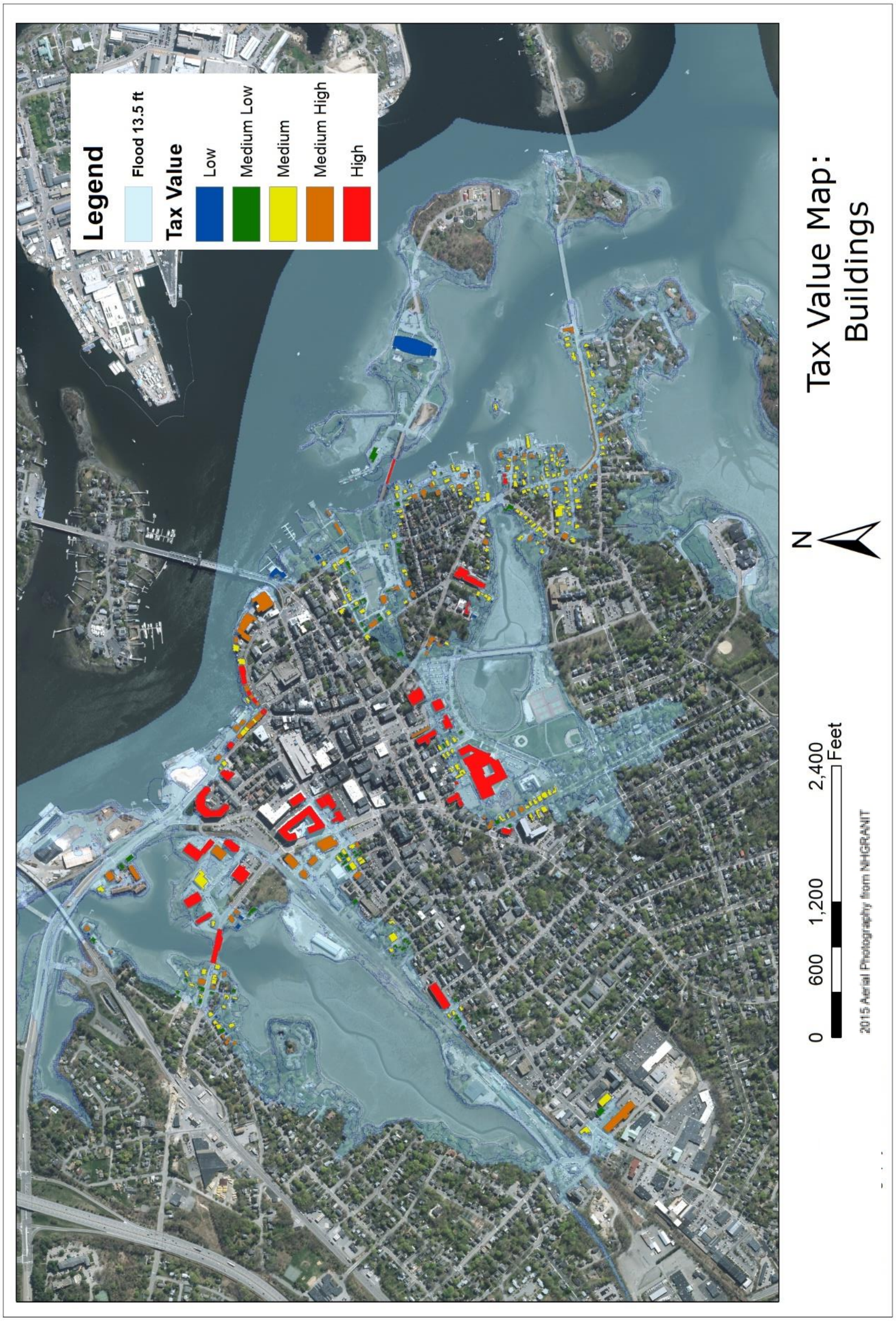


Figure 7. Tax Value Map: Sites

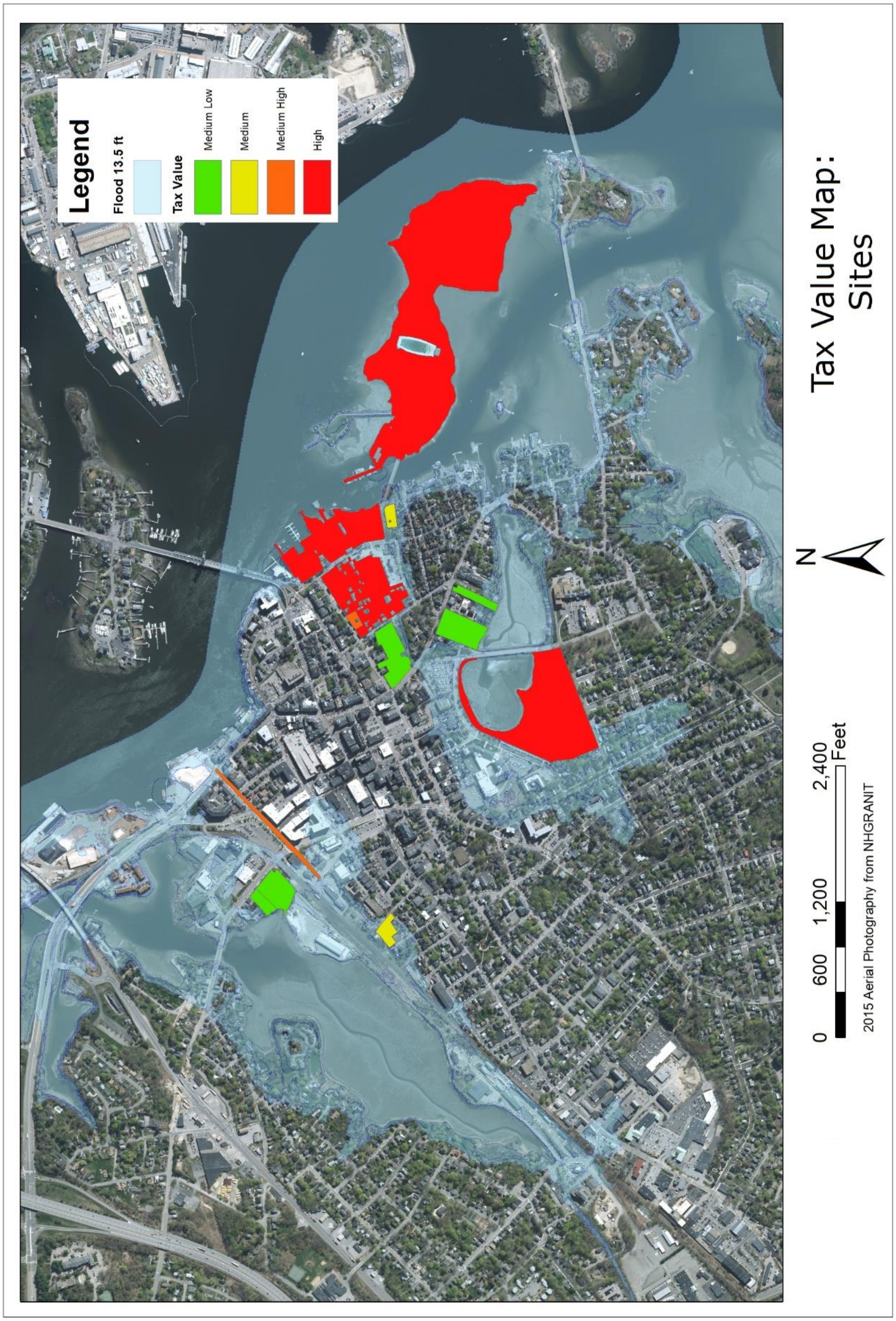


Figure 8. Composite Value Map: Buildings

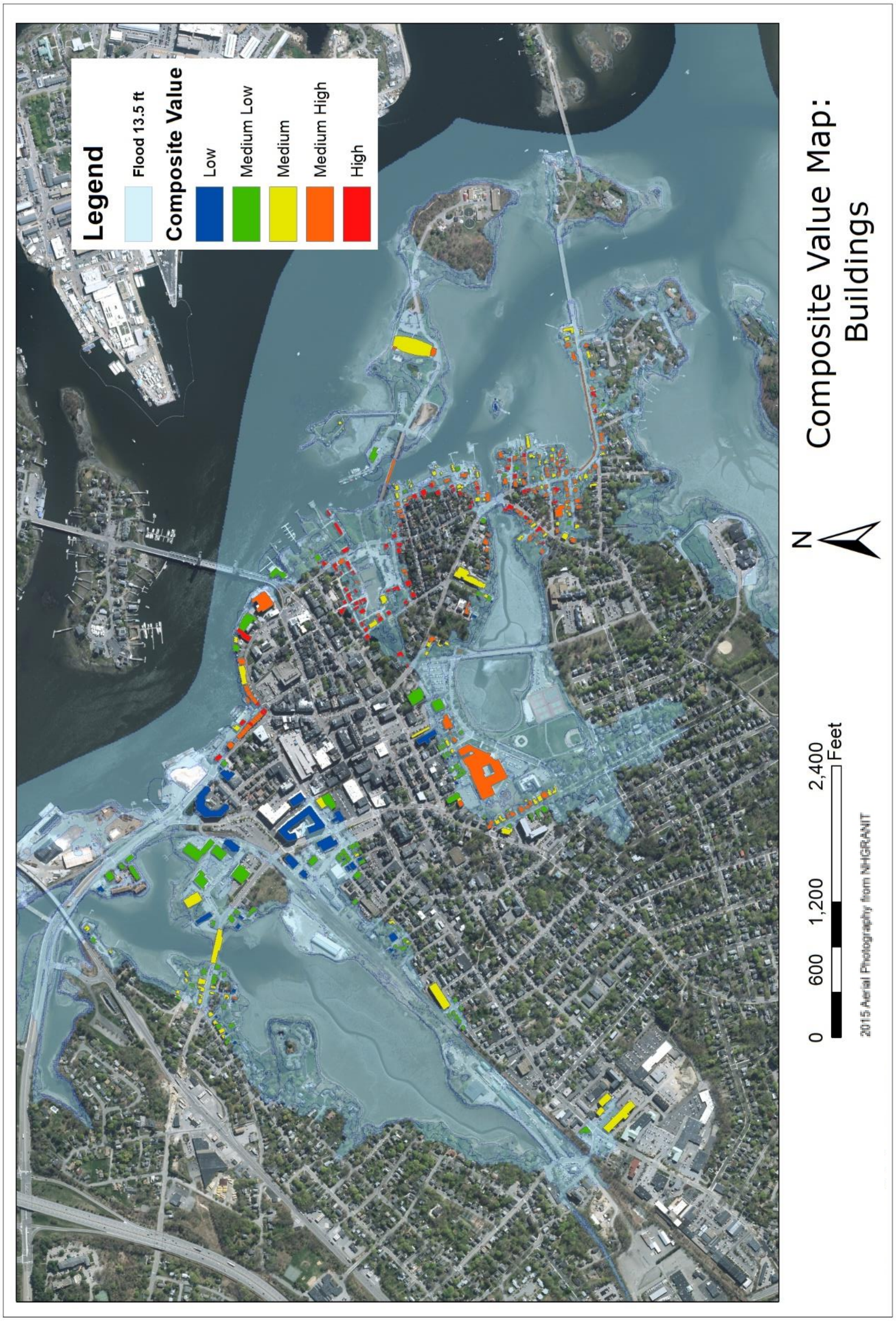


Figure 9. Composite Value Map, Sites

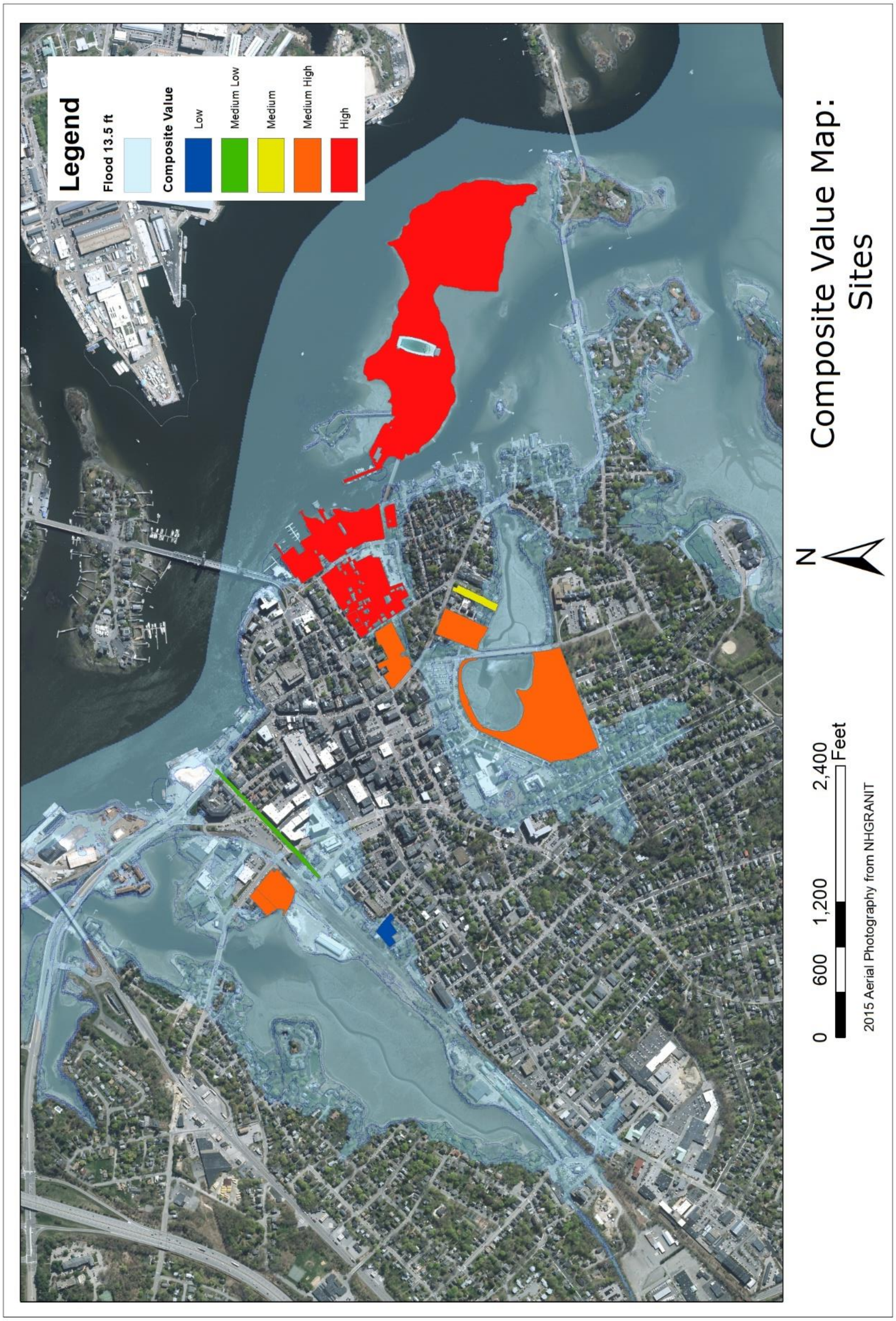


Figure 10. Risk Map: Buildings

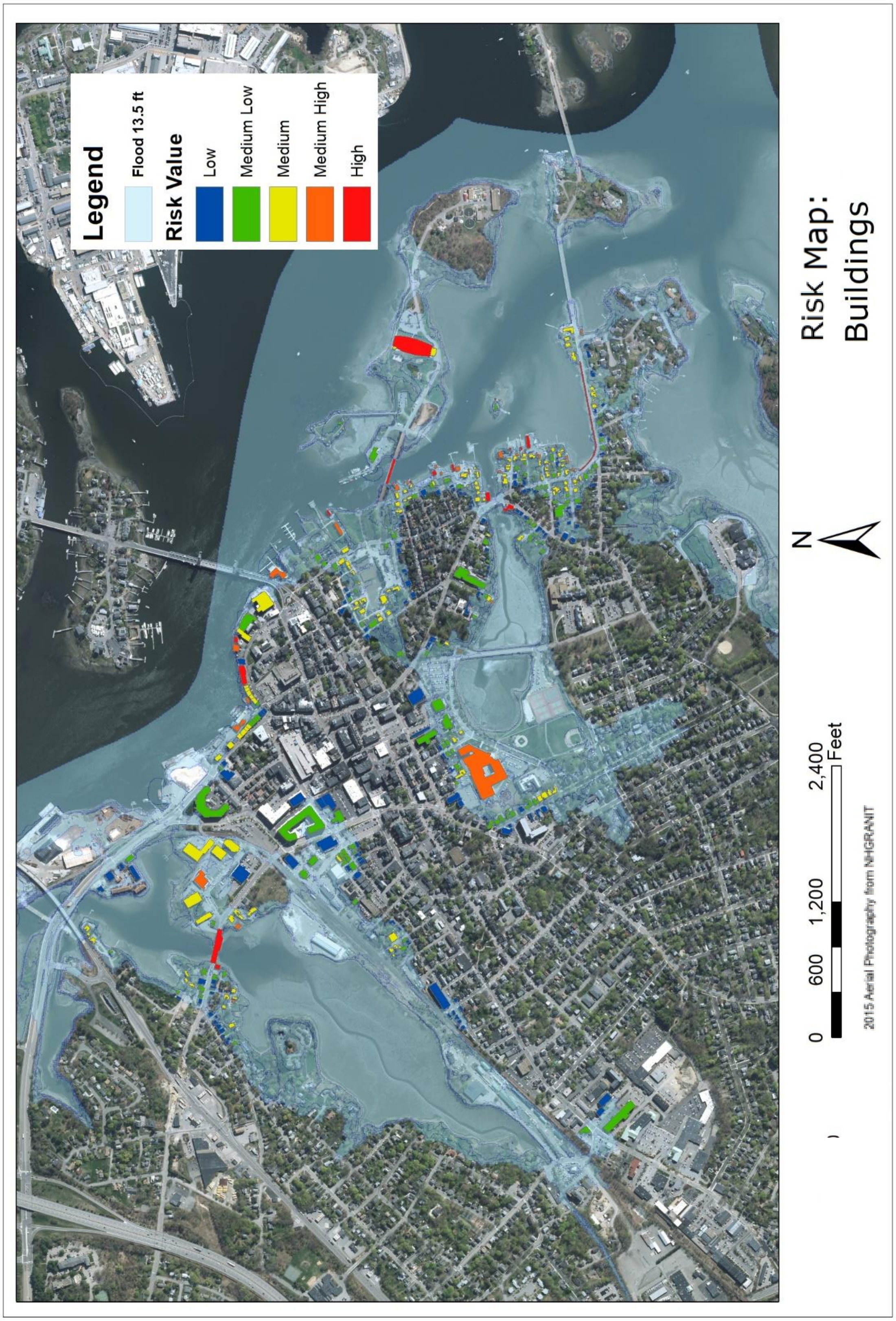


Figure 11. Risk Map: Sites

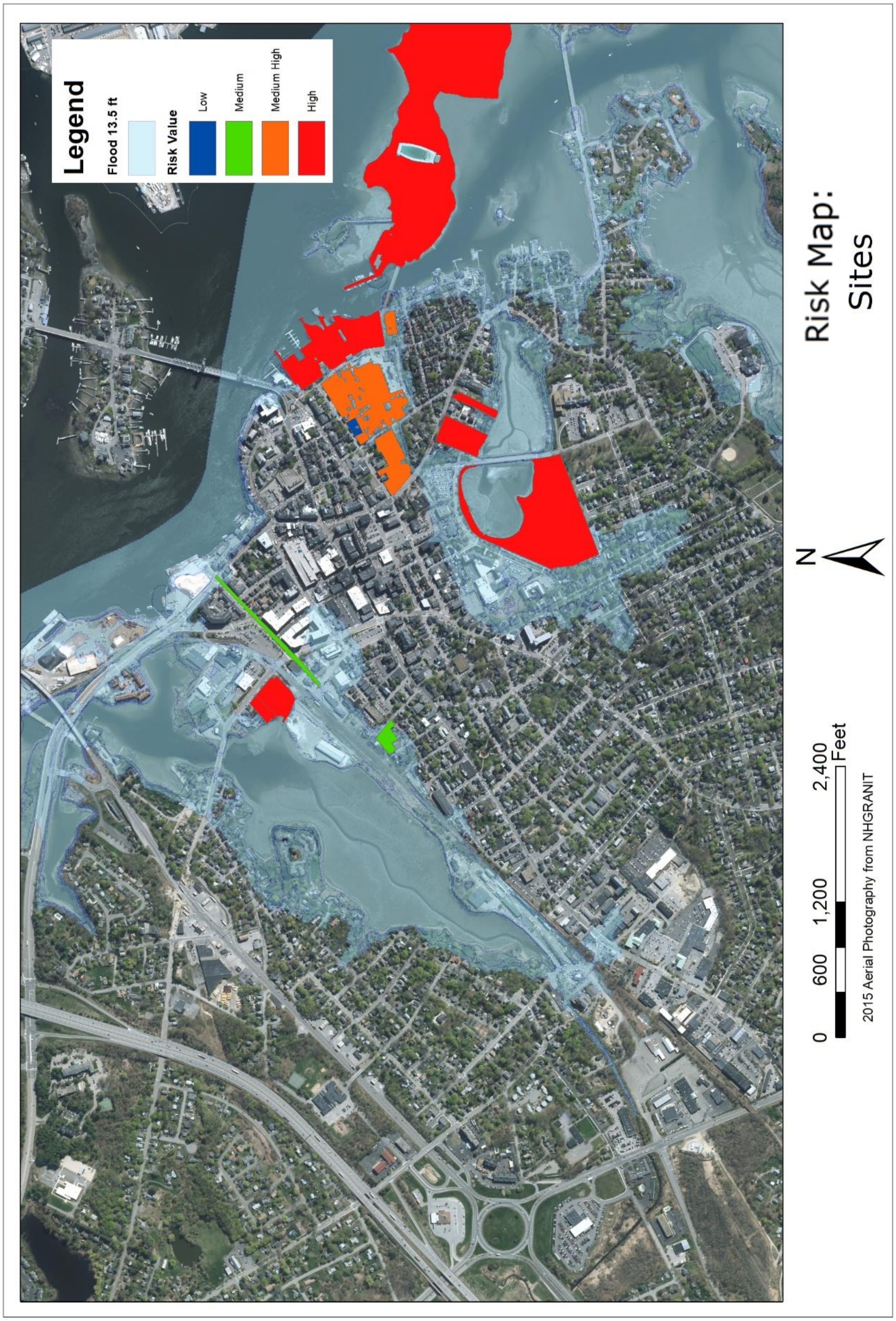


Figure 12. Composite Risk and Value Map: Buildings

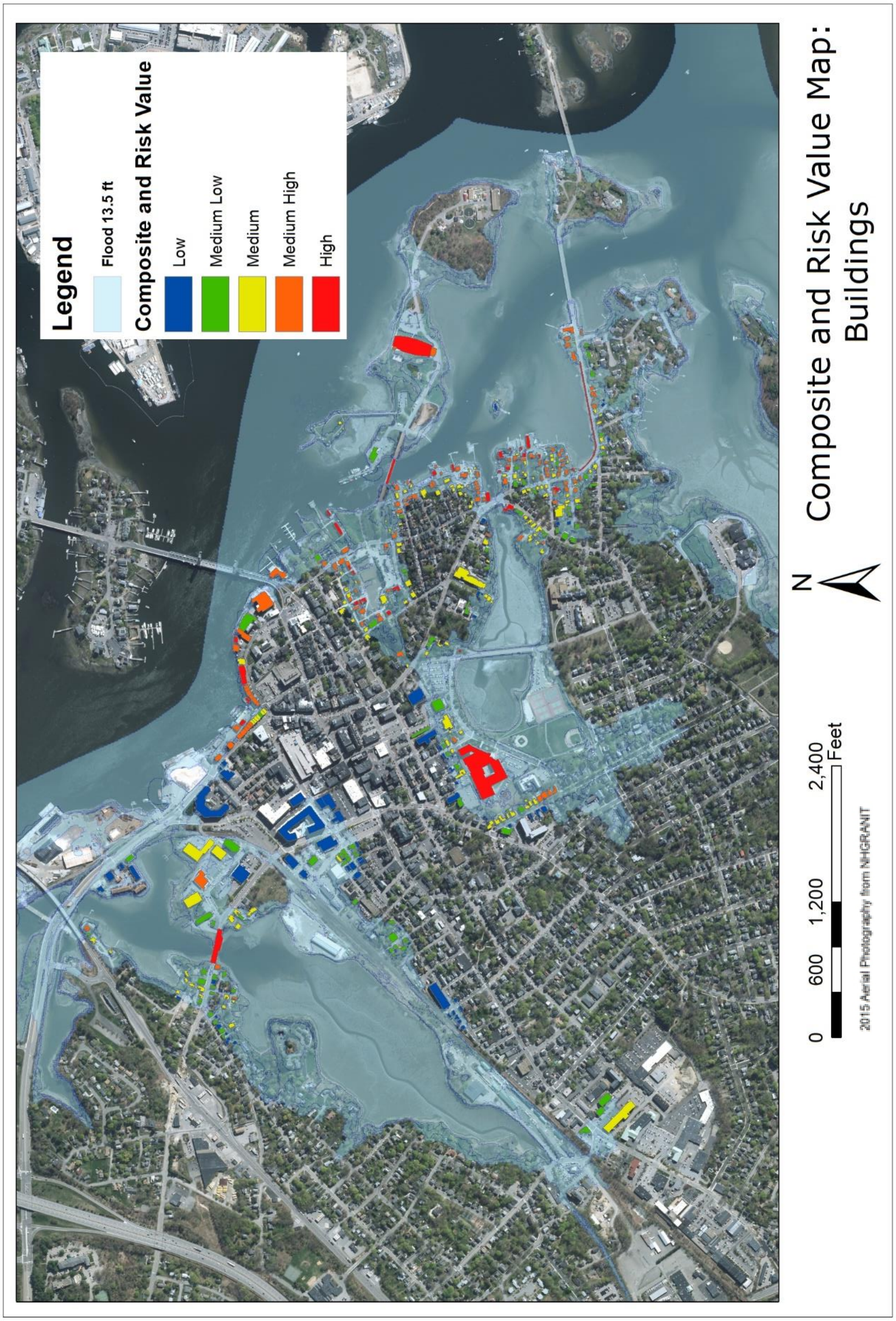
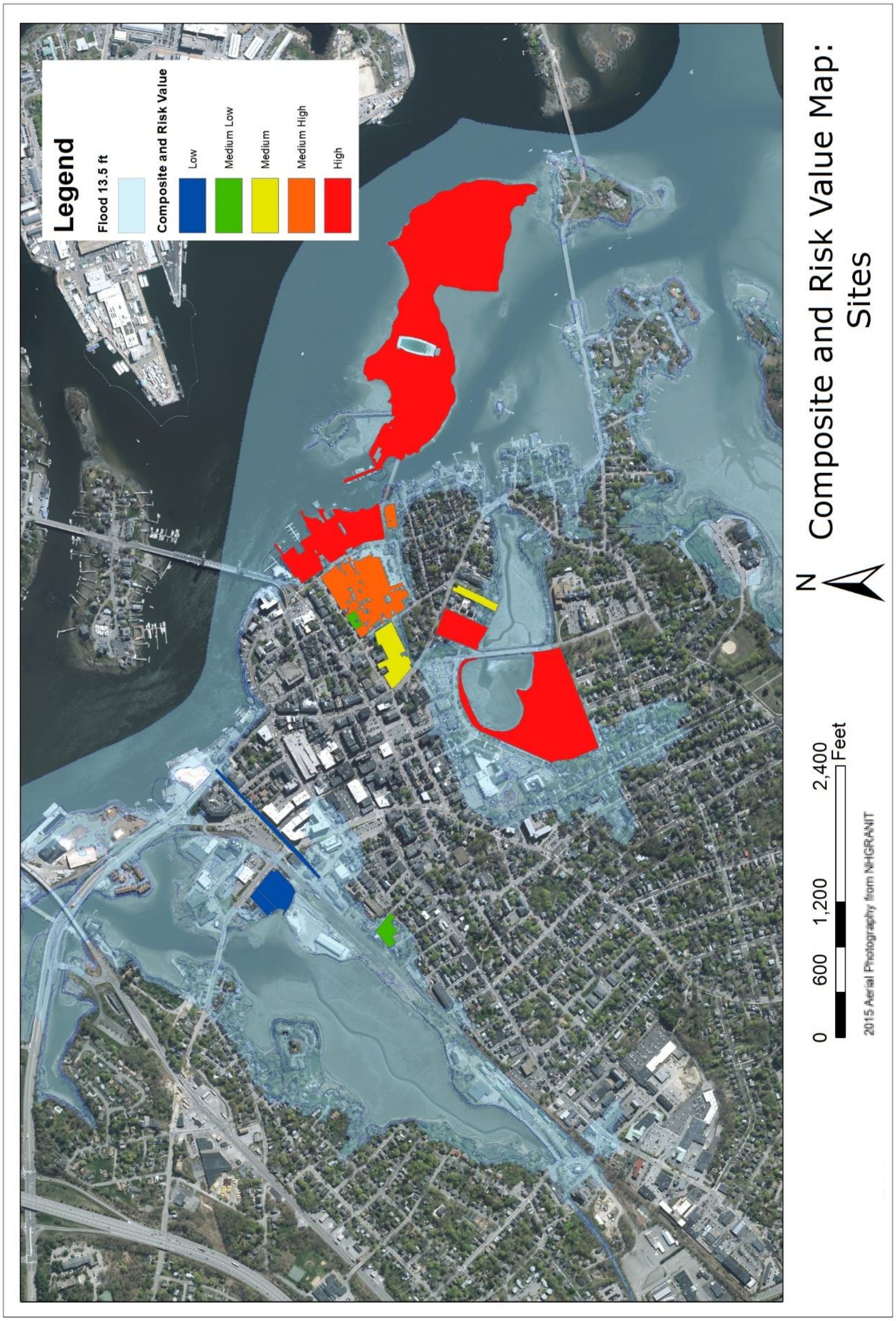


Figure 13. Composite Risk and Value Map: Sites



Appendix A – LAC Meeting Minutes

Local Adaptation Committee Meeting #1
June 27, 2017
Minutes

The Local Adaptation Committee (LAC) meeting began at 7:00pm with the following in attendance:

LAC Members: Eric Spear, Reagan Ruedig, Adrianne Harrison, Rodney Rowland, and Brian Goetz.

Project Team/City Staff: Sam Merrill, Julie LaBranche, Jenna Dunham, Peter Britz and Nick Cracknell

City Staff Peter Britz and Nick Cracknell opened the meeting with introductions of the Project Team and LAC members, and presented an overview of actions by the City to address climate change related flooding and impacts. They reviewed the project, its goals and outputs, and role of the LAC in guiding the project.

Sam Merrill reviewed the project elements and provided a comparison of the geographic extent of the Historic District compared with areas most vulnerable to flooding as identified in the Climate Resilience Initiative Report.

Jenna Dunham reviewed the proposed methods for conducting the vulnerability assessment including prioritization and selection of "candidate sites" and "building types" to evaluate.

Julie LaBranche led the LAC through an exercise to solicit input based on 3 key questions. LAC responses are recorded below.

Question 1:

What would be the most damaging impacts of coastal flooding on historic resources?
Loss of access to resource (isolation). Water damage undermines structural integrity. Can no longer be occupied/has to be demolished. Inaccessibility of access roads. Washing away wooden structures on the waterfront. Pervasive rot of wood structures. Economic loss from fewer visitors, less access. Basement impacts, structural stability, utilities, mold, object/housing loss. Street and utility loss or disruption. Deterioration of historic fabric over time.

Question 2:

Based on the introductory information presented tonight, what are the most important types of adaptation actions you think might be worth deeper investigation as we develop this adaptation plan for historic resources in the City?

Sea walls, walls and flood gates. Block the river. They were all good ideas. Dry techniques (sea walls, elevation of structures, gates). Flood storage capacity. Spaces that connect people to water, public parks that embrace higher tides. Fortification of foundations and raising structures. Elevate, changes to basements to accommodate water.

Question 3:

How can the City most effectively communicate risks of these impacts and the need for substantial actions that might be necessary to address them?
Have Strawbery Banke staff wear waders or hip boots all the time ;-) Make a disaster movie. Neighborhood focus groups (i.e. FOSE). Computer simulation, 3D map. Visualize a "coastal flood day". Direct communication with building owners. High water marks on historic resources of concern. Hold public meetings and virtual meetings. Examples of cumulative flood impacts.

For members not present, feel free to submit responses to the above questions to jlabranche@rpc-nh.org to capture your thoughts and perspectives as we move forward with the assessment.

The LAC and Project Team scheduled the following LAC meetings from 10:00am-noon: July 20th, August 24th, and September 21st. The meeting concluded at 8:40pm.

Local Adaptation Committee Meeting #2
July 20, 2017
Minutes

The Local Advisory Committee (LAC) meeting began at 10:00am with the following in attendance:

LAC Members: Eric Spear, Richard Shea, Reagan Ruedig, Rodney Rowland, and Jim Sanders.

Project Team/City Staff: Sam Merrill, Julie LaBranche, Jenna Dunham, Peter Britz and Nick Cracknell

City Staff Peter Britz and Nick Cracknell opened the meeting with introductions of the Project Team and LAC members, and presented an overview of the meeting agenda. Richard Shea commented that his name should be added to the June 27th minutes as being in attendance.

Jenna Dunham reviewed the work completed on the historical values survey which will be used to select the adaptation "candidate sites" for the project. The complete survey will be presented at the August 24th LAC meeting and maybe available on the City's project website in advance.

Nick Cracknell presented a description and map of the preliminary Cultural Value Areas: Working Waterfront, Downtown Waterfront, Prescott Park, Strawbery Banke and Langdon House, Civic Campus along South Mill Pond, Peirce Island, and South End Neighborhood. He asked the LAC for recommendations to modify the Cultural Value Area boundaries. Richard Shea noted that the Working Waterfront boundary should be enlarged slightly to include all land south of the Sarah Long Bridge. The LAC agreed on the proposed Cultural Value Areas and their boundaries.

Nick Cracknell presented the Cultural Value Areas scoring matrix which the LAC would use to rate the relative importance of each Cultural Value for each of the selection Areas: Public Use & Access, Aesthetic Value, Economic Value, Educational Value and Symbolic Value. Adrianne Harrison submitted input on the Cultural Value Area scoring in advance of the meeting. Julie LaBranche and Nick Cracknell led LAC members through the scoring process and recorded responses on a master Cultural Values matrix. Based on the combined scoring, the LAC and Project Team assigned relative scores for each Cultural Value Area. Refer to the attached final matrix results. In discussion of each Cultural Value Area, the LAC identified the following unique assets:

Working Waterfront – salt piles, Thomas Leighton, deep water port
Downtown Waterfront – Bow and Ceres Streets historic waterfront
Prescott Park – historic working waterfront, views
Strawbery Banke and Langdon House – historical significance and gathering place

- Civic Campus along South Mill Pond – library, school, water feature and fringing neighborhoods
- Peirce Island – sweeping harbor and ocean views
- South End Neighborhood – working waterfront, historic homes and colonial neighborhood fabric, sightseeing destination

Peter Britz wrapped up the meeting by reviewing "Next Steps" in the scoring process and selection of candidate sites. An expanded scoring matrix will be prepared which will include Historical Value scores, Cultural Value scores, flood depth/risk value scores, and property Assessed Value. The Story Map will be loaded to the City's project webpage soon so that the LAC and Project Team can populate the site.

The LAC and Project Team scheduled the following LAC meetings from 10:00am-noon on August 24th and September 21st at the Strawbery Banke conference room.

The meeting concluded at 11:30am.

Local Adaptation Committee Meeting #3
August 31, 2017
Minutes

The Local Advisory Committee (LAC) meeting began at 10:00am with the following in attendance:

LAC Members: Eric Spear, David Moore, Brian Goetz, Reagan Rudig, Adrianne Harrison, Rodney Rowland, and Jim Sanders. Project Team/City Staff: Sam Merrill, Julie LaBranche, Jenna Dunham, Peter Britz and Nick Cracknell

City Staff: Peter Britz and Nick Cracknell opened the meeting with introductions of the Project Team and LAC members, and presented an overview of the meeting agenda.

Jenna Dunham presented the Department of the Interior methodology used for the historical values scoring and map for the 761 structures and assets in the 13.5' flood impact area that are greater than 50 years old.

Peter Britz and Nick Cracknell reviewed progress with interpreting assessing database information and inherent inconsistencies in the data. Many properties have different conditions on them that are valued differently such as mixed use, condominiums, non-profits, multiples buildings on the same parcel, and the value of land versus the value of buildings. They will continue to extract appropriate information as possible. LAC members were concerned about assigning values which might be perceived as ranking one property over another especially since valuation is not always uniform among different properties and types of ownership like non-profits. *Note – economic value was considered during the Cultural Values scoring from LAC Meeting #2. See summary of scoring in the box below.*

Summary of Cultural Values Scoring from previous LAC Meeting #2:
At LAC Meeting #3, Nick Cracknell presented the Cultural Value Areas scoring matrix which the LAC uses to rate the relative importance of each Cultural Value for each of the selection Areas: Public Use & Access, Aesthetic Value, Economic Value, Educational Value and Symbolic Value. Based on the combined scoring, the LAC and Project Team assigned relative scores for each Cultural Value Area. Refer to the final matrix results. In discussion of each Cultural Value Area, the LAC identified unique assets for each area:

Working Waterfront – salt piles, Thomas Leighton, deep water port
Downtown Waterfront – Bow and Ceres Streets historic waterfront
Prescott Park – historic working waterfront, views
Strawbery Banke and Langdon House – historical significance and gathering place
Civic Campus along South Mill Pond – library, school, water feature and fringing neighborhoods
Peirce Island – sweeping harbor and ocean views

South End Neighborhood – working waterfront, historic homes and colonial neighborhood fabric, sightseeing destination

Nick Cracknell presented his selection of potential 'Adaptation Strategy Areas' to focus on selecting candidate sites for adaptation actions:

North Mill Pond – mostly commercial, masonry construction
South Mill Pond – mixed municipal facilities, mostly newer construction
South End/Working Waterfront – wood frame residential structures and working waterfront
Downtown Working Waterfront – mostly commercial, masonry construction

Adaptation strategies can be applied to individual structures (e.g. case-by-case basis) or 'pooled approaches' where collective resources are applied to a single or series of strategies that benefit an area or neighborhood. Depth of flooding impacts will also play a role in selection adaptation strategies as low-level flooding is treated differently than greater flood depth impacts. *Note: Refer below to a summary of the cultural values scoring methods and results for information about the features identified in the proposed Adaptation Strategy Areas. Economic value was one of the cultural values considered in this scoring; this should be reflected in the final report.*

The group discussed the inherent problems with freshwater flooding from extreme precipitation events. Any adaptation strategy would need to incorporate stormwater management in its design. Storage and detention of stormwater will be an important approach to controlling flood impacts when combined with sea-level rise or storm surge events.

Alex Gray presented information about possible adaptation actions centered around the options do nothing, fortify (modify the flow path of water), accommodate (modify the impact of water), and relocate. Actions to fortify include sea walls, revetments, earthen berms and tide/flood gates. Actions to accommodate are typically modifications to the flood prone levels/floors of a structure to allow flood water to pass under and through parts of the structure below the base flood elevation (e.g. crawl spaces and open construction basements). Julie LaBranche noted that it will be important to identify the physical constraints at each site that might preclude certain adaptation strategies in favor of others.

Julie LaBranche noted that it's important to acknowledge adaptation actions completed by the City to date such as rebuilding a higher wall on Mechanic Street and requiring all kitchens and utilities be removed from the lower levels of buildings on Bow Street.

Peter Britz wrapped up the meeting by reviewing "Next Steps" in compilation of the final overall value scores and selection of candidate adaptation actions.

The LAC and Project Team tentatively scheduled the LAC meeting #4 for September 28th or October 12th at the Strawbery Banke Tyco conference room. The meeting date will be confirmed shortly.

The meeting concluded at 12:00pm.

Local Adaptation Committee Meeting #4
October 12, 2017
Minutes

The Local Advisory Committee (LAC) meeting began at 10:00am with the following in attendance:

LAC Members: David Moore, Brian Goetz, Reagan Rudig, Rodney Rowland, and Jim Sanders.

Project Team/City Staff: Sam Merrill, Julie LaBranche, Jenna Dunham, Peter Britz and Nick Cracknell

Peter Britz opened the meeting with a review of the flood risk map, cultural values score map, historic value score map, monetary value score map (structure replacement value not including internal features or contents), and the composite score map. It was noted that the flood risk map captures any parcel touched by flooding, assigns a uniform value irrespective of the extent of flooding on the parcel, and does not represent the extent of inundation from the 13.5-foot flood elevation.

As discussed at LAC meeting #3, the next step in the assessment would be to selection candidate sites from the four Adaptation Strategy Areas:

North Mill Pond – mostly commercial, masonry construction
South Mill Pond – mixed municipal facilities, mostly newer construction
South End/Working Waterfront – wood frame residential structures and working waterfront
Downtown Working Waterfront – mostly commercial, masonry construction

Sam Merrill began the meeting by reiterating the 4 basic categories of candidate adaptation actions – fortify, accommodate, retreat and relocation. Sam noted that wet floodproofing is not appropriate for many historic structures with porous masonry foundations. He then presented the 16 preliminary candidate sites selected for review and discussion. Four sites in each of the four Adaptation Strategy Areas were selected based on their representation of structures in each Adaptation Strategy Area, to some degree its composite value score., and the transferability of adaptation actions to other structures in the Adaptation Strategy Area. The LAC and project team discussed each of the 16 candidate sites, and revised site selections and candidate adaptation actions accordingly. Refer to attached LAC#4 Handout (revised). LAC members noted additional impacts from groundwater rise and freshwater flooding to historic structures and sites.

Sam Merrill explained that any one candidate adaptation action alone may protect a single structure or site but would not protect entire blocks or neighborhoods. Rather a multi-pronged approach would be necessary in most locations to address flood inundation from multiple directions. Because "piecemeal" adaptation solutions, property by property over time, are not ideal, one approach might be to create "incentive districts" (refer to NH SB185 legislation) to encourage actions my multiple property owners either individually or as a collective action. In areas where substantial barriers might be the only long-term solution to sea-level rise, buyout programs may be a viable solution.

Peter Britz offered the next LAC meeting would focus on review of the revised candidate sites and adaptation actions.

The LAC and Project Team did not set a date for LAC meeting #5. A meeting date will be confirmed for November.

The meeting concluded at 12:00pm.

Local Adaptation Committee Meeting #5
November 29, 2017
Minutes

The Local Advisory Committee (LAC) meeting began at 10:00am with the following in attendance:

LAC Members: Richard Shea, David Moore, Brian Goetz, Adrianne Harrison, Reagan Rudig, Rodney Rowland, and Eric Spear.

Project Team/City Staff: Sam Merrill, Julie LaBranche, Peter Britz and Nick Cracknell

Sam Merrill opened the meeting with a brief review of the flood risk map, cultural values score map, historic value score map, monetary value score map (structure replacement value not including internal features or contents), and the composite score map. He then reviewed the recommended adaptation actions for each of the 16 candidate sites using the new the Story Map platform. The Story Map includes a description of each site, value score and historical significance, building/structural conditions, and possible adaptation actions appropriate for the site and conditions.

LAC members offered the following comments:

- Rodney Rowland described observation of groundwater/sea water seepage in the basement of Strawbery Banke's Drisco House during the November 5-7 King Tide event. He showed a brief video and intends to observe and document flood conditions again for the December 5th highest tide event.
- Voluntary buyout programs lack incentives for property owners to take this action and seem contrary to the goals of historic preservation in the Historic District.
- Public/private partnerships are needed to advance adaptation. Government action can be slow especially when funding/spending money is involved. Need incentives for private investment and cost sharing for implementation of adaptation at the block, neighborhood or larger scales.

Discussion Questions: Collaborative Monitoring

Sam Merrill lead discussion with the LAC about the concept of and feasibility of Collaborative Monitoring.

What are the trigger points?

1. Wet basements? How many? What would be launched when they are found?

   Already a need to do wet floodproofing for both surface and groundwater flooding.
   Is filling basements a possible adaptation option?
   Need strategies to minimize impact to historic value of properties.
   Is public involvement needed for monitoring? Will they want to do it? Education about benefits needed.

2. Standing water on important sites? How much? What would be launched when they are found?

   Identify flood impacts on structural integrity of buildings.
   Use maps of projected flood scenarios for outreach/education. Be consistent about use of "red colors" as highest risk.

3. How is data collection organized? Where does responsibility for tracking and responding to it reside? How would participants be engaged and communicated with over time?

   Rather than basement monitoring, install neighborhood groundwater level monitoring wells (done by UNH in the past?).
   Strategic selection of monitoring sites (museums, government buildings). Provide monitoring devices for private homes. Use monitoring data for public education/outreach about adaptation need/benefits.
   Define whether there is a role for researchers to collect data.

Discussion Questions: Planning Recommendations

Julie LaBranche lead discussion with the LAC about draft planning recommendations and regulatory approaches.

1. What are important "triggers" that provide opportunity for adaptation of existing structures? [e.g. exterior modifications, damage, modernization]

   Macro-citywide groundwater data and/or flood event data
   Micro-level property by property data collection
   At building permit stage, provide adaptation information and options
   Evaluate code requirements to implement stricter standards; need support from city government not just HDC as the "tip of the spear"
   Identify thresholds for adding regulations when necessary (planning board action)
   City must lead by example by adapting their own infrastructure and facilities
   Update/confirm climate change projections annually to respond to current conditions
   Use King Tide and monitoring data to provide rationale for taking action
   Need a process to report and record "wet basement" complaints and a way to provide guidance

2. Can collaborative monitoring provide rationale/evidence for regulatory approaches?
   YES!

3. What information would incentivize voluntary adaptation actions by property owners?
   Revise HDC guidelines document and add guidance/intervention at building permit phase

4. Does property owner education play a role in planning the future of the historic district?

YES!

5. How might adaptation modifications impact the status of historic district and designated properties?
Preferred course of action in the short term – guidance and information sharing, not new regulations

Discussion Questions: Emergency Planning/Preparedness

1. What can the city do to help owners of historic structures be better prepared to address flood impacts?

   See discussion under Collaborative Monitoring and Planning Recommendations.

2. In what ways can historic preservation be used as an emergency management tool?

   Hazard Mitigation Plan could identify the Historic District as an important city asset. Mitigation strategies would be identified and prioritized that protected assets and resources in the District.

3. Is it feasible for neighborhoods or groups of property owners to pool resources to create emergency preparedness plans or implement collaborative adaptation measures.

   Yes, pooling of resources makes sense and would leverage funds and adaptation implementation on a broader scale.

Final LAC comments: Partnerships could be very useful and who will lead climate adaptation moving forward?

The LAC and Project Team did not set a date for LAC meeting #6. A meeting date will be confirmed for January, with HDC as host at a regularly scheduled meeting. The meeting concluded at 12:00pm.