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BURLINGTON CITY, NJ

COASTAL VULNERABILITY

ASSESSMENT REPORT



NEW JERSEY
RESILIENT
COASTAL
COMMUNITIES
INITIATIVE

Prepared for the City of Burlington by the Delaware Valley Regional Planning Commission; funded by the National Oceanic and Atmospheric Administration for the New Jersey Resilient Coastal Communities Initiative, managed by the New Jersey Department of Environmental Protection Office of Coastal and Land Use Planning



The Delaware Valley Regional Planning Commission is the federally designated Metropolitan Planning Organization for a diverse nine-county region in two states: Bucks, Chester, Delaware, Montgomery, and Philadelphia in Pennsylvania; and Burlington, Camden, Gloucester, and Mercer in New Jersey.



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Executive Summary

Located along the Delaware River and bisected by the tidal Assiscunk Creek, Burlington City is susceptible to the effects of coastal flooding (i.e., flooding along the tidal portions of the Delaware River shoreline and other tidal waterways). The combination of rising tidal waters and increasing frequency of extreme weather events along these creeks will gradually increase the risk of coastal flooding in the city over time.

In this project, Burlington City staff and residents worked with DVRPC to conduct a coastal vulnerability assessment (CVA) and complete a “Getting to Resilience” (GTR) questionnaire to evaluate their coastal flooding risks and determine ways to increase their resiliency to this hazard.

Coastal Vulnerability Assessment

In the CVA, participants reviewed and prioritized future risks to the city from the combined effects of storm surge and sea level rise. The CVA used 2050 sea level rise projections (1.4 feet) and 2100 sea level rise projections (3.3 feet) in combination with a model that shows the depth and extent of storm surge from a Category 2 storm if it were to strike at high tide and at an angle and direction that maximized the amount of surge.

The CVA project team examined the impact of this “CVA scenario” on 97 assets in Burlington. Assets include properties, infrastructure, or natural resources that are of high value to the community and/or facilities and populations that might be particularly vulnerable to extreme events (see Table 1). The project team determined whether each asset would get flooded using the previously described flooding scenario, what would happen to the asset if it were to be flooded, and the consequences to the city if the asset were damaged or unable to function during a flood.

Table 1: Breakdown by Type for All Analyzed Assets

Asset Category	Count
Institutional/Cultural/Government	40
Evacuation Route/Transportation	15
Hazardous Site	14
Utility	11
Emergency Facility	10
Vulnerable Population	4
Neighborhood with Previous Flooding Issues	2
Open Space	1
Total Number of Assets	97

Burlington has a high overall vulnerability to the flooding scenario described. The analysis revealed six types of assets that Burlington should consider as being of high concern (Table 2).

Table 2: List of Asset Types Identified as High-Concern

Asset Category	Number of Individual Assets
Designated Evacuation Route	5
Fire Department	5
Flood Control Structure	3
Designated Emergency Shelter	2
City Hall/Police Department	1
Wastewater Treatment Plant	1

The assets of high concern include the city's evacuation routes, designated emergency shelters, fire stations, flood control structures, the municipal building/police department, and the city's wastewater treatment plant (Table 2).

Getting to Resilience Questionnaire

In the GTR portion of the project, participants reviewed and discussed the GTR questionnaire, which included 226 questions about Burlington City's efforts to increase the community's resilience to coastal flooding hazards. The GTR questions focus on five categories of action, including vulnerability assessments, public engagement, planning products, emergency operations, and resiliency projects that implement the community's plans and analysis. By discussing these questions, municipalities can evaluate the work they have accomplished and pinpoint strategies to better protect themselves. The GTR process also brings together municipal staff, leaders, and residents with different areas of expertise to brainstorm solutions to coastal flooding problems that have not been solved.

Burlington City has extensive emergency operations and has already created or commissioned plans and studies on the effects of coastal flooding on its community. GTR participants commented that they had accomplished many of the actions in the questionnaire. However, the questionnaire uncovered additional coastal resiliency actions, and potential means to accumulate more credits in the National Flood Insurance Program's (NFIP's) Community Rating System (CRS), of which Burlington City is a participant. These new coastal resilience actions served as one of the primary sources for the recommendations in this report.

Introduction

Between September 2015 and August 2016, Burlington City used two tools to analyze its vulnerability to coastal flooding from storm surge and sea level rise: the coastal vulnerability assessment (CVA) and the Getting to Resilience questionnaire (GTR). Every level of government—federal, state, and local—has a role in planning for stressors and threats likely to afflict its citizens. However, municipalities that have the tools to understand, predict, and prepare for the natural disasters that occur within their borders are arguably best poised to assist their constituents in reducing potential harms associated with climate hazards and extreme weather events.

Coastal Vulnerability Assessment

The CVA is a tool to help communities plan for flooding along their coastlines and tidal waterways and prioritize flood mitigation strategies, enabling them to better manage and recover from these floods. The CVA assesses the degree to which a community's "assets" (its properties, infrastructure, natural resources, and populations) will be affected by flooding from projected sea level rise and storms. For those assets that are affected, the CVA analyzes the consequences that their temporary or long-term loss poses to the community. With this assessment, communities become better informed to make decisions about land use planning, flood mitigation, sea level rise adaptation, infrastructure maintenance, capital improvements, and post-disaster recovery.

On September 3, 2015, Burlington City met with DVRPC, the region's Metropolitan Planning Organization, to begin the CVA process. The project team used a CVA methodology created by Sustainable Jersey within the New Jersey Resilient Coastal Communities Initiative (NJRCCI), a program run by the Office of Coastal and Land Use Planning in the New Jersey Department of Environmental Protection (NJDEP). NJDEP and Sustainable Jersey developed the methodology to help municipalities prepare for sea level rise and likely increases in the frequency of extreme storm events.

Getting to Resilience Questionnaire

In addition to undertaking a CVA, Burlington City also completed the GTR questionnaire on August 3, 2016. The GTR questionnaire was originally a paper questionnaire developed by NJDEP, which was expanded and maintained by the Jacques Cousteau National Estuarine Research Reserve to include an interactive online component and connections to other resiliency programs. Like the CVA, this planning tool is designed to help New Jersey municipalities increase their resiliency to coastal flooding through a facilitated discussion. Whether conducted internally by municipal staff or externally with help from a technical assistance provider, attendees complete a questionnaire with a series of questions about different resiliency actions they may have taken to prepare for flooding or respond to flood damages. GTR topics, broadly, include coastal vulnerability assessments, municipal plans, public engagement on coastal hazards, disaster preparedness and recovery, and municipal implementation (i.e., how the municipality's plans have been converted into physical projects).

Each question of the GTR solicits a "Yes," "No," "Not sure," or "Not applicable" response. When the questionnaire is completed online, the project team's response automatically guides them to recommendations that are matched to each question. The results from the online questionnaire also contain suggestions for municipalities to earn additional points in the National Flood Insurance Program's (NFIP's) Community Rating System (CRS), which participating municipalities can use to help reduce their residents'

flood insurance premiums. The online questionnaire also provides suggestions on how municipalities participating in the Sustainable Jersey municipal certification program can achieve credits to improve their rating.

Burlington City's previous and ongoing coastal resiliency actions, as discussed during the GTR session, have been incorporated into the **Current Preparedness for Flooding** section of this report (page 8). Recommendations from the GTR have been incorporated into the **Recommendations** section of this report (page 24).

Community Presentation

On November 30, 2016, DVRPC staff presented a summary on the process and results of the city's CVA and GTR sessions to the Burlington City community at a monthly meeting of the Burlington City Land Use Board. Attendees listened to the presentation and shared their own concerns about flooding in Burlington City. A representative from the NJDEP Office of Coastal Land Use Planning was also present and contributed to the discussion.

Burlington's Location

Burlington City is a suburban municipality that encompasses 3.8 square miles in Burlington County, New Jersey. Located along the Delaware River and bisected by the tidal Assiscunk Creek, it is at risk to coastal flooding hazards. Burlington will feel the effects of sea level rise, and will also be affected by the stronger storms anticipated in the Northeastern United States. The combination of rising tidal waters, increasingly severe coastal storms, and more extreme precipitation events will increase the risk of flooding in the city over time.

Historical Flooding in Burlington City

Like other communities in New Jersey, Burlington City is susceptible to extreme precipitation events and potential flooding. According to CVA participants, the flood of 1955, Tropical Storm Lee, and Hurricane Irene caused the most significant flooding in recent history. During Irene and Lee, some of the major streets in the city flooded, and the city was forced to close U-turns and interchanges to Keim Boulevard, a major connector to Pennsylvania via the Burlington-Bristol Bridge. In the 1955 flood, the downtown and highways through it were completely flooded, and some residents remember the floodwaters coming up the wheels of their cars.

Communities north of the head-of-tide at Trenton along the Delaware River have experienced numerous devastating floods since the beginning of the 20th century, with eight major floods having occurred since 1996. However, the impacts of these floods were experienced from Trenton northward, where the river is not tidal and the water is confined to a narrower channel. CVA participants indicated that the highest water levels experienced in Burlington were those associated with Hurricane Irene and Tropical Storm Lee in August/September 2011 and Hurricanes Connie and Diane in 1955. However, hydrographic data from NOAA's Burlington City tide gauge show that Superstorm Sandy had a maximum flood height of about 7.7 feet above mean sea level.

Generally, the city has had a certain degree of luck; rather than a highly damaging, "catastrophic" storm, the city has mainly experienced storms that produce minor floods. Even the floods of Irene and Lee were relatively minor. Floodwaters from the Assiscunk Creek have seeped into the Columbus Park area from

under its levee, and some residential blocks flood sufficiently regularly to be placed on the repetitive loss properties list, but overall, reported damages from flooding in the city have not been extreme. The public works garage is occasionally flooded, as are Federal, Mitchell, and Wood Streets. Also, during major high tides, some water comes over the city's bulkhead along the Delaware River.

Burlington City's Coastal Vulnerability

Why Coastal Resiliency is Relevant to Burlington City

Despite the lack of catastrophic floods in Burlington's past, about 75 percent of the city falls within the 1-percent/100-year floodplain, and the combination of sea level rise and increases in the intensity and frequency of coastal storms caused by climate change will introduce new vulnerabilities in Burlington that the city will need to address.

Since 1900, the sea level has risen approximately one foot in the tidal Delaware River.¹ Climate change will continue to cause an accelerating rate of sea level rise and increases in the intensity of severe storm events in the coming decades. The following is a summary of the expected coastal and riverine flooding changes in New Jersey, assuming global greenhouse gas emissions trends continue as they are today.

Sea Level Rise

In New Jersey, the most recent sea level rise central estimate (meaning that the estimate has a 50 percent probability of being met or exceeded) is 1.4 feet from current sea level by 2050, and 3.4 feet by 2100 assuming current rates of emissions continue.²

Figure 1 shows sea level rise projections for New Jersey at Atlantic City in 2030, 2050, and 2100. In the top chart, the box-and-whisker plots indicate sea level rise projections. In 2030 and 2050, the projections are the same for the low- and high-emissions scenarios (Representative Concentration Pathways [RCP] 2.6 and 8.5, respectively). In 2100, the red box-and-whisker plot indicates the sea level rise projection for the high-emissions scenario (RCP 8.5), and the blue box-and-whisker plot indicates sea level rise projections for a low-emissions scenario (RCP 2.6).

The white line across the middle of each box-and-whisker plot denotes the 50th percentile value (the value that has a 50 percent probability of occurring). For example, in 2050, the white line is located at 1.4 feet. Looking above the white line, again for 2050 as an example, there is a 33 percent chance that sea level rise will be between 1.4 and 1.8 feet, a 12 percent chance that sea level rise will be between 1.8 and 2.0 feet, and a 4 percent chance that sea level rise will be above 2.0 feet. The same probabilities exist for three sets of sea level rise values below the white line of the box-and-whisker plot.

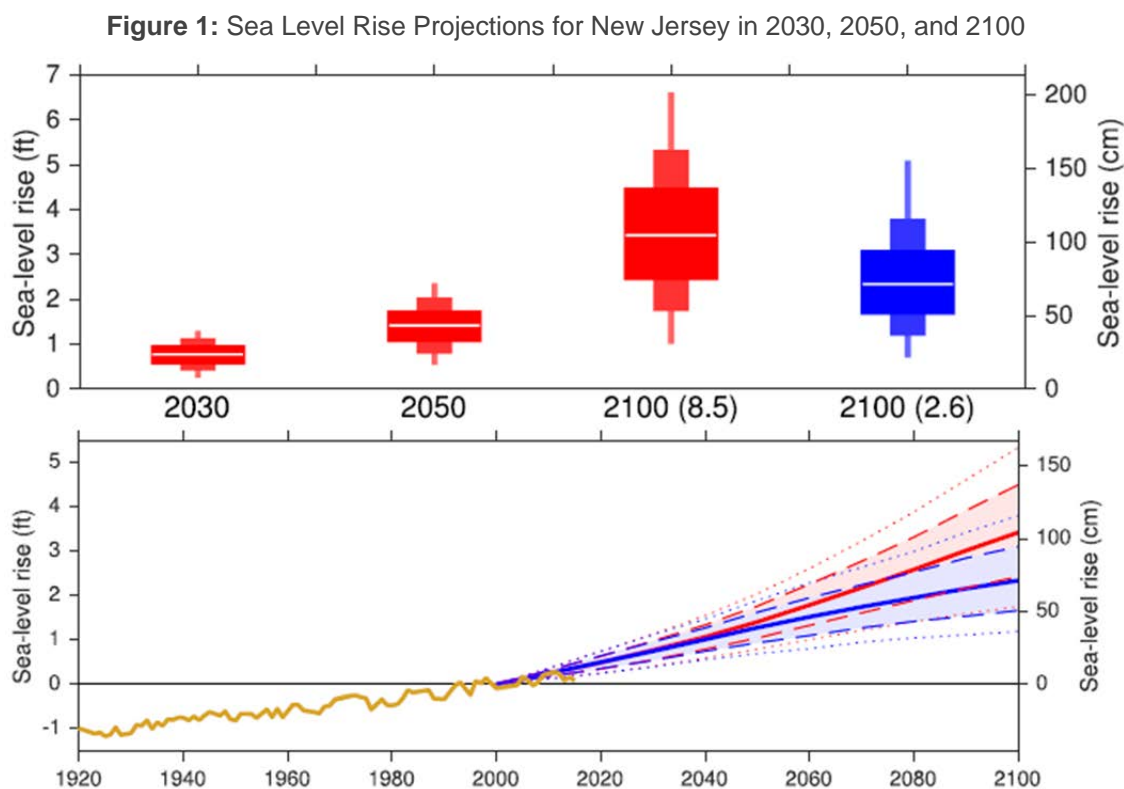
In the bottom chart, the gold-colored line indicates observed tide-gauge heights. Solid red and blue lines are the 50th percentile projection for the high-emissions (RCP 8.5) and low-emissions (RCP 2.6) scenarios, respectively. Dashed lines are 17th–83rd percentile projections, and dotted lines are 5th–95th percentile

¹ Radley Horton et al., "Ch. 16: Northeast," in *Climate Change Impacts in the United States: The Third National Climate Assessment*, ed. J. M. Melillo, T. C. Richmond, and G. W. Yohe (U.S. Global Change Research Program, 2014), 373, accessed January 9, 2017, pubs.giss.nasa.gov/docs/2014/2014_Horton_ho06500e.pdf.

² R. E. Kopp et al., *Assessing New Jersey's Exposure to Sea-Level Rise and Coastal Storms: Report of the New Jersey Climate Adaptation Alliance Science and Technical Advisory Panel*, prepared for the New Jersey Climate Adaptation Alliance (New Brunswick, NJ: Rutgers University, October 2016), 2.

projections, with blue and red shading showing the ranges for, and distinguishing between, the low- and high-emissions scenarios.

The data presented in this report are the result of research conducted in 2016 by the New Jersey Climate Adaptation Alliance Advisory Committee, a consortium of respected climate researchers led by a team at Rutgers University.³



Source: Kopp et al., 2016.

Scenes from the aftermath of severe coastal storms, such as Superstorm Sandy, demonstrate the potential adverse impacts of storm surge and coastal flooding on the basic functioning of municipalities, their businesses, and their residents. While coastal storms can strike at any time, sea level rise will exacerbate their impact. Absent any changes in storms, a two-foot rise in sea level, which New Jersey is likely to experience by 2100, would more than triple the frequency of dangerous coastal flooding in the region.⁴

Coastal Storms and Storm Surge

Flooding from storm surge occurs when winds associated with strong coastal storms drive water onto land. This is the exact process that produced extreme flooding on the Atlantic coast of New Jersey during Superstorm Sandy. The tidal Delaware River did not experience the same levels of storm surge during Superstorm Sandy, but it could have happened if the storm had taken a different track.

Unlike sea level rise, storm surge is a temporary condition. However, storm surge can happen at any time, and the potential height of water pushed onto land in the Delaware River region from a strong storm is much

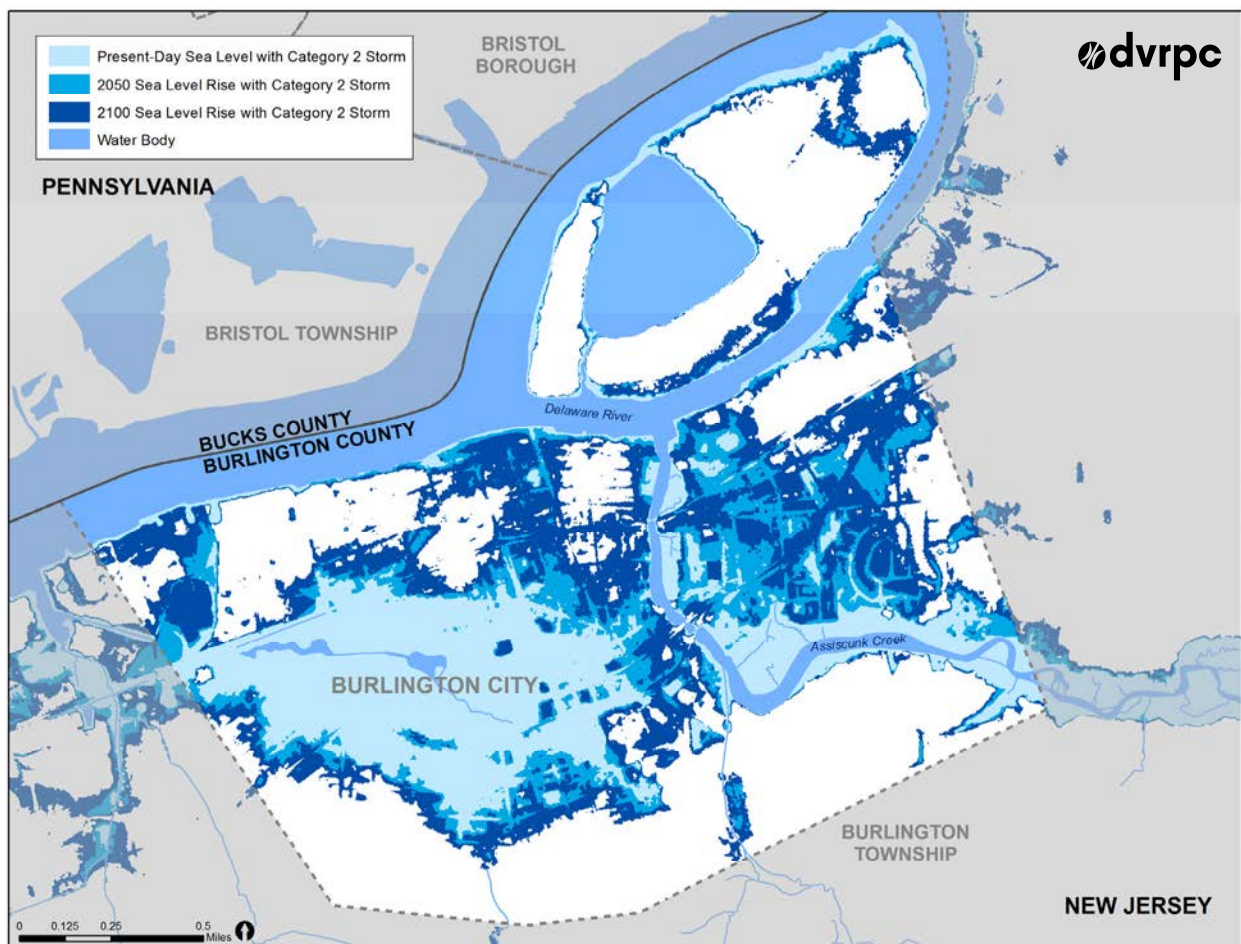
³ Ibid.

⁴ Horton et al., 374.

greater than the projected amount of sea level rise. For example, storm surge heights during Superstorm Sandy exceeded 10 feet in some parts of Northern New Jersey and New York, three times the median amount of projected sea level rise by 2100. Figure 2 shows the areas flooded by a Category 2 storm in the present day, a Category 2 storm with sea level rise in 2050, and a Category 2 storm and sea level rise in 2100.

While the future frequency and intensity of coastal storms cannot be predicted with certainty, the warming in the atmosphere and oceans associated with climate change is likely to increase the intensity of coastal storms, particularly in the latter part of the 21st century.⁵

Figure 2: Flooding Extents from a Category 2 Storm, Sea Level Rise in 2050, and Sea Level Rise in 2100⁶



Sources: NJDEP, NJDOT, DVRPC

⁵ NOAA, "Geophysical Fluid Dynamics Laboratory," in *Global Warming and Hurricanes: An Overview of Current Research Results*, accessed March 17, 2017, www.gfdl.noaa.gov/global-warming-and-hurricanes/.

⁶ This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not state-authorized.

Riverine Flooding

While this report focuses primarily on coastal flooding, riverine flooding cannot be ignored, as it poses a flooding risk to many areas of Burlington City. Burlington currently uses the Federal Emergency Management Agency's (FEMA's) 1-percent/100-year floodplain map (or "Flood Insurance Rate Map" [FIRM]) to evaluate the threat of riverine flooding. The city's FIRM is so called because it shows the flooding expected (based on historical patterns) from a storm that has a 1 percent chance of occurring in any given year.

The city should continue to use this map to evaluate threats, but at the same time should recognize that the frequency of storms with heavy downpours is projected to increase as a result of climate change.⁷ As products and models become available to project the spatial extent of this evolving threat, they should be evaluated by city officials.

Current Preparedness for Flooding

Burlington City officials and staff have taken a wide range of actions to address flood hazards in the community. Their participation in the CRS program helps guide their efforts. The city currently has a rating of 8, which helps residents with mortgages save 10 percent on their flood insurance within the NFIP. The city is striving to reach a rating of 7, which would yield flood insurance savings of 15 percent.

Vulnerability Assessment and Mapping

Before participating in the CVA, Burlington City assessed and mapped coastal hazards and other areas vulnerable to floods. The city has mapped flooding that was part of federally declared disasters, which included the flood of 1955 and Hurricane Irene. Burlington City has also mapped the city's few repetitive loss properties, which it tracks through the NFIP. As part of a grant application to FEMA, the city calculated total losses from Hurricane Irene, which it estimated were between \$65 and \$80 million.

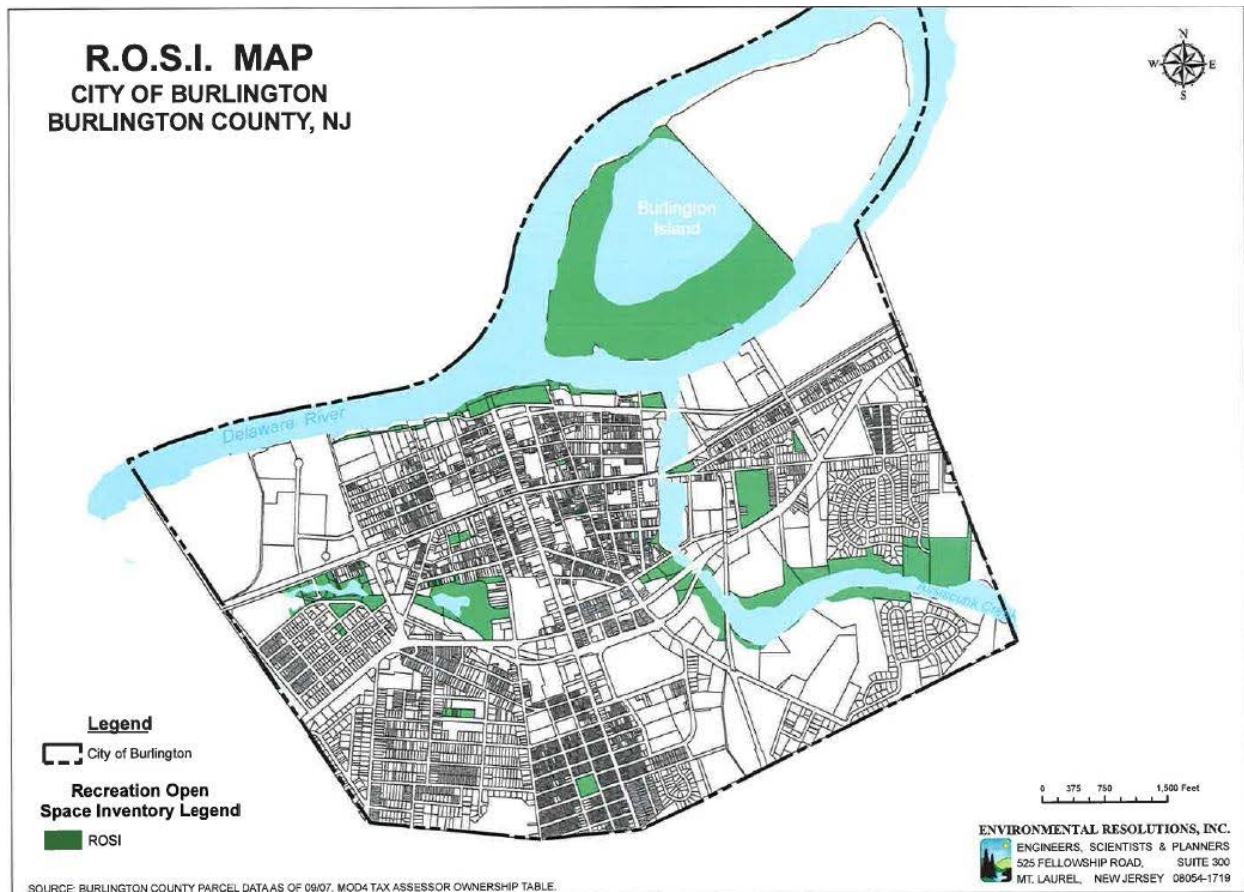
Because much of Burlington City is within the FEMA's 1-percent/100-year floodplain, staff and officials make frequent use of FEMA's FIRMs.

Land Use Planning Strategies

Burlington City is almost completely developed, and is relatively dense and urbanized with a lack of available open space, so there is much property at risk of flooding. When it has proved possible, however, the city has preserved parcels in areas most likely to flood, including some along the Delaware River, the Assiscunk Creek, and low-lying areas in the center of the city around Kennedy Lake. These parcels are listed on Burlington City's Recreation and Open Space Inventory, which is a database held by NJDEP that includes all properties conserved by a municipality for open space or recreational purposes using an easement or fee simple acquisition (see Figure 3).

⁷ Horton et al., 374.

Figure 3: Parcels in the Burlington City Recreation and Open Space Inventory



Source: Burlington City 2010 Master Plan

Burlington City makes frequent use of its All-Hazard Mitigation Plan, which was approved by FEMA. This multijurisdictional plan contains maps of flood zones and a coastal vulnerability index, and includes a list of flood hazard mitigation projects with timelines for completing them. Burlington also has a stormwater management plan, which was developed with assistance from the city's planner and engineer.

Emergency Operations Procedures

Although Burlington has not been substantially affected by flooding since 1955, city officials and staff feel prepared for emergency evacuations. According to the city, their Office of Emergency Management (OEM) center, located at their City Hall, is on par with Burlington County's.

The city makes use of numerous plans to help it carry out its emergency operations more effectively, including an OEM plan, emergency operations plan, evacuation plan, and continuity of operations plan.

Officials and emergency response managers have multiple means of city-wide communication. The city currently uses six different programs: Swift911, which conducts reverse 911 calls using phone lines or voice over internet protocol; social media; Nixle, which is a public alert texting system; the city website; NJ Register Ready, a county-wide registration program for residents with mobility or other impairments; and a recent addition, an early flood warning system. CVA participants noted that seniors, residents who need more involved medical treatment, and residents who have physical disabilities have heeded previous warnings to

evacuate. CVA participants also noted that many people with access or functional needs have their own plans to go with family members.

To prepare for storms, Burlington City also works with Burlington Township, which is at a higher elevation and farther away from the Delaware River. For example, Burlington Township holds some of the city's critical movable infrastructure during storms, including trucks and generators.

During storms, the city has two designated emergency shelters, one at Wilbur Watts Intermediate School and one at Burlington City High School. If more sheltering was needed, residents would be transported to a regional shelter at the Fountain of Life Center in Florence Township. The city also helps run a volunteer Community Emergency Response Team (CERT), which is a FEMA program that provides education about disaster preparedness and training in basic disaster response skills. Participants then assist the city as first responders during disasters.

For its comprehensive storm preparedness program, the National Oceanic and Atmospheric Administration (NOAA) has recognized Burlington City as a "Storm Ready Community."

Coastal Resiliency Projects

Three of Burlington City's most significant past flood protection capital projects include constructing Kennedy Lake and its surrounding park as a flood control structure, constructing a bulkhead along the Delaware River, and constructing a levee along the Assiscunk Creek. More recent capital projects have involved maintenance of these facilities.

One of the city's most recent projects was clearing a portion of the levee of trees that had grown on top of it and were threatening to undermine its structural integrity. Phase 2 of the levee improvements is currently under design. During Phase 1 of the permitting process, NJDEP required that the city plant two times the number of trees removed from the levee that were 8 inches in diameter or larger because of their location in the floodplain. Similar mitigation is expected for future phases as well. Furthermore, the levee is located in habitat for bald eagles, which are on New Jersey's Threatened and Endangered Species list. Their presence affects how the levee can be reconstructed.

Burlington City has also been cleaning its storm drains and studying the possibilities of moving significant structures, like the public works garage, to higher ground.

The city has relied on several sources to fund its projects, including the FEMA Pre-Disaster Mitigation Grant program, the NJDEP Blue Acres program for buying repetitive loss properties, and OEM grants. However, the city is still searching for more sources for future projects: completing projects listed in its all-hazards mitigation plan, buying pump stations (which CVA participants estimated at about \$400,000 per pump, plus long-term maintenance), and maintaining its levee, bulkhead, and existing pumps.

Community Outreach

The city provides residents and business owners with access to its FEMA floodplain maps and other floodplain information, keeping copies on a table outside the main conference room at City Hall, publicizing them in letters, sharing them on the city website, and publishing them in the *Beverly Bee* newsletter. More infrequently, the city has used television and radio as a means of communicating flooding information, and at

a recent National Night Out community event, staff set up a Community Response/CRS table to share information about flooding.

The city also shares flooding information with insurance agents, real estate agents, and lenders. Property owners can request a package that the city has assembled with information about the city's past coastal hazards. In addition, a public information session is held at least once per year.

Burlington City provides residents with guidance on actions to take before, during, and after storms. Topics include developing a personal or family evacuation plan; stocking emergency kits and supplies; locations of evacuation routes, evacuation bus pick-up locations, and shelters for residents and their pets. The city also has brochures on strategies that residents can take to protect their homes against storm damage. After Superstorm Sandy, the city provided information on available funding for damages from the Sandy recovery program in the *Beverly Bee* newsletter and on its website.

In the 1960s, when Kennedy Park was established as a flood control measure, and when the Assiscunk Levee was constructed, Burlington City provided the public with information on the benefits of floodplains. However, it does not regularly present information on that topic.

Vulnerable Populations

Burlington has a population of approximately 9,868 residents (2015 5-Year American Community Survey [ACS]), and a density of 2,597 residents per square mile. There are several populations that may need additional assistance in the event of a storm, but as indicated in the **Current Preparedness** section (page 8), the city continues to demonstrate its desire to ensure that all citizens are given the assistance they need before, during, and after storms.

Geographical Distribution

In 2015, two of Burlington city's census tracts, 7012.05 and 7012.04, were home to a higher percentage of vulnerable residents than the average for the nine-county DVRPC region. Census tract 7012.05 is bordered by the Delaware River to the north, High Street to the east, NJ-130 to the south, and Burlington Township to the west. It contains high representations of elderly residents and residents with a disability. These streets are particularly at risk to flooding from the Kennedy Lake Park area. Census Tract 7012.04 is bordered by Delaware River to the north, the Assiscunk Creek to the east, NJ-130 to the south, and High Street to the west. It corresponds roughly with the boundaries of the New Yorkshire neighborhood, which is among the lowest-lying areas in the city along the Delaware River and therefore vulnerable to coastal flooding. This census tract has high representations of elderly residents, residents with a disability, households in poverty, carless households, and households with limited English proficiency. This neighborhood is at risk to flooding from all sides, from the Delaware River, the Assiscunk Creek, and the Kennedy Lake Park area.

Neighborhoods in both census tracts, but particularly the New Yorkshire neighborhood, should be prioritized for education on preparing for sea level rise as well as storm events, evacuation before storms, and recovery after storms.

Seniors

In 2015, Burlington City as a whole had a slightly lower population of seniors relative to the state and county averages (18.1 percent in comparison with 20.2 percent for the state and 21.0 percent for the county).⁸ However, this population has mobility and health issues that the city needs to consider during evacuation and recovery. There are two retirement homes that are somewhat vulnerable to coastal flooding, particularly in egress areas, which may bring challenges for people with limited mobility.

Residents with a Disability

Residents with a disability may need additional physical assistance or outreach in the event of a storm. This population made up 14.1 percent of Burlington City's population in 2015, which is higher than that in Burlington County (11.0 percent) or New Jersey (10.3 percent).⁹

Households in Poverty

From a poverty standpoint, Burlington City has a comparably high percentage of low-income residents that may lack resources to prepare for, respond to, or recover from an emergency. The city's poverty level in 2015 was 11.2 percent, which is higher than the state and county values of 10.5 percent and 6.3 percent.¹⁰

Carless Households

Approximately 2.5 percent of households in Burlington City did not own cars in 2015, which is higher than the county's reported value (1.5 percent), though similar to the state's value (2.4 percent).¹¹ Carless households face additional challenges in evacuating before a storm by relying on alternative modes of transportation to leave the city. However, the majority of Burlington City residents (97.5 percent) have cars and thus more options to evacuate before an emergency.

Rental-Occupied Households

In 2015, 34.4 percent of households in Burlington City lived in rental units, which is higher than the county's value (23.5 percent), but lower than the state's value (35.5 percent).¹² Renters have less ability to repair their homes following a disaster, so while the majority of the city's residents, as homeowners, are more secure in this regard, there are still a substantial portion of households that, as renters, are more at risk of displacement following a severe storm.

Limited English Speakers

In 2015, 2.0 percent of Burlington City residents reported that they spoke English "not well" or "not at all," which is higher than that reported for Burlington County (1.7 percent), though not for New Jersey (6.3 percent).¹³ This population may need additional outreach to enable them to understand threats associated

⁸ U.S. Census Bureau, "B01001: Sex by Age," 2011–2015 ACS 5-Year Estimates.

⁹ U.S. Census Bureau, "B18101: Sex by Age by Disability Status," 2011–2015 ACS 5-Year Estimates.

¹⁰ U.S. Census Bureau, "B17017: Poverty Status in the Past 12 Months by Household Type by Age of Householder," 2011–2015 ACS 5-Year Estimates.

¹¹ U.S. Census Bureau, "B25044: Tenure by Vehicles Available," 2011–2015 ACS 5-Year Estimates.

¹² U.S. Census Bureau, "B25044: Tenure by Vehicles Available," 2011–2015 ACS 5-Year Estimates.

¹³ U.S. Census Bureau, "B16004: Age by Language Spoken at Home by Ability to Speak English for the Population 5 Years and Over," 2011–2015 ACS 5-Year Estimates.

with incoming flooding, what is required for them to prepare, what resources are available to avoid harm, and what assistance can help with recovery from these events.

Scenarios

The flood levels used in the mapping component of Burlington City's CVA show the result of storm surge generated by a Category 2 storm plus sea level rise projections of 1.4 feet by 2050 and 3.3 feet by 2100.¹⁴ Storm surge was modeled using NOAA's SLOSH (Sea, Lake, and Overland Surge from Hurricanes) model and shows what would happen if a Category 2 storm were to strike the Delaware Bay at an angle that would maximize storm surge at high tide.

While the CVA project team mapped sea level rise data for 2050 and 2100, in its analysis, it focused on the 2100 sea level rise data because of its usefulness as a “worst case scenario.” **In the report, when the term “CVA scenario” is used, it refers to the combined effects of flooding from sea level rise in 2100 and a Category 2 storm striking land at an angle that would cause a maximal degree of storm surge.**

Notably, the inundation resulting from the combined sea level rise and storm surge depicted in the CVA scenario closely resembles the 1-percent/100-year flooding extent. Figure 4 demonstrates this similarity in the center of Burlington City. The Federal Emergency Management Agency (FEMA) uses the 1-percent scenario in its FIRMs, and Burlington City uses these maps for planning purposes. Because the extent of flooding from sea level rise in 2100 during a Category 2 storm is similar to the extent of the city's FEMA floodplain, the authors determined that the “CVA scenario” was not overly pessimistic or of such a low probability as to not warrant modeling. Furthermore, the storm surge heights expected in a modeled Category 2 storm are certainly possible, as was experienced in Northern New Jersey during Superstorm Sandy.¹⁵ Since storm surge heights associated with a Category 3 or Category 4 storm are less likely, the authors of this report determined that these are not scenarios for which municipalities should focus their planning efforts.

Flood depths were determined using a baseline elevation derived from LiDAR data.¹⁶ These two data layers were developed statewide by NJDEP and layered on maps developed by DVRPC. The maps for this study are in Figure 2, Figure 4, and Appendix C.

¹⁴ The 3.3-foot figure was from a report produced by the New Jersey Climate Adaptation Alliance Science and Technical Advisory Panel that predates the current report. The 3.3-foot figure was already built into the maps and models by the time the report with the 3.4-foot median estimate was produced.

¹⁵ The storm surge experienced in Sandy Hook in Northern New Jersey during Superstorm Sandy was approximately 8.5 feet above mean higher high water. This height is commensurate with what the SLOSH model would predict for a Category 2 hurricane striking the area. Sandy was not technically a hurricane when it made landfall on the New Jersey coast, but the storm's large wind field and low pressure generated a storm surge that would normally be associated with a category 2 hurricane according to predictive modeling.

¹⁶ Note that the projected flood events used in this assessment were generated by several models prepared by state and national agencies and professionals, and are suitable for planning purposes. However, due to the uncertainty of projections and accuracy of certain types of data, the maps should not be the sole resource for conducting site-specific analyses.

PENNSYLVANIA
BUCKS CO.
BURLINGTON CO.

Delaware River

W Pearl St
 W Union St
 W Broad St
 W Federal St
 W 2nd St
 W 3rd St
 W 4th St
 W 5th St
 W 6th St
 W 8th St
 W 9th St

E Pearl St
 E Union St
 E Broad St
 E Federal St
 E 2nd St
 E 3rd St
 E 4th St
 E 5th St
 E 6th St
 E 7th St

Burlington Pike

Lincoln Ave
 Grant Ave
 Evans Ave
 Morris St
 High St
 Wood St

Temple Ave
 Salem Rd
 Elm Ave
 Mill Rd

BURLINGTON CITY

BURLINGTON TOWNSHIP

NEW JERSEY

1-Percent Floodplain

Water Body

2100 SLR + Cat 2 Storm Flood Depth (ft)

0 - 2
 2.01 - 4
 4.01 - 6
 6.01 - 8
 8.01 - 10
 Greater than 10

0 0.125 0.25 Miles

Sources: NJDEP, NJDOT, DVRPC. This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state-authorized.

dvrpc

Sources: NJDEP, NJDOT, DVRPC.
This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state-authorized.



Assessing Vulnerabilities

Methodology

On September 3, 2015, DVRPC staff met with Burlington City staff and elected officials to discuss Burlington's past vulnerabilities to flooding. On February 23, 2016, this group met again to discuss the city's critical assets and conduct the CVA. This team examined the vulnerability of 97 "assets," which are properties, infrastructure, or natural resources that are owned by the city or have high value to the community, as well as vulnerable populations located within the city. The assets are evaluated using a three-step process:

1. Community assets are identified, mapped, and compared with maps of flooding for selected flood scenarios to determine if they will be exposed to flooding or not.
2. The sensitivity of individual assets is determined. *Sensitivity* is shorthand for the impact of flooding on an asset. For example, a flooded basketball court will be relatively unimpacted after floodwaters recede, while paper documents in a repository will likely be permanently destroyed if they were exposed to flooding. While this is a clear-cut example, the sensitivity of many types of assets, such as a downtown building or shopping center, is challenging to determine with much specificity.
3. The consequence is determined by the potential effects on the community from temporary, long-term, or permanent damage to each individual asset.

Identifying and Mapping Community Assets

The CVA relies on Geographical Information System (GIS) maps to locate and analyze community assets and flood hazards. Community assets are identified among three categories—Built Environment, Natural Environment, and Vulnerable Populations—and are plotted using GIS. As mentioned previously, DVRPC mapped assets and plotted them against two scenarios: (1) 2050 sea level rise plus a Category 2 storm, and (2) 2100 sea level rise plus Category 2 storm, to determine whether they would be exposed to flooding.

Evaluating Asset Sensitivity and Vulnerability

Sensitivity is the degree to which an asset may become affected by predicted floodwaters. *Vulnerability* is the product of exposure and sensitivity. If an asset is exposed to flooding *and* it is sensitive to flooding, then it is vulnerable. The level of vulnerability is thus a function of the level of sensitivity of an asset. In other words, an asset that is exposed to flooding and is highly sensitive to flooding would be highly vulnerable, while an asset that is exposed and moderately sensitive would be moderately vulnerable. Assets that are not exposed are not vulnerable, regardless of their sensitivity.

For each asset, vulnerability was categorized as insignificant, low, moderate, or high. A description of the categories can be found in Appendix B. When there was insufficient information to determine the exact vulnerability ranking for an asset, a range was used.

Evaluating the Consequences of Asset Damage

Consequence is the effect on the community if an asset is temporarily or permanently damaged or impaired by flooding. Consequence is ranked as insignificant, minor, moderate, or high for each asset. A description of the meaning of each ranking can be found in Appendix B.

Analysis and Findings

Burlington's coastal vulnerability assessment examined 97 assets, which were listed by type in Table 1.

The CVA indicates that Burlington will likely sustain significant impacts from the combined effects of a Category 2 storm surge and sea level rise in 2100. Burlington's geographical position along the Delaware River and Assiscunk Creek, its low-lying, bowl-shaped topography, and its historical development patterns are to a great extent responsible for this vulnerability. As such, many assets in the city are vulnerable to potential flooding, and there are six groups of assets that should be considered assets of high concern.

Assets of High Concern

Six assets examined by this CVA were determined to be of high concern. These assets are the most vulnerable to flooding of the total examined and have the greatest consequences to the city should they become damaged.

Table 3 shows the vulnerability and consequences ratings for those assets. The asset category with the greatest number of high-concern assets is emergency facilities, which includes designated emergency shelters, the city's stations in its fire department, and the city hall/police department building. Also of high concern are the city's designated evacuation routes, and two types of utilities: flood control structures and the city's wastewater treatment plant. For the full asset matrix, which lists flood exposure, vulnerability, and consequences for each individual asset, see Appendix A.

Table 3: Overview of Assets Identified as High-Concern

Assets of High Concern					
Asset Name	Asset Category	Number of Structures in Asset Group	Flood Exposure Range for Asset or Asset Group in 2100 with Category 2 Storm	Vulnerability	Consequences
Designated Evacuation Route	Evacuation Route/ Transportation	5 routes	0–13 ft	Low to High	Minor to Moderate
Fire Department	Emergency Facility	5 buildings	0–6 ft	Low to High	Minor to Moderate
Flood Control Structure	Utility	3 structures	1–11 ft	Low to High	Minor to Moderate
Designated Emergency Shelter	Emergency Facility	2 buildings	2–3 ft	Moderate to High	Moderate to High

Assets of High Concern					
Asset Name	Asset Category	Number of Structures in Asset Group	Flood Exposure Range for Asset or Asset Group in 2100 with Category 2 Storm	Vulnerability	Consequences
City Hall/Police Department	Emergency Facility	1 building	1–5 ft	Moderate to High	High
Wastewater Treatment Plant	Utility	1 building	0–16 ft	Low to High	Moderate to High

Designated Evacuation Routes

Burlington City has designated five evacuation routes leading out of the city. Broad Street and NJ-130 move traffic between east and west, High Street (NJ Route 541) moves traffic between north and south, and Salem Road and Jacksonville Road move traffic south.

With the exceptions of its intersection with Wood Street and in an area close to the Assiscunk Creek, the entirety of Broad Street will likely be flooded. The eastbound section of Broad Street between Uhler Avenue and Ellis Street will likely be hardest hit, with flooding of between three and seven feet, and up to 12.8 feet possible from the Kennedy Park Lake. At the intersection of Broad Street with Talbot Street and eastward, flooding will more likely be between one to two feet.

Flooding of High Street (Figure 5) will likely be most severe between Library Street and 2nd Street, with depths typically between three and six feet, and the greatest depths of seven feet between Belmont Street and Wall Street. There will be less (and more shallow) flooding north and south of those intersections.

Figure 5: High Street



Source: Google Maps, September 2013

Jacksonville Road is expected to flood from its westmost extent (its intersection with NJ-130) to just southeast of James Street. Typical flooding depths are up to two feet. Jacksonville Road is likely to experience less flooding than some of the other evacuation routes.

Almost all of the east- and westbound lanes of NJ-130 will likely be flooded. As with Broad Street, the length of NJ-130 closest to Kennedy Lake will be hardest-hit, with flood depths of up to seven feet. East of the Assiscunk Creek, typical flood depths on this route will likely be between one and three feet, while west of the creek, typical flood depths will likely be between one and five feet.

Salem Road will likely have the deepest flooding where it intersects NJ-130. Flood depths at that location will be between four and five feet, but these levels will drop to about 1.5 feet at the Dickenson Road intersection and are predicted to abate south of the Farmer Avenue intersection.

Each of these evacuation routes was assigned a vulnerability rating of low to high. More information is needed about how these roads might function in a flood before a more exact rating can be assigned. Extended periods of flooding, high-velocity floods, or flooding that parallels a road can cause erosion of roadway infrastructure. However, the elevation of any of these roadways may reduce damages from flooding.

The routes were assigned a minor to moderate consequence range. The city's grid system enables it to have redundant evacuation routes, and drivers attempting to leave the city would likely be able to reroute to other parallel roads. The inconveniences of traffic rerouting and delays on redundant unflooded roads would be temporary. However, residents living in the center of the city, where the flooding is expected to be deepest, should be evacuated well in advance of the storm. Despite the redundancy of the evacuation route system as a whole, there may be few unflooded routes for evacuation from the center of Burlington City during a storm.

Fire Department Stations

Burlington City's fire department includes five stations. The building located at 545 High Street may experience between five and six feet of flooding in the CVA scenario, Mitchell Fire Company (Figure 6) may become completely flooded with two to three feet of water, Niagara Hose Company and Neptune Hose Fire Company may become completely flooded with one to two feet of water, and Endeavor Emergency Squad—the site of the oldest fire company in New Jersey—may experience flooding of up to 0.5 feet.

Figure 6: Mitchell Fire Company



Source: Google Maps, September 2013

The vulnerability of most of the stations is presented in a range: generally, moderate to high. More information is needed on the durability of many of the buildings' materials and the degree to which the buildings and key equipment in them are elevated above floodwaters. Egress during a flood may be difficult for Niagara Hose Company, Mitchell Fire Company, and Neptune Hose Company. The Endeavor Emergency Squad building is an outlier: it is less exposed than the other buildings, but its age may make it more sensitive to floods.

The individual consequence ratings of the stations range from minor to moderate. However, the effectiveness of the group as a whole could be hampered by a strong storm. Given the critical emergency services in these buildings, a loss of function from flooding could greatly reduce the city's ability to react to flooding during a storm and recover afterwards. If one or two fire stations were compromised by flooding, the other companies could assist in covering their responsibilities, but they could become overburdened in the process.

Flood Control Structures

Burlington City relies on three flood control structures that may be at risk in the CVA scenario: Kennedy Park, a park in the center of the city designed to hold and absorb flood waters; the city's bulkhead, which prevents coastal erosion along the Delaware River; and the city's levee, which prevents coastal erosion along the Assiscunk Creek.

Kennedy Park will likely be completely flooded in the CVA scenario, with some of the greatest depths in Burlington City, generally between 9 and 11 feet. To a certain extent, flooding in the park is not an issue, as it is intended to flood. However, the lake faces limitations that reduce its effectiveness in controlling floods. The city cannot pump the lake because it is protected under NJDEP regulations as fish habitat, which reduces the city's capacity to move water out in advance of a storm. Adding to this restriction, it accepts water upstream from Burlington Township before storms. For these reasons, the park's vulnerability is a range from low to moderate.

The consequences of its flooding are minor to moderate; a flood could overtop Kennedy Lake's banks and expand into the neighborhood around the park, causing damage to nearby commercial and residential properties. The closure of the park to additional floodwaters would also prevent Burlington Township from sending its own excess floodwaters through pipes to Kennedy Park, thus making the township more vulnerable to flooding.

The city's bulkhead and promenade (Figure 7) is anticipated to face about 10 feet of flooding from the Delaware River in the CVA scenario, and flooding of up to eight feet may occur on the landward side. Its vulnerability was assigned a range from low to high. Currently, it gets overtopped during major high tides, and while the pipes at its tide gates have lost flappers during floods, it has not been structurally damaged. However, the sensitivity of the bulkhead depends on its height relative to the potential height of the predicted flood waters, and how it might function after being pounded with waves in a Category 2 storm.

The consequences of its loss or damage range from moderate to high. If it were damaged or destroyed in a flood, much of the historic and commercial core of Burlington City, particularly the vulnerable New Yorkshire neighborhood, could be flooded or eroded. Damages to some of the older and more fragile buildings could be permanent, and there could be substantial costs to the neighborhood and city to reconstruct or move them. However, some of the land immediately landward of the bulkhead is at a higher elevation than neighborhoods farther inland and due south, and this topography could help cushion the impacts.

Figure 7: Burlington City Promenade with Bulkhead



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The city's levee may face flood depths of between one and seven feet. Depending on the height of the levee, it may be overtopped. The levee's vulnerability ranges from moderate to high. The levee is made more sensitive to flooding by structural problems. Tide gates have been installed on stormwater discharges to prevent backflow, but objects can get stuck in the openings. Trees and animal burrows along the levee threaten its structural stability and the city has a program to inspect the levee annually to plan for proper maintenance.

The consequences of the levee's damage in a flood range from minor to moderate. The levee holds back water from residential neighborhoods (particularly Columbus Park and an apartment complex), part of a commercial strip along NJ-130, and NJ-130 itself. The structures are all located at sufficiently high elevations that they would likely not be faced with more than three feet of flooding, so recovery could be short and relatively inexpensive to the city. However, flood damage to the levee, and subsequent floodwater intrusion, would be a substantial inconvenience for drivers on NJ-130, who might have to reroute around large parts of Burlington City to avoid the flooding. It could be expensive for Columbus Park residents, and a temporary inconvenience for those who use the nearby Agway and auto body, which could both be in harm's way.

Designated Emergency Shelters

Burlington City has two designated emergency shelters. One is located at Burlington City High School, and one is located at Wilbur Watts Intermediate School (Figure 8). In the CVA scenario, most of the high school building will not be substantially flooded, but much of the site may flood with up to two feet of water. Virtually all of the intermediate school will likely be flooded, with the main building potentially facing depths of between 1.5 feet and 7 feet of water. The high school was assigned a moderate vulnerability rating, and the middle school was assigned a moderate to high vulnerability rating. More information is needed on the durability of the buildings' materials and the degree to which the buildings are elevated above floodwaters. The predicted flood depths at the Wilbur Watts Intermediate School could cause substantial damage. Information is also needed on any emergency equipment that is in harm's way. Egress through floodwaters may be difficult at the intermediate school, though a relatively minor inconvenience at the high school.

The consequences of the loss or damage of either of these buildings in a flood are moderate. The loss of either of them would require a large percentage of residents to be rerouted to another shelter, causing additional strain on shelter resources. After the storm, students and staff would experience the inconveniences of relocation for multiple weeks to multiple months after the storm as the school was being renovated to remove flooding damage.

Figure 8: Wilbur Watts Intermediate School



Source: Google Maps, September 2013

City Hall and Police Department Building

The Burlington City Hall (Figure 9), located at 525 High Street, contains a variety of functions: it holds the city offices, the city police department, and the city OEM offices. It is also a designated emergency shelter for Burlington City. In the CVA scenario, all of the site will likely be flooded. Half of the site will be flooded by about one foot of water, and the other half of the site will be flooded by three to five feet.

Burlington City Hall has been assigned a moderate to high vulnerability rating. A range is used because more information is needed regarding several factors. These factors include the durability of the building's materials, the height to which the building is elevated above the floodwaters that are predicted in the CVA scenario, and the presence of vulnerable equipment within the building.

Because Burlington City Hall contains some of the most important emergency services in the city, any loss of the building's function from flooding could greatly reduce Burlington City's ability to respond to flooding during a storm, and could slow recovery after a storm. For this reason, the building was assigned a high consequence rating.

Figure 9: Burlington City Hall



Source: Google Maps, September 2013

Wastewater Treatment Plant

The city's wastewater plant (Figure 10), located at 900 West Broad Street, treats the entire city's wastewater. The majority of the site, including key infrastructure, will likely become flooded in the CVA scenario. Some structures at the plant may receive up to 15 or 16 feet of water. The vulnerability of the plant is a range from low to high for several reasons. The site is built to the 1992 flood elevation, and is on track to be updated with new stormwater pumps using FEMA Hazard Mitigation Grant Program and New Jersey Environmental Infrastructure Trust funding. These pumps will help keep the plant protected from some floods, but those safeguards may not be sufficient for floods later in this century. More information is needed on the durability of the materials in each structure, and any sensitive equipment that may be in harm's way. The consequences of the damage of the plant are moderate to high. The closure of parts of the plant after a flood would affect much of the city, unless there is a possibility that the city could use Burlington Township's facility. Repairs to systems that were damaged in the flood could take weeks or months, during which time the city would have to find other means to treat residential and commercial wastewater.

Figure 10: Burlington City Wastewater Treatment Plant



Source: Google Maps, September 2013

A full table showing the exposure, sensitivity, and consequences of all assets can be found in Appendix A of this report. In Appendix C, Figure C1 shows a map of all listed assets superimposed with the 2050 sea level rise and Category 2 storm surge flooding scenario, while Figure C2 shows the same assets superimposed with the 2100 sea level rise and Category 2 storm surge scenario.

Municipal Assets of Lower Risk

The project team evaluated 80 additional assets in Burlington City, which were determined to be of lower risk than the assets of top concern. Table 4 combines the vulnerability and consequences rating to show the overall risk rating for all assets. The combined rating was determined by assigning each vulnerability and consequences ranking (insignificant to high) a number from 1 to 4, with insignificant receiving a 1 and high receiving a 4. Vulnerability and consequences were added together, and the sum was associated with degree of risk as follows: any asset with an insignificant amount of vulnerability was considered out of harm's way, a sum of 2 through 4 was considered minor risk, a sum of 5 or 6 was considered moderate risk, and a sum of 7 or 8 was considered high risk.

Of the 80 identified assets, 19 are considered to be “out of harm’s way” because they are not predicted to be exposed to flooding in the CVA scenario. Only one asset, the Captain James Lawrence Elementary School, was considered to be at minor risk. Thirty-six assets were determined to be at moderate risk, and 24 assets were determined to be at high risk.

Table 4: Breakdown of Remaining Assets by Degree of Risk

Rating	Number of Assets
Out of Harm’s Way	19
Minor Risk	1
Moderate Risk	36
High Risk	24
Total	80

The assets at high risk included 12 hazardous sites, nine historic structures, the city’s public works building, Burlington Township’s wastewater treatment plant (which was included with the assumption that Burlington City could rely in this plant in an emergency), and the New Yorkshire neighborhood.

The assets at moderate risk included the city’s riparian open space and habitat, the Columbus Park neighborhood, the city’s repetitive loss properties, four streets, three schools, two bridges, two utilities structures, two medical centers, two retirement home complexes, 20 historic structures, and a recreation center.

The assets out of harm’s way included five historic buildings, four utilities structures, four bridges, two hazardous sites, two schools, the J. Frank Budd retirement home, and Burlington Island.

As mentioned previously, a full table showing the exposure, sensitivity, and consequences of all assets can be found in Appendix A of this report.

Recommendations

The project team’s CVA and GTR sessions uncovered specific initiatives that could help make the city more resilient to coastal flooding. Recommendations are organized by priority in each section using a combination of importance to the overall resilience of the city, as determined by the CVA results, and ease of implementation. The questions listed in the footnotes are some of the ones to which Burlington City responded “no” during the GTR session.

Risk and Vulnerability Assessments

Citywide Estimation of Damages from Flooding¹⁷

If Burlington City determines the cost of damages to assets from past or future storms, it can better prioritize which assets to protect in a future flood. One source for cost estimates is HAZUS-MH, a GIS tool that estimates the results of damage and economic loss for buildings and infrastructure from natural hazards, including flooding. FEMA HAZUS-MH training courses provide instruction in all steps of the loss estimation process, including using GIS and managing data; developing an inventory; running a loss analysis; and using the results in flooding mitigation projects and comprehensive planning, response, and recovery activities.

Elevation Certificates

The city should work with an engineer, architect, or land surveyor to get elevation certificates for its most vulnerable assets, including the Burlington City High School, Wilbur Watts Intermediate School, the fire building at 545 High Street, Mitchell Fire Company, Niagara Hose Company 6, the City Municipal Building, the Wastewater Treatment Plant, the Public Works building, the Water Treatment Plant, and historical buildings owned by the city that are in harm's way. While these certificates are typically used by FEMA to determine rates for flood insurance, here they would aid the city in determining which floors and what equipment and infrastructure in the buildings is predicted to get wet in the CVA scenario, and thus help the city prioritize its floodproofing efforts.

Public Engagement

Citywide Community Education and Empowerment Strategy

The city should develop a comprehensive, communitywide outreach strategy to get residents to understand Burlington City's potential flood problems and risks from floods, enabling them to act appropriately before, during, and after a storm. High priority should be given to neighborhoods with high concentrations of vulnerable populations discussed previously and neighborhoods faced with greater flood depths. This outreach could also generate support for policies that would reduce community-wide risks over time. This is a significant project, and the city may want to partner with other organizations or entities that have experience in educating residents on flood hazards, particularly those that can offer translation services from English to other major languages spoken in the city. This recommendation would be an expansion of the city's existing outreach on these topics.

High Water Mark Signs¹⁸

The city should install high water mark signs, which show the heights of past floods or projected floods at select locations, to serve as a constant visual reminder of how and where floods could affect the city in the

¹⁷ GTR Question 1.16: Have municipal employees utilized any of the following vulnerability assessment methodologies? (HAZUS-MH). 1.17: Are municipal employees trained in the use of FEMA's HAZUS-MH? 1.18: Do any plans describe the damage and cost of previous storms, floods, or erosion? 1.19: Do any plans estimate future financial losses that may result from flooding? 1.20: Do any plans estimate future financial losses that may result from sea level rise?

¹⁸ GTR Question 2.2: Does the municipality have publicly visible high water mark signs or storm surge elevation signs?

future. Monmouth County, New Jersey, which recently completed a High Water Mark Initiative, is one resource. More information on this project and resources to implement it locally are also available online.¹⁹

Planning Integration

Post-Disaster Recovery Plan²⁰

Using the results of the CVA and other analyses, the city should create a post-disaster redevelopment plan that enables it to prioritize what it rebuilds after a storm. The plan can identify redevelopment opportunities outside of flood hazard areas, identify opportunities to retrofit structures or relocate existing structures in hazard-prone areas, or relocate those structures or infrastructure outside of hazard-prone areas.

Master Plan and All-Hazards Mitigation Plan Updates²¹

During the city's next master plan update and all-hazards mitigation plan update, the city should identify sea level rise as a hazard, include information on coastal hazards, describe their effects on local assets, and include goals and objectives to mitigate expected flooding impacts. The master plan should in particular make use of land use planning strategies to protect against flood damages as well as findings from the CVA, and identify economic vulnerabilities to the city from coastal hazards.

Stormwater Management Plan Update²²

The city should include more information in its stormwater management plan on green stormwater infrastructure technologies that can be used to reduce stormwater volumes. It should also develop regulations or policies encouraging their use, such as tree protection ordinances, impervious cover limits, or riparian buffer ordinances. Green stormwater infrastructure projects, when incorporated early in the design phase of a capital project, can be less expensive than "grey infrastructure," which includes conventional stormwater piping systems.

Hazard Mitigation Implementation

Siting Emergency Facilities

The city should consider moving key emergency facilities and other important operations facilities out of the floodplain, or at minimum ensure that they are safe to enter and leave during a flood and can handle some flooding on the first floor. The individual emergency facilities that appear to be most at risk in the CVA analysis include Wilbur Watts Intermediate School, the fire building at 545 High Street, Mitchell Fire

¹⁹ NOAA National Weather Service Office of Climate, Water, and Weather Services, *High Water Mark Project*, accessed November 1, 2017, www.nws.noaa.gov/os/water/high_water/.

²⁰ GTR Question 4.15: Does the community have a Post-Disaster Redevelopment Plan?

²¹ GTR Question 3.1.5: Does the municipal master plan identify resilience within its mission vision, or goals? 3.1.7: Are hazards addressed among the elements of the municipal master plan? 3.1.8: Does the plan identify potential coastal hazard impacts on infrastructure, land uses, housing and community facilities? 3.1.9: Does the plan make recommendations to reduce hazard vulnerability through land use planning? GTR Question 3.4: Does the municipality have a FEMA-approved All-Hazards Mitigation Plan? 3.4.12 Does the plan identify sea-level rise as a hazard? 3.4.14 Do mitigation goals correspond with measurable mitigation objectives? 3.8: Does the municipality have an Economic Development Plan or Strategy?

²² GTR Question 3.6: Does the municipality have a stormwater management plan? 3.6.4: Does the plan identify low-impact regulatory options to decrease runoff?

Company, Niagara Hose Company 6, Endeavor Emergency Squad, the Burlington City Municipal Building and Police Department, and the Burlington City Public Works Department.

Partner with NJDEP to Review Contaminated Sites

Burlington City has 14 sites that are listed in NJDEP's list of known contaminated sites. Together with NJDEP, Burlington City should conduct meetings with each site owner to determine what types of contamination are located onsite, the possibility that floodwaters could carry them offsite through surface water or groundwater, and potential risks to the surrounding neighborhood. This group should then discuss how to address any major issues, including what type of cleanup may be required and who is responsible for implementation.

Reexamine Reference Flood Elevation²³

Burlington City currently requires in its flood damage prevention ordinance that new construction or substantial improvements in special flood hazard areas be elevated to the base flood elevation as described in its FIRM.²⁴ The Preliminary FIRM recently published by FEMA indicates that the base flood elevation in the city is 11 feet in most areas, with several smaller flood zones having base flood elevations of 10 or 12 feet.²⁵ The city should consider employing a 1-foot (or higher) freeboard requirement above base flood elevation to account for the fact that sea level rise will contribute to gradually increasing flood depths over time that are likely to eventually be higher than those currently listed in the FIRM.

Flood Control Structures

The city should compare the heights of its bulkhead and levee with the flood depths predicted in the CVA scenario to determine if these structures should be reconstructed or reinforced, whether to protect against additional damages from permanent sea level rise or from strong storms.

The city should also meet with NJDEP and Burlington Township to discuss the issue of flood storage at Kennedy Lake. The agreements and regulations mentioned previously, which add water to Kennedy Lake, are well-intentioned, but they make the city more vulnerable to flooding. The city, Burlington Township, and NJDEP should discuss ways in which existing practices could change in order to reduce flooding risk at Kennedy Lake.

Retrofitting Strategies²⁶

Burlington City should consider training several of its staff in new construction and retrofitting standards for flood-prone areas. FEMA's Coastal Construction Manual²⁷ is one helpful resource. One CVA participant commented on the prevalence of historic assets in the city, some of which are from 1600s, but noted that there are no active discussions on how to preserve them from coastal flooding. The city should prioritize

²³ GTR Question 5.4: Do municipal codes reflect the state's 1-foot Freeboard above base flood elevation? 5.5: Do municipal building codes exceed the state's 1-foot Freeboard above base flood elevation?

²⁴ Burlington City, *Flood Damage Prevention Ordinance*, Section 170-22E, ecode360.com/13611271#13611271.

²⁵ Federal Emergency Management Agency, "Preliminary Flood Insurance Rate Map for Burlington County, New Jersey," panels 109, 126, 127, 128, and 129, version 2.3.3.2, April 8, 2016, msc.fema.gov.

²⁶ GTR Question 5.6: Have building and permitting officials completed training in FEMA's Coastal Construction Manual? 5.8: Have building and permitting officials completed training on retrofitting flood-prone residential buildings?

²⁷ U.S. Federal Emergency Management Agency, *Coastal Construction Manual*, fourth ed., August 2011, www.fema.gov/media-library-data/20130726-1510-20490-2899/fema55_voli_combined.pdf.

researching and using flood retrofitting practices targeted to its historic structures. FEMA developed guidance for adding historic resources into the hazard mitigation planning process,²⁸ and the agency's publication could be used during a hazard mitigation plan update or be applied to other planning products.

Willing Seller Buyouts²⁹

Returning land to natural floodplain functions reduces the loss of a community's assets to flooding. A medium-term to long-term strategy for the city to reduce its risk to flooding is to buy out the most vulnerable land from willing sellers and convert it back to natural floodplains. In pursuing this strategy, the city should begin by identifying which properties are the most vulnerable to flooding, which properties have repetitive loss claims, where there are willing sellers and where there are groups (or "blocks") of vulnerable properties whose conversion back to natural floodplain would make a meaningful impact on reducing the city's level of overall vulnerability. Green Acres, Blue Acres, the Nature Conservancy, the Trust for Public Land, and the New Jersey Conservation Foundation are potential sources of funding acquisition or easements, and for maintaining the land's natural functions into the future.

Resources and Funding Opportunities

A variety of agencies at the federal, state, and county level, as well as private-sector organizations, have created programs to help municipalities with flooding issues. Resources that may be available to help Burlington City implement the recommendations in this report is listed in this section.

Federal Programs: Flood Hazards

FEMA: Flood Mitigation Assistance Grants

The Flood Mitigation Assistance Grants Program provides funding to states, municipalities, and other groups for projects or plans that reduce or eliminate the long-term risk of flood damage to structures insured under the National Flood Insurance Program. The funds for this grant program are disbursed through states. Burlington should contact the New Jersey State Hazard Mitigation Officer (www.state.nj.us/njoem/) if it is interested in applying. More information is available at www.fema.gov/flood-mitigation-assistance-grant-program.

FEMA: Hazard Mitigation Grants

The Hazard Mitigation Grant Program helps communities implement hazard mitigation measures following a presidential major disaster declaration. The funds for this grant program are disbursed through states. Burlington should contact the New Jersey State Hazard Mitigation Officer (www.state.nj.us/njoem/) if it is interested in applying and has an eligible project. More information is available at www.fema.gov/hazard-mitigation-grant-program.

²⁸ U.S. Federal Emergency Management Agency, *Integrating Historic Property and Cultural Resource Considerations into Hazard Mitigation Planning*, May 2005, www.fema.gov/pdf/fima/386-6_Book.pdf.

²⁹ GTR Question 5.10: Does the municipality use land acquisition programs to buy-out or purchase land conservation easements in hazard prone areas? Does the community utilize impact fees, accommodation taxes or user fees to acquire properties in hazard areas?

FEMA: Pre-Disaster Mitigation Grants

The Pre-Disaster Mitigation Grant Program assists states, municipalities, and other groups in implementing a sustained pre-disaster natural hazard mitigation program to reduce overall risk from future hazards while reducing reliance on federal funding in future disasters. This program awards planning and project grants and provides opportunities for raising public awareness about reducing future losses before disaster strikes. The funds for this grant program are disbursed through states. Burlington should contact the New Jersey State Hazard Mitigation Officer (www.state.nj.us/njoem/) if it is interested in applying. More information is available at <https://www.fema.gov/pre-disaster-mitigation-grant-program>.

Federal Programs: Community Support

Partnership for Sustainable Communities

This partnership between the U.S. Department of Housing and Urban Development (HUD), the U.S. Department of Transportation, and the Environmental Protection Agency provides grants to help communities create vibrant, healthy neighborhoods that provide more housing options, economic opportunities, and efficient transportation while reinforcing existing investments. The program website includes grant offerings from each of these agencies. More information is available at www.sustainablecommunities.gov/partnership-resources. Information about the grants available in this program is also posted on www.grants.gov.

HUD: Community Development Block Grant Program

Burlington County receives funding from the federal Community Development Block Grant Program for developing viable urban communities with an emphasis on assisting low-income persons. Funding may be used to meet urgent needs where conditions pose a threat to the health or welfare of the community. Examples of projects funded include reconstruction of affordable housing after a flood, or the redevelopment of public access along waterways to include Americans with Disabilities Act (ADA) access. More information is available at www.co.burlington.nj.us/258/Block-Grant-Program.

U.S. Economic Development Administration: Economic Adjustment Assistance Program

This program provides financial assistance to communities experiencing gradual or sudden adverse economic changes, including but not limited to those caused by federally declared disasters. More information is available at www.eda.gov/funding-opportunities/.

Federal Programs: Infrastructure

U.S. Army Corps of Engineers: Emergency Streambank and Shoreline Protection

This program funds the construction of streambank and shoreline protection projects to reduce erosion risks for structures, including highways, municipal water supply systems and sewage disposal plants, churches, hospitals, schools, nonprofit public services, and known cultural sites. More information is available at www.mvr.usace.army.mil/Business-With-Us/Outreach-Customer-Service/Flood-Risk-Management/Section-14/.

U.S. Army Corps of Engineers: Small Flood Risk Management Projects

This program funds construction or improvement of flood control works, levees, floodwalls, impoundments, or pumping stations; flood proofing; relocation of structures; or flood warning and preparedness systems. The Corps of Engineers oversees planning, design, and construction of flood risk management projects in coordination with the project sponsor. More information on this funding resource is available at www.mvr.usace.army.mil/Business-With-Us/Outreach-Customer-Service/Flood-Risk-Management/Section-205/.

Federal Programs: Open Space and Natural Resources

U.S. Army Corps of Engineers: Aquatic Ecosystem Management and Restoration

This program provides financial and technical assistance to restore degraded aquatic ecosystems to a more natural condition. More information is available at www.mvr.usace.army.mil/Business-With-Us/Outreach-Customer-Service/Ecosystem-Restoration/Section-206/.

U.S. Army Corps of Engineers: Project Modification for Improvement of the Environment

This program offers financial and technical assistance for the planning, engineering, design, and construction of projects to restore ecosystems that have been degraded by a previously constructed Corps of Engineers project. Projects typically involve environmental restoration of aquatic, floodplain, and upland areas. More information on this program is available at www.mvr.usace.army.mil/Business-With-Us/Outreach-Customer-Service/Ecosystem-Restoration/Section-1135/.

U.S. Army Corps of Engineers: Snagging and Clearing for Flood Control

This program provides financial and technical assistance to reduce flood damages by clearing and excavating channels, as well as constructing embankments in some instances, using materials from the clearing operation. More information on this program is available at www.mvr.usace.army.mil/Business-With-Us/Outreach-Customer-Service/Flood-Risk-Management/Section-208/.

State Programs: General Assistance

NJDEP Bureau of Flood Control

The Community Assistance Program Unit in NJDEP's Bureau of Flood Control offers a range of floodplain assistance to municipalities. This unit offers assistance with floodplain issues (in person or on the phone), floodplain ordinance and floodplain map creation and adoption, solving problems on development within Special Flood Hazard Areas, CRS applications and compliance, flood mapping, and disaster response. The unit also offers regular workshops on floodplain-related topics. More information on this program is available at www.nj.gov/dep/floodcontrol/about.htm#management.

NJDEP Coastal Management Program

The New Jersey Coastal Management Program is part of the National Coastal Zone Management Program and provides resources for sustainable and resilient coastal community planning, and climate change planning. Their technical assistance offerings include contractor assistance, direct municipal grant programs, and funding for land use planning and the implementation of living shorelines or other nature-based mitigation

projects. The available resources are updated regularly. For more information, contact the Coastal Management Office (www.state.nj.us/dep/cmp/czm_contact.html).

State Programs: Flood Relief and Control

NJDEP Shore Protection Program

This cost-share program provides grants to protect property and infrastructure from coastal storm damage, erosion and shoreline migration, and sea level rise. Funds can be used for the protection, stabilization, restoration, or maintenance of the shore, including monitoring studies and land acquisition. Projects must be consistent with the New Jersey Shore Protection Master Plan and Coastal Zone Management Program. Project areas must be affected by normal tidal cycles and be located on public or private property that has legal, perpetual easements assigned to the state for public access and use. More information is available at www.nj.gov/dep/shoreprotection/funding.htm.

NJ Office of Emergency Management Public Assistance Program

This program was developed to assist public entities in New Jersey with getting federal funding for repairs, restorations, reconstruction, or replacement of public facilities or infrastructure damaged by a disaster. The program coordinates damage and needs assessments in response to expected or actual emergency situations as part of the Federal Disaster Assistance Program. The funds available differ for each community in each declared disaster area. More information is available at ready.nj.gov/programs/public-assistance-program.shtml.

State Programs: Open Space Preservation and Management

NJDEP Blue Acres Program

In 2009, New Jersey passed an act to authorize bonds for the acquisition of lands in the state's floodways for recreation and natural resources protection. Twenty-four million dollars are available for acquiring properties that have been damaged by storms, may be prone to incurring damage from storms or storm-related flooding, or protect other lands from such damage. All Blue Acres acquisitions must be from willing sellers. More information is available at www.nj.gov/dep/greenacres/blue_flood_ac.html.

NJDEP Community Stewardship Incentive Program Grant

This program provides grants to local governments and shade tree commissions to help implement a comprehensive community forestry management plan. Grant categories include resiliency planning, hazard mitigation, and reforestation and tree planting. More information on the program is available at www.state.nj.us/dep/parksandforests/forest/community/grants-csip.html.

NJDEP Green Acres Program

The Green Acres Program provides low-interest loans and grants to municipal and county governments to acquire open space and develop outdoor recreation facilities. Green Acres works with local governments from grant application through project completion. All land funded under this program must be open to the public. More information is available at www.nj.gov/dep/greenacres/local.html.

NJDEP Green Communities Grant (Community Forest Program)

This program assists local governments in developing Community Forestry Management Plans that guide communities in establishing and maintaining urban and community forests. Funding is provided through the U.S. Department of Agriculture Forest Service Urban and Community Forestry Program. More information is available at www.nj.gov/dep/grantandloanprograms/nhr_gccg.htm.

State Programs: Contaminant Mitigation

NJDEP Hazardous Discharge Site Remediation Fund

This program provides grants to municipalities, counties, and redevelopment entities for investigating and remediating contaminated sites identified as areas in need of redevelopment, and for remediating contaminated sites located in a designated Brownfield Development Area. Applications are available online or may be obtained by request from NJDEP. More information on the program is available at www.nj.gov/dep/srp/finance/hdsrf/.

NJDEP Technical Assistance Grants

Technical Assistance Grants provide funding to nonprofit community groups to improve the community's understanding of the environmental conditions at a contaminated site and remediation processes. The bulk of the funding must be used to hire an independent Licensed Site Remediation Professional as a technical advisor to help interpret and comment on site documents. The grant funds are available to community groups during the Remedial Investigation phase and the Remedial Action phase of remediating a contaminated site. Local governments have to partner with an eligible nonprofit organization to make use of these funds. More information is available at www.nj.gov/dep/grantandloanprograms/sr_techassist.htm.

State Programs: Water Quality Protection

NJDEP and New Jersey Environmental Infrastructure Trust (NJEIT) Environmental Infrastructure Financing Program

This program, funded through both NJDEP and NJEIT, provides low-interest loans for constructing water quality protection facilities, including for wastewater treatment and stormwater and nonpoint source pollution management. The Financing Program also provides loans for such activities as open space land purchase and conservation, contamination remediation, and well sealing. More information is available at www.nj.gov/dep/grantandloanprograms/sr_techassist.htm and www.njeit.org/.

NJDEP Nonpoint Source Pollution Control Grants (319 Grant Program)

The Nonpoint Source Pollution Control Grants Program provides grants to reduce water quality impairment through nonpoint source pollution control projects. More information on the program is available at www.nj.gov/dep/grantandloanprograms/eps_nspc.htm.

Rutgers University Cooperative Extension Water Resources Program

The Water Resources Program is a specialized program at Rutgers Cooperative Extension that identifies and addresses community water resources issues. Their projects and programs currently include agricultural watershed planning and implementation, green infrastructure education and construction, impervious cover reduction, municipal stormwater management, community training on water quality issues, rain garden and

rain barrel workshops, and watershed planning and implementation. More information is available at water.rutgers.edu.

Water Quality Restoration Grants Program

The money from this grant program is available for watershed restoration projects that address stormwater runoff from nonpoint sources. Eligible projects include green infrastructure that reduces stormwater runoff in communities with aging combined wastewater-stormwater infrastructure; and projects that improve suburban stormwater management systems, help agricultural operations reduce nonpoint source pollution, implement water quality improvements in the Raritan River and Delaware River and Bay watersheds, construct living shorelines, improve water quality in coastal lakes, and promote environmental education. More information is available at www.state.nj.us/dep/wms/bears/npsrestgrants.html.



Appendix A

Coastal Vulnerability Assessment Matrix for Burlington's Assets
Vulnerability of Structures, Properties, and Populations in a Category 2 Storm in 2100

Sea Level Rise (SLR) Projections

YEAR	SLR FROM PRESENT
Present	-
2050	+ 1.4 ft
2100	+ 3.3 ft

TOP AREAS OF CONCERN									
Map #	Asset Category	Asset Name	Asset Description	Flood Depths on Parcel	Exposure	Sensitivity	Vulnerability Rating	Consequences	Consequences Rating
1	Emergency Facilities (Designated Emergency Shelter) and Institutional/Cultural/Gov't (Schools)	Burlington City High School	Public high school and designated emergency shelter located at 100 Blue Devil.	0 ft - 6.2 ft	Most of the building will not likely be substantially flooded, but much of the site may flooded with up to 2 ft of water.	More information is needed on the durability of the buildings' materials and the degree to which the buildings are elevated above floodwaters. The predicted flood depths at the Wilbur Watts Intermediate School could cause substantial damage. Information is also needed on any emergency equipment that is in harm's way. Egress through floodwaters may be difficult at Wilbur Watts, and a relatively minor inconvenience at the High School.	Moderate	As a designated emergency shelter, the loss of either of these buildings would require a large percentage of residents to be rerouted to another shelter, causing additional strain on shelter resources. After the storm, students and staff would experience the inconveniences of relocation for several weeks to several months after the storm as the school was being renovated to remove flooding damage.	Moderate
2		Wilbur Watts Intermediate School	Public middle school and designated emergency shelter for Burlington City located at 550 High St.	1.4 ft - 8.2 ft	Virtually all of the site will likely be flooded, with the main building potentially facing depths of between 1.5 ft and 7 ft of water.		Moderate to High		Moderate
3	Emergency Facilities (Fire Departments)	The Fire Building	Fire station located at 545 High St.	4.3 ft - 6.1 ft	The fire building may experience between 5 and 6 ft of flooding.	More information is needed on the durability of the buildings' materials and the degree to which the buildings are elevated above floodwaters. Information is also needed on any equipment that is located in harm's way. Egress may be difficult for Niagara Hose Company, Mitchell Fire Company, and Neptune Hose Company.	Moderate to High	Given the critical emergency services in these buildings, a loss of function from flooding could greatly reduce the city's ability to react to flooding during a storm and recover afterwards. If one or two fire stations were compromised by flooding, the other companies could assist in covering their responsibilities, but they could become overburdened in the process.	Minor to Moderate
4		Mitchell Fire Company	Fire station located at Federal St. and Mitchell Ave.	1.7 ft - 3.2 ft	Virtually all of the building will likely be flooded, with between 2 and 3 ft of water.		Moderate to High		Moderate
5		Neptune Hose Company 5	Fire station located at 731 Bordentown Rd.	1.0 ft - 2.2 ft	Virtually all of the building will likely be flooded, with between 1 and 2 ft of water.		Moderate		Moderate
6		Niagara Hose Company 6	Fire station located at NJ Route 130 (NJ-130) and High St.	3.5 ft - 4.9 ft	Virtually all of the building will likely be flooded, with between 2 and 4 ft of water.		Moderate to High		Moderate
7	Emergency Facility (Fire Department) and Institutional/Cultural/Gov't (Place with Historic Significance)	Endeavor Emergency Squad and Fire Company - Brickwall Tavern	Fire station and historic site of the oldest fire company in New Jersey, located at 19 E. Union St.	0 ft - 0.5 ft	The Emergency Squad building and Fire Company building may experience flooding of up to 0.5 ft.	More information is needed on the durability of the buildings' materials and the degree to which the buildings are elevated above floodwaters. Historic structures may be more sensitive because they are old, fragile, and/or cannot be moved, or they may be less sensitive because they were built to withstand decades of use with durable materials and high levels of craftsmanship.	Low to Moderate	Given the critical emergency services in these buildings, a loss of function from flooding could greatly reduce the city's ability to react to flooding during a storm and recover afterwards. The other fire companies could assist in covering the responsibilities of this company, but could become overburdened in the process. The loss of the Endeavor Fire Building, as a historic building, would be a notable cultural loss to the city and state.	Moderate
8	Emergency Facility (Police, Designated Emergency Shelter) and Institutional/Cultural/Gov't (Civic Building)	Burlington City Municipal Building and Police Department	Located at 525 High St. The facility holds the city offices, Police Department, and Office of Emergency Management, and is a designated emergency shelter for Burlington City.	0.5 ft - 5.1 ft	All of the site will likely be flooded, half of the site by about 1 ft of water and half by 3 to 5 ft.	The city's records and equipment are stored on the second floor and are out of harm's way. More information is needed on the durability of the building's materials and the degree to which the building is elevated above floodwaters, and the equipment that the building contains. The predicted flood levels at the front of the building may make egress difficult during the flood.	Moderate to High	Given the critical emergency services in this building, a loss of function from flooding could greatly reduce the city's ability to react to flooding during a storm and recover afterwards.	High

TOP AREAS OF CONCERN (CONTINUED)									
Map #	Asset Category	Asset Name	Asset Description	Flood Depths on Parcel	Exposure	Sensitivity	Vulnerability Rating	Consequences	Consequences Rating
9	Park and Utility (Flood Control Structure)	Kennedy Park	Lakeside park on W. Broad St. and Wood St., designed to absorb flood waters.	4.6 ft - 13.1 ft	Kennedy Park will likely be completely flooded, with some of the greatest depths in Burlington City, generally between 9 and 11 ft.	<p>The lake is already facing limitations that reduce its effectiveness in controlling floods. The city cannot pump the lake because it is protected under NJDEP regulations as fish habitat, which reduces the city's capacity to move water through Burlington City and from upstream communities to the Delaware River. The city should compare the volume of floodwaters that the park can accept with the volumes of water predicted in this flooding scenario.</p> <p>The park contains play equipment and paths, which could sustain some damages in a flood, depending on their materials.</p>	Low to Moderate	If Kennedy Park could no longer accept upstream floodwaters because of internal damage from flooding, a flood could overtop Kennedy Lake's banks and expand into the neighborhood around the park, temporarily damaging nearby commercial and residential properties. The closure of the park to additional floodwaters would also prevent Burlington Township from sending its own excess floodwaters through pipes to Kennedy Park, thus making the township more vulnerable to flooding.	Minor to Moderate
10	Transportation (Designated Evacuation Routes)	Broad St.	Evacuation route between east and west neighborhoods within Burlington City.	0 ft - 12.8 ft	With the exceptions of the intersection at Wood St. and an area close to the Assiscunk Creek, the entirety of Broad St. will likely be flooded. The eastbound section of the street between Uhler Ave. and Ellis St. will likely be hardest hit, with flooding of between 3 and 7 ft, and up to 12.8 ft possible from the Kennedy Park lake. At the intersection of Talbot St. and east, flooding will more likely be between 1 to 2 ft.	Extended periods of flooding, high-velocity floods, or flooding that parallels a road can cause erosion of roadway infrastructure, but the elevation of the roadway may prevent flooding from occurring.	Low to High	<p>Burlington City has several redundant evacuation routes, as well as a gridded road system, and drivers attempting to leave the city would likely be able to reroute to other parallel roads. The inconveniences of traffic rerouting and delays on redundant unflooded roads would be temporary.</p> <p>Residents living in the center of the city, where the flooding is expected to be deepest, should be evacuated well in advance of the storm, as there may be few unflooded routes for evacuation during the storm.</p>	Minor to Moderate
11		High St./NJ-541	Evacuation route between the north and south extents of Burlington City.	0 ft - 7.0 ft	Flooding of High St. will likely be most severe between Library St. and 2nd St. with depths typically between 3 and 6 ft, and the greatest depths of 7 ft between Belmont St. and Wall St. There will be less (and more shallow) flooding north and south of those intersections. No flooding is anticipated along High St. south of 4th St.		Low to High		Minor to Moderate
12		Jacksonville Rd.	Evacuation route to the south of Burlington City.	0 ft - 2.5 ft	Jacksonville Rd. is expected to flood from its westmost extent (its intersection with NJ-130) to just southeast of James St. Typical flooding depths are up to 2 ft. While Jacksonville Rd. is likely to experience less flooding than some of the other evacuation routes, the roads that one would need to take to get to Jacksonville Rd. in order to leave the city, including Federal St., NJ-130, Wall St., and Mitchell Ave., will likely face more severe flooding in the 3- to 4-ft range.		Low to High		Minor to Moderate

TOP AREAS OF CONCERN (CONTINUED)									
Map #	Asset Category	Asset Name	Asset Description	Flood Depths on Parcel	Exposure	Sensitivity	Vulnerability Rating	Consequences	Consequences Rating
13	Transportation (Designated Evacuation Routes, Continued)	NJ Route 130	Evacuation route between the east and west extents of Burlington City.	0 ft - 7.1 ft	With the exceptions of the intersection at Uhler Ave. and an area close to the Assiscunk Creek, the entirety of both the east- and westbound sides of NJ-130 will likely be flooded. As with Broad St., the area closest to Kennedy Lake will be hardest-hit, with flood depths of up to 7 ft. East of the Assiscunk Creek, typical depths will likely be between 1 and 3 ft, while west of the creek, typical depths will likely be between 1 and 5 ft.	Extended periods of flooding, high-velocity floods, or flooding that parallels a road can cause erosion of roadway infrastructure, but the elevation of the roadway may prevent flooding from occurring.	Low to High	Burlington City has several redundant evacuation routes, as well as a gridded road system, and drivers attempting to leave the city would likely be able to reroute to other parallel roads. The inconveniences of traffic rerouting and delays on redundant unflooded roads would be temporary.	Minor to Moderate
14		Salem Rd	Evacuation route to the south of Burlington City.	0 ft - 5.5 ft	Salem Rd. will likely have the deepest flooding where it intersects NJ-130. Flood depths at that location will be between 4 and 5 ft, but these levels will drop to about 1.5 ft at the Dickenson Rd. intersection and are predicted to abate south of the Farner Ave. intersection.		Low to High	Residents living in the center of the city, where the flooding is expected to be deepest, should be evacuated well in advance of the storm, as there may be few unflooded routes for evacuation during the storm.	Minor to Moderate
15	Utility (Flood Control Structure)	Bulkhead	Located along the Delaware River between Keim Rd. and the Assiscunk Creek. Controls erosion of the city's Delaware River shoreline.	3.0 ft - 8.2 ft	The bulkhead is anticipated to be faced with about 10 ft of flooding on its Delaware River side, and about 8 ft of flooding on its landward side.	<p>The bulkhead gets overtopped during major high tides, but it does not currently have structural issues as a result. However, the pipes at the bulkhead's tide gates have lost flappers during floods.</p> <p>The sensitivity of the bulkhead depends on the height of the bulkhead relative to the potential height of the predicted flood waters. Newer construction or more durable materials may also increase its resilience to flood effects.</p>	Low to High	If the bulkhead were destroyed, parts of the historic and commercial core of Burlington City, particularly the vulnerable New Yorkshire/Ward 1 neighborhood, could become vulnerable to eroding into the Delaware River. There could be substantial costs to the neighborhood and city to reconstruct older, more fragile buildings affected by erosion.	Moderate to High
16	Utility (Flood Control Structure)	Levee	Located along the Assiscunk Creek between NJ-130 and the Columbus Park neighborhood. Controls flooding from the Assiscunk Creek.	1.1 ft - 7.1 ft	The levee is projected to hold back depths of water ranging between 1 and 7 ft. Depending on the height of the levee, it may be overtopped.	<p>The levee is made more sensitive to flooding by several structural problems. Water bottles get stuck in the levee and cause flooding. "Duckbills" installed to prevent backflow are pushed in by tides. The trees that were recently removed from the levee damaged its structure.</p> <p>The sensitivity of the levee also depends on the height of the levee relative to the potential height of the predicted flood waters.</p>	Moderate to High	The levee holds back water from several residential neighborhoods (particularly Columbus Park), part of a commercial strip along NJ-130, and NJ-130 itself. The structures would likely not be faced with more than 3 ft of flooding, so recovery would be relatively short and inexpensive. Flood damage to the levee, and subsequent floodwater intrusion, would be a substantial inconvenience for drivers on NJ-130, who might have to reroute around large parts of Burlington City to avoid the flooding. It could be expensive for Columbus Park residents, and a temporary inconvenience for those who use the nearby Agway and auto body, which are in harm's way.	Minor to Moderate
17	Utility (Wastewater Treatment Plant)	Wastewater Treatment Plant (Burlington City)	Located at 900 W. Broad St. Treats wastewater for the city.	0 ft - 18.8 ft	The majority of the site, including key infrastructure, will likely become flooded. Some buildings may receive up to 15 or 16 ft of water.	The facility is on track to be updated with new pumps, which will remove floodwaters more efficiently. However, the site is built to the 1992 flood elevation, which may not be sufficient for floods in 2050 or 2100. The city should compare the elevation of each structure to projected flood depths for 2050 and 2100, as some of these depths could cause damage purely from their exerted pressure. More information is needed on the durability of the materials in each structure, and any sensitive equipment that may be in harm's way.	Low to High	The closure of parts of the wastewater treatment plant after a flood would affect much of the city, unless there is a possibility that the city could use Burlington Township's facility. Repairs to systems that were damaged in the flood could take weeks or months, during which time the city would have to find other means to treat residential and commercial wastewater.	Moderate to High

BUILT ENVIRONMENT									
Map #	Asset Category	Asset Name	Asset Description	Flood Depths on Parcel	Exposure	Sensitivity	Vulnerability Rating	Consequences	Consequences Rating
18	Communications Infrastructure	Cecchi Building	Building with installed cell antennas, located at 415 St. Mary St.	0 ft - 1.6 ft	The east wing of the building may be flooded with water depths of up to 1 ft. The north façade of the west wing may experience flooding of up to 1.6 ft.	More information is needed about the height at which the cell antennas are installed. However, it is unlikely that they will be affected by less than 2 feet of water.	Insignificant	The loss of the cell antennas to flooding would disable cell phone use for part of the city, which could prevent these neighborhoods from having adequate access to emergency communications during and immediately after the storm.	Minor to Moderate
19		Veterans Drive Water Tower	Water tower with installed cell antennas, located at 400 Veterans Dr.	0 ft - 0.9 ft	The water tower may be exposed to up to 0.9 ft of floodwater.		Insignificant		Minor to Moderate
20	Emergency Facilities (Hospitals)	Burlington North Dialysis	Dialysis center located at 1164 NJ- 130 N.	0 ft - 3.4 ft	The facility will likely be entirely flooded, with water depths of up to 2 ft.	The predicted flooding depths expected for Southern Jersey Medical Centers could cause substantial damage, but more definitive information is needed on the durability of the buildings' materials and the degree to which the buildings are elevated above floodwaters. Although the flooding is not particularly deep for Burlington North Dialysis, egress may be a particular challenge for patients visiting both facilities.	Moderate	After a storm, flooding damages to this building would cause temporary inconveniences to staff and patients while the facility was being renovated for damages, although these damages would likely be minor given the anticipated flood depths. There are other dialysis centers in nearby towns, so patients with a great need could be directed to another facility.	Minor
21		Southern Jersey Medical Centers	Family health center located at 651 High St.	3.6 ft - 5.9 ft	The entire building may receive between 4 and 6 ft of flooding.		Moderate	As a family medicine practice, this facility does not contain emergency rooms, so flood damage would not adversely impact the city during the storm to the degree that the damage of a major hospital would. After a flooding event, in the weeks or months required to address the damage, staff and patients would be inconvenienced by lack of access to the facility, and those patients needing care within the reconstruction timeframe might face serious health setbacks without a plan to see a doctor at another facility.	Minor
22	Institutional/ Cultural/Gov't	Keegan Recreation Center	Municipal recreation center, which functions as a senior center, summer arts and crafts center, polling place for the Board of Island managers, recreation department offices, and group meeting facility, located at 522 Wood St.	5.1 ft - 9.1 ft	The building may experience between 5 ft and 6.5 ft of flooding.	More information is needed on the durability of the building's materials and the degree to which the building is elevated above floodwaters.	Low to High	The city could likely find another interim space after a flood to accommodate the programs at Keegan.	Minor

BUILT ENVIRONMENT (CONTINUED)									
Map #	Asset Category	Asset Name	Asset Description	Flood Depths on Parcel	Exposure	Sensitivity	Vulnerability Rating	Consequences	Consequences Rating
23	Hazardous Sites (Gas and Oil Stations and Distributors)	American Tire	Auto center located at 1040 Bordentown Rd.	0 ft - 1.1 ft	The area above the holding tanks may experience up to 1 ft of flooding.	<p>At Cenco, oil is stored in trucks, not in onsite tanks, substantially decreasing its vulnerability to flooding.</p> <p>The PEH Corp property may be inundated in Category 2 storms in decades after 2100, or it may be protected by NJ-130, which could serve as a berm.</p> <p>More information on the storage practices of the other gas and oil distributors is needed to determine their degrees of vulnerability to flooding.</p>	Moderate to High	A flood event could spread contaminants from each site onto other property after a storm, but the consequences depend on the location of the contamination, the type of contaminants onsite, and their current rate and volume of migration through soil and groundwater. More information is needed on how the fuel is stored on each site and the precautions that each owner has put in place to protect against flooding and further soil and groundwater contamination.	Minor to Moderate
24		Burlington Getty	Gas station located at 58 NJ-130.	4.9 ft - 6.8 ft	The entire site will likely be flooded, and the area above the fuel storage tanks may experience 5.3 to 5.7 ft of flooding.		Moderate to High		Minor to Moderate
25		Burlington Gulf	Gas station located at 9629 High St.	1.9 ft - 4.4 ft	The entire site will likely be flooded, and the area above the fuel storage tanks may experience 2 to 3 ft of flooding.		Moderate to High		Minor to Moderate
26		Burlington Sunoco	Gas station located at 357 E. Federal St.	1.8 ft - 2.8 ft	The entire site will likely be flooded, and the area above the fuel storage tanks may experience 2 to 3 ft of flooding.		Moderate to High		Minor to Moderate
27		Cenco Heating Oil	Heating oil distributor, located at 325 NJ-130.	5.3 ft - 7.3 ft	The entire site will likely be flooded, and the area above the holding tanks may experience 5 to 6.5 ft of flooding.		Moderate to High		Minor to Moderate
28		Citgo On the Go	Gas station located at NJ-130 N. and Keim Blvd.	5.1 ft - 6.6 ft	The entire site will likely be flooded, and the area above the fuel storage tanks may experience 5.5 to 6 ft of flooding.		Moderate to High		Minor to Moderate
29		Curtin Marina	Sells tanks for boating, located at 501 E. Pearl St.	0.7 ft - 10.0 ft	The entire site will likely be flooded. Structures on the site may experience 1 to 6.5 ft of flooding. More information is needed concerning where the fuel tanks are stored.		Moderate to High		Minor to Moderate
30		Exxon	Gas station located at 631 Salem Rd.	3.6 ft - 6.3 ft	The entire site will likely be flooded, and the area above the fuel storage tanks may experience 3.5 to 5 ft of flooding.		Moderate to High		Minor to Moderate
31		Gasko of Burlington	Gas station located at 844 Columbus Rd.	0.2 ft - 1.9 ft	The entire site will likely be flooded, and the area above the fuel storage tanks may experience up to 1 ft of flooding.		Moderate to High		Minor to Moderate
32		Lester Fellows	Trucking dispatch and fuel facility at E. Pearl and Tatham Sts.	0 ft to 9.9 ft	The entire site will likely be flooded. Structures on the site may experience up to 1 ft of flooding. More information is needed regarding where the fuel tanks are stored.		Moderate to High		Minor to Moderate
33		Lukoil	Gas station located at 420 Keim Blvd.	4.4 ft - 7.5 ft	The entire site will likely be flooded, and the area above the fuel storage tanks may experience 5 ft of flooding.		Moderate to High		Minor to Moderate
34		PEH Corp	Gas station located at 1011 NJ-130 and Princeton Circle.	0 ft	No flooding is expected from coastal flooding or sea level rise.		Insignificant		Minor to Moderate
35		US Gas IV	Gas station located at 911 High St.	0 ft - 0.2 ft	No flooding is expected from coastal flooding or sea level rise.		Insignificant		Minor to Moderate
36		Wawa Fuel	Gas station located at 350 E. NJ-130 S.	0 ft - 2.9 ft	The majority of the site may be flooded, and the area above the fuel storage tanks may experience 1 to 3 ft of flooding.		Moderate to High		Minor to Moderate

BUILT ENVIRONMENT (CONTINUED)									
Map #	Asset Category	Asset Name	Asset Description	Flood Depths on Parcel	Exposure	Sensitivity	Vulnerability Rating	Consequences	Consequences Rating
37	Institutional/Cultural/Gov't (Civic Building), Communications Infrastructure	Burlington City Public Works	Public works facility located at E. Federal and Mitchell Ave. that also contains a radio tower. It houses equipment for maintenance and upkeep of the city's roadways and park space, as well as city vehicles.	2.3 ft - 3.3 ft	The entire building may be flooded by between 2 and 3 ft of water.	<p>The building currently gets flooded in storms, so the city is already addressing flooding issues associated with the site. The city is considering moving the facility to the Armory (559 High St.) or the YMCA (302 Commerce Square Blvd.). However, the Armory will likely receive more flooding in 2100 than the current Public Works site, while the YMCA is at a higher elevation but could be surrounded by water.</p> <p>The Public Works Dept. moves its trucks and generators to Burlington Township before major storms, but more information is needed on any other equipment that may be in harm's way. Egress may be difficult for some vehicles during a storm.</p> <p>The radio tower is likely installed high enough to be out of harm's way.</p>	Moderate to High	This facility plays a critical role in cleanup after floods, and with few redundant services in Burlington City, the loss of the facility could greatly slow the city's flood recovery process.	Moderate
38	Institutional/Cultural/Gov't (Current or Former Homes with Historic Significance)	Bard-How House	Historic museum representing mid-1700s life and home of former Justice Samuel How, located at 453 High St.	1.5 ft - 4.5 ft	The entire site will likely be flooded, and the house may experience between 2 and 4 ft of flooding.	<p>Many of these buildings contain vulnerable stone foundations; however, some historic buildings were constructed with more durable materials than modern buildings. More information is needed on the durability of the buildings' materials and the degree to which the buildings are elevated above floodwaters.</p>	Moderate to High	<p>As historic buildings, the loss of these buildings would be a notable cultural loss to the city and region, and in the case of the Boudinot-Bradford House, the country.</p> <p>Many of these buildings are privately owned, and could be reconstructed with minimal or no cost to Burlington City.</p>	Minor to Moderate (relative to other historical and cultural assets)
39		Biddle-Pugh House	Private historic home of Delia Biddle-Pugh, Burlington City benefactor, located at 130 W. Broad St.	0 ft - 1.6 ft	The entire site will likely be flooded, and the house may experience up to 1.6 ft of flooding.		Moderate		Minor to Moderate (relative to other historical and cultural assets)
40		Bloomfield-Birch House	Private historic shop owned by carriage manufacturer James Birch, located at 415 High St.	0.9 - 3.2 ft	The entire site will likely be flooded, and the house may experience between 2 and 3 ft of flooding.		Moderate to High		Minor to Moderate (relative to other historical and cultural assets)
41		Boudinot-Bradford House	Private historic home and former home of founding father Elias Boudinot, located at 2017 W. Broad St.	0.4 ft - 2.0 ft	The entire site will likely be flooded, and the house and accessory structure may experience up to 2 ft of flooding.		Moderate		Moderate to High (relative to other historical and cultural assets)
42		Carriage House	City-owned historic site and headquarters of Burlington City Historical Society, located at 23 Smith Ln.	0 ft - 0.6 ft	Much of the building is on higher ground, and only the north façade may receive up to 0.2 ft of flooding.		Insignificant to Low		Moderate (relative to other historical and cultural assets)

BUILT ENVIRONMENT (CONTINUED)									
Map #	Asset Category	Asset Name	Asset Description	Flood Depths on Parcel	Exposure	Sensitivity	Vulnerability Rating	Consequences	Consequences Rating
43	Institutional/Cultural/Gov't (Current or Former Homes with Historic Significance, Continued)	Nathaniel Coleman House	Private historic home of Nathaniel Coleman, Quaker silversmith, located at 320 High St.	0 ft	No flooding is expected from coastal flooding or sea level rise.	Many of these buildings contain vulnerable stone foundations; however, some historic buildings were constructed with more durable materials than modern buildings. More information is needed on the durability of the buildings' materials and the degree to which the buildings are elevated above floodwaters.	Insignificant	As historic buildings, the loss of these buildings would be a notable cultural loss to the city and region, and in the case of the James Fenimore Cooper House, the country. Many of these buildings are privately owned, and could be reconstructed with minimal or no cost to Burlington City.	Minor to Moderate (relative to other historical and cultural assets)
44		Isaac Collins House	Private historic site: former print shop and source of state's first newspaper, located at 206 High St.	0 ft - 0.8 ft	The building may receive up to 0.6 ft of flooding.		Low to Moderate		Minor to Moderate (relative to other historical and cultural assets)
45		James Fenimore Cooper House	Museum - part of the Burlington County Historical Society complex - and birthplace of celebrated "American Wilderness" novelist James Fenimore Cooper, located at 457 High St.	2.0 ft - 5.5 ft	The entire site will likely be flooded, and the house may experience between 2.0 and 3.5 ft of flooding.		Moderate to High		Moderate to High (relative to other historical and cultural assets)
46		Oliver Cromwell House	Private historic home and final residence of African American Revolutionary War soldier Oliver Cromwell, located at 114 E. Union St.	0.5 ft - 2.0 ft	The entire site will likely be flooded, and the house may receive between 1 and 2 ft of flooding.		Moderate		Minor to Moderate (relative to other historical and cultural assets)
47		Gardiner House	Private historic home and former home of Thomas Gardiner, Quaker leader, located at 228 High St.	0 ft	No flooding is expected from coastal flooding or sea level rise.		Insignificant		Minor to Moderate (relative to other historical and cultural assets)
48		Gummere House	Private historic home of the Gummere Brothers, members of the Society of Friends and scholars, located at 222 Wood St.	0 ft - 1.8 ft	Much of the site may be flooded, including a small part of the main building and the entire accessory building. These structures may experience up to 1 ft of flooding.		Low to Moderate		Minor to Moderate (relative to other historical and cultural assets)
49		Grubb Estate	Private historic site, part of the underground railroad and a former tavern/small-scale industrial site, located at 46 Riverbank.	0 ft - 4.7 ft	Much of the site may be flooded, including all of the main house, which may be flooded with between 1 and 2 ft of water.		Moderate		Minor to Moderate (relative to other historical and cultural assets)
50		Hoskins House	Private colonial-period structure that serves as a model for preservation, located at 202 High St.	0.6 ft - 1.8 ft	The entire site will likely be flooded, and the house may receive between 1 and 2 ft of flooding.		Moderate		Minor to Moderate (relative to other historical and cultural assets)

BUILT ENVIRONMENT (CONTINUED)									
Map #	Asset Category	Asset Name	Asset Description	Flood Depths on Parcel	Exposure	Sensitivity	Vulnerability Rating	Consequences	Consequences Rating
51	Institutional/Cultural/Gov't (Current or Former Homes with Historic Significance, Continued)	Captain James Lawrence House	Historic museum and former home of War of 1812 naval hero Captain James Lawrence, located at 459 High St.	2.3 ft - 6.1 ft	The entire site will likely be flooded, and the house may receive between 2 and 4 ft of flooding.	Many of these buildings contain vulnerable stone foundations; however, some historic buildings were constructed with more durable materials than modern buildings. More information is needed on the durability of the buildings' materials and the degree to which the buildings are elevated above floodwaters.	Moderate to High	<p>As historic buildings, the loss of these buildings would be a notable cultural loss to the city and region, and in the case of the Captain James Lawrence House, the country.</p> <p>Many of these buildings are privately owned, and could be reconstructed with minimal or no cost to Burlington City.</p>	Moderate to High (relative to other historical and cultural assets)
52		Dr. Pugh House	Private historic site, former home of prominent citizen Dr. John Pugh, located at 214 High St.	0.7 ft - 2.5 ft	The entire site will likely be flooded, and the house may receive up to 2 ft of flooding.		Moderate		Minor to Moderate (relative to other historical and cultural assets)
53		Revell House	Private historic site, arguably the oldest building in Burlington City, that was visited by Benjamin Franklin. Also the site of the Wood Street Fair. Located at 213 Wood St.	0 ft - 0.5 ft	The building may be flooded by up to 0.5 ft of water.		Low to Moderate		Moderate to High (relative to other historical and cultural assets)
54		Riverbank Houses	Private historic summer homes of prominent Philadelphians, located at 180, 202, 212, and 234 Riverbank.	0 ft - 2.6 ft	The north extremity of 212 Riverbank may receive up to 0.5 ft of flooding, but none of the other Riverbank homes will likely be affected. The driveways of 212 and 234 Riverbank may be flooded with about 2 ft of water, making egress difficult during a storm.		Moderate		Minor to Moderate (relative to other historical and cultural assets)
55		Dr. Smith House	Private historic home of Dr. Richard Smith, sire of one of the city's largest and most influential families, located at 315 High St.	0 ft - 0.8 ft	The building may be flooded by up to 0.8 ft of water.		Low to Moderate		Minor to Moderate (relative to other historical and cultural assets)
56		Ulysses Grant House	Private historic site and home of Ulysses' wife Julia and their children during the final years of the Civil War, located at 309 Wood St.	0 ft	No flooding is expected from coastal flooding or sea level rise.		Insignificant		Moderate (relative to other historical and cultural assets)

BUILT ENVIRONMENT (CONTINUED)									
Map #	Asset Category	Asset Name	Asset Description	Flood Depths on Parcel	Exposure	Sensitivity	Vulnerability Rating	Consequences	Consequences Rating
57	Institutional/ Cultural/Gov't (Other Place with Historic Significance)	Alcazar Building	Private historic site that includes the oldest standing construction in the city, located at 406 High St.	0 ft - 2.4 ft	Much of the site may be flooded, and the building may experience up to 2.5 ft of flooding.	Many of these sites contain buildings with vulnerable stone foundations; however, some historic structures were constructed with more durable materials than their modern equivalents. More information is needed on the durability of the sites' construction materials and the degree to which structures are elevated above floodwaters.	Moderate	Each of these sites provides distinct lessons on the City's history, but the loss of Burlington Island, the site of the city's first settlement, would be a particularly significant loss to the city. Closure from flooding of the Lyceum, as a long-standing arts and cultural focal point of Burlington City, would be a major cultural loss to the city and region.	Minor to Moderate (relative to other historical and cultural assets)
58		Burlington Island	City-owned historic site with settlement dating back to 1624, located due north of Burlington City, across the Delaware River.	0 ft	No flooding is expected from coastal flooding or sea level rise.		Insignificant		Moderate (relative to other historical and cultural assets)
59		Burlington Pharmacy	Private historic site and New Jersey's oldest pharmacy in continuous operation, located at 301 High St.	0 ft	No flooding is expected from coastal flooding or sea level rise.		Insignificant		Minor to Moderate (relative to other historical and cultural assets)
60		H. T. Costello-Lyceum Hall	City-owned historic site, formerly a lecture hall, theater, and city hall. Now an arts and cultural building located at 432 High St.	1.9 ft - 3.3 ft	The building may experience between 2 and 3 ft of flooding.		Low to High		Minor to Moderate (relative to other historical and cultural assets)
61		Old Barracks Site	Private historic site used by the Grand Army of the Republic, located at E. Broad St.	0 ft - 2.0 ft	Much of the barracks site and cemetery may be flooded, and the cemetery may experience up to 2 ft of flooding.		Low to High		Minor to Moderate (relative to other historical and cultural assets)
62		Oneida Boat Club	Private historic site of the oldest boat club on the Delaware River, located at York St. and Riverfront.	2.6 ft - 3.7 ft	The entire site will likely be inundated, and the building may experience between 3 and 3.7 ft of flooding.		Moderate to High		Minor to Moderate (relative to other historical and cultural assets)
63		Ship "Shield" Marker	City-owned historic site located on the inland side of Riverbank, west of Wood St., honoring the first ship to navigate the Delaware River from the Atlantic Ocean to Burlington City.	Approx. 2 ft	The plaque may be flooded with approximately 2 ft of flooding.		Low		Minor (relative to other historical and cultural assets)
64		Statue of Mercury	City-owned historic site with a cast-iron statue of the Roman god Mercury, which was originally located at the Birch Opera House and is now at 427 High St.	3.5 ft - 4.2 ft	The statue may experience between 3.5 and 4 ft of flooding.		Low to High		Minor (relative to other historical and cultural assets)
65		Temple B'Nai Israel (Former)	One of South Jersey's oldest synagogues, located at 212 High St.	0 ft - 2.38 ft	The entire site will likely be flooded, and the building may experience up to 2 ft of flooding.		Moderate to High		Minor to Moderate (relative to other historical and cultural assets)

BUILT ENVIRONMENT (CONTINUED)									
Map #	Asset Category	Asset Name	Asset Description	Flood Depths on Parcel	Exposure	Sensitivity	Vulnerability Rating	Consequences	Consequences Rating
66	Institutional/Cultural/Gov't (Religious Site with Historic Significance)	Bethlehem African Methodist Episcopal Church	Historic church, one of the oldest African-American churches in the state and Burlington's oldest African-American institution, located at 213 Pearl Blvd.	0 ft - 2.5 ft	Virtually the entire site may be flooded, and the buildings may be receive up to 2 ft of water.	Many of these buildings contain vulnerable stone foundations; however, some historic buildings were constructed with more durable materials than modern buildings. More information is needed on the durability of the buildings' materials and the degree to which the buildings are elevated above floodwaters.	Low to Moderate	As historic and religious structures, the loss of these buildings would be a notable cultural and religious loss to the region.	Moderate (relative to other historical and cultural assets)
67		Friends Meeting House	Historic Quaker meetinghouse, located at 340 High St.	0 ft - 0.5 ft	No flooding is expected from coastal flooding or sea level rise.		Insignificant		Moderate (relative to other historical and cultural assets)
68		Friends School House	City-owned historic site and former Quaker schoolhouse, located at York St. between Penn and E. Union Sts.	0 ft - 2.6 ft	The building may be flooded by up to 1 ft.		Low to Moderate		Low to Moderate (relative to other historical and cultural assets)
69		St. Mary's Church, St. Mary's Guild Hall	Site includes Old St. Mary's, the oldest Episcopal church in New Jersey; New St. Mary's, a church designed by noted American architect Richard Upjohn, and St. Mary's Guild Hall, a community space. Located along W. Broad St between Talbot St. and Wood St.	0 ft - 3.2 ft	The Guild Hall may experience flooding of up to 1 ft in the southwest corner of the building. The cemetery may be flooded with up to 3 ft of water.		Insignificant to High		Moderate (relative to other historical and cultural assets)
70	Institutional/Cultural/Gov't (Schools)	Captain James Lawrence Elementary School	Public elementary school located at 316 Barclay St.	0 ft - 3.4 ft	Much of the parking lot and some of the southeast part of the building may be affected, mainly with depths of up to 1 ft.	More information is needed on the durability of the buildings' materials and the degree to which the buildings are elevated above floodwaters. At Samuel Smith Elementary School, the predicted flood depths could cause substantial damage to most buildings.	Low	Elementary-school students and staff would likely experience inconveniences for several weeks or months after the storm while any of the schools were being renovated to remove flooding damage. For Captain James Lawrence, Elias Boudinot, and St. Paul Elementary Schools, relocation would likely not be necessary given the predicted flooding. Relocation may be necessary for Holy Light Christian Academy and Samuel Smith Elementary School, but some of the other schools in the city could temporarily accept these students.	Minor
71		Elias Boudinot Elementary School	Public elementary school located at 213 W. Pearl St.	0 ft - 0.34 ft	The southeast corner of the school's parking lot may be flooded, but the building will not be affected.		Insignificant		Insignificant to Minor
72		Holy Light Christian Academy	Private elementary school located at 133 E. Union St.	0.7 ft - 2.6 ft	The building may receive up to 3 ft of flooding.		Low to Moderate		Minor
73		Samuel Smith Elementary School	Public elementary school located at 250 Farner Ave.	3.8 ft - 5.4 ft	The entire building will likely be flooded, and may receive between 4 and 6 ft of flooding.		Moderate to High		Minor
74		St. Paul Elementary School	Private Catholic elementary school at 250 James St.	0 ft - 2.8 ft	No flooding is anticipated beyond the northeast corner of the lot.		Insignificant		Minor

BUILT ENVIRONMENT (CONTINUED)									
Map #	Asset Category	Asset Name	Asset Description	Flood Depths on Parcel	Exposure	Sensitivity	Vulnerability Rating	Consequences	Consequences Rating
75	Institutional/ Cultural/Gov't (School and Place with Historical Significance)	Doane Academy/Former Temple B'Nai Israel	Private Episcopal school for Pre-K through 12th grade, located at 350 Riverbank Ave.	0 ft - 7.0 ft	Flooding with a depth of up to 3.5 ft may occur at the north entrances to the site. Flooding with a depth of up to 2 ft may occur in buildings at the east side of the site. Failure of the bulkhead along the Delaware River to the north may cause erosion at the site.	<p>While the Delaware River bulkhead is secure, the site will not likely be substantially damaged by flooding. With the exception of the buildings on the east side of the site, most flooding will likely be over parking lots and onto Riverbank, potentially making egress difficult.</p> <p>More information is needed on the durability of the buildings on the east side of the site, and the degree to which they are elevated above floodwaters. The city may want to consider the durability of all of the buildings campus, however, to determine potential impacts from erosion should the bulkhead fail.</p>	Low to High (higher if bulkhead fails)	As a historic synagogue, the structure would be a notable cultural and religious loss to the region. Students and staff might experience inconveniences from relocating for several weeks to several months after the storm while the school was being renovated in order to remove flooding damage. Other schools in the city could temporarily accept these students.	Minor to Moderate
76	Transportation (Bridges)	Burlington-Bristol Bridge	Bridge crossing the Delaware River.	0 ft	No flooding is expected from coastal flooding or sea level rise.	<p>The vulnerability of each bridge depends on whether overtopping occurs. The velocities of water associated with flooding of the Delaware River or Assiscunk Creek may also cause scouring of the bed of the waterway on which each bridge is anchored, potentially destabilizing it. If the deck of a bridge is overtopped, flood waters may also cause substantial pressure on the bridge, potentially leading to its destruction.</p>	Insignificant	<p>The Burlington-Bristol Bridge is a major bridge connecting New Jersey and Pennsylvania via NJ/PA Route 413. If this bridge were damaged from flooding, traffic would have to be rerouted to the Route 276 Bridge, or possibly the Palmyra Bridge, which would cause additional traffic congestion in the region. There would also be a substantial cost to replace it or any of the bridges.</p>	Moderate
77		E. Broad St./Columbus Rd. Bridge	Bridge crossing the Assiscunk Creek.	4.4 ft - 7.3 ft	The bridge may be faced with flooding of up to 7 ft.		Low to Moderate		Minor to Moderate
78		E. Pearl St. Bridge	Bridge crossing the Assiscunk Creek.	0 ft	No flooding is expected from coastal flooding or sea level rise.		Insignificant	<p>The E. Broad St./Columbus Rd. Bridge, E. Pearl St. Bridge, Mitchell Ave. Bridge, and NJ-130 Bridges all pass over the Assiscunk Creek and generally parallel each other. With this structural redundancy, the two most major effects of the damage of any one bridge from flooding would be the temporary inconvenience of rerouted traffic and the costs and time to restore the bridge. However, if the E. Pearl St. Bridge, Mitchell Ave. Bridge, or NJ-130 Bridge is overtopped, then it is likely that the other bridges have already been overtopped, leaving few or no means of crossing the Assiscunk Creek and providing more serious inconveniences to traveling through the city, particularly during a storm.</p>	Minor to Moderate
79		Jacksonville Rd. Bridge	Bridge crossing the Assiscunk Creek.	0 ft	No flooding is expected from coastal flooding or sea level rise.		Insignificant		Minor to Moderate
80		Mitchell Ave. Bridge	Bridge crossing the Assiscunk Creek.	0 ft	No flooding is expected from coastal flooding or sea level rise.		Insignificant		Minor to Moderate
81		NJ-130 Bridges	Two bridges crossing the Assiscunk Creek.	0 ft - 7.0 ft	The eastbound lanes may be faced with about 7 ft of flooding, but the westbound lanes will not be flooded.		Low to Moderate	<p>The flooding of the Jacksonville St. Bridge would eliminate the Jacksonville Rd. evacuation route south into Burlington Township. Drivers would have to find an alternate route.</p>	Minor to Moderate

BUILT ENVIRONMENT (CONTINUED)									
Map #	Asset Category	Asset Name	Asset Description	Flood Depths on Parcel	Exposure	Sensitivity	Vulnerability Rating	Consequences	Consequences Rating
82	Transportation (Roadways)	Federal St.	Roadway that historically floods frequently.	2.9 ft - 7.2 ft	Federal St. will continue to be flooded in this scenario. Sea level rise and storm surge is predicted to yield typical depths of 5 to 6 ft west of High St., and 3 to 5 ft east of High St.	<p>These streets currently get flooded, and flooding will only worsen with the addition of water from the combined effects of sea level rise and tidal storm surge. Extended periods of flooding, high-velocity floods, or flooding that parallels a road can cause erosion of roadway infrastructure, but the elevation of the roadways may prevent flooding from occurring.</p> <p>The area around Wood St. is particularly sensitive because it is underlain with pipes coming from the Sylvan Lakes in Burlington Township. The township lowers the water levels of those lakes through pipes when preparing for severe storms, adding additional volumes of water to Burlington City's stormwater infrastructure.</p>	Low to High	<p>Burlington City has a gridded road system, and drivers attempting to get around flooded streets would likely be able to reroute to other parallel roads. The inconveniences of traffic rerouting and delays on redundant unflooded roads would be temporary. However, residents living in the center of the city, where the flooding is expected to be deepest, should be evacuated well in advance of the storm, as there may be few unflooded routes for evacuation during a storm.</p>	Minor to Moderate
83		Keim Blvd.	Roadway that historically floods frequently.	0 ft - 8.9 ft	Outside of the blocks between Delaware Ave. W. and Pearl St., Keim Blvd. will continue to be flooded in this scenario. Sea level rise and storm surge is predicted to yield depths that gradually increase heading south and reach 5 to 6 ft south of Broad St. with some pockets of even greater depths on the north side of the Keim-Washington rotary.		Low to High		Minor to Moderate
84		Mitchell Ave.	Roadway that historically floods frequently.	0 ft - 4.4 ft	Mitchell Ave. will continue to flood in this scenario with storm surge and sea level rise, generally between 2 and 3 ft.		Low to High		Minor to Moderate
85		Wood St.	Roadway that historically floods frequently.	0 ft - 13.1 ft	Wood St. will continue to be flooded in this scenario. Sea level rise and storm surge is predicted to yield depths of 7 ft (and greater in some isolated locations) near the NJ-130 intersection. Flood depths will decrease south along the street, and are predicted to abate around the Fernwood Ave. intersection.		Low to High		Minor to Moderate
86	Utilities (Pump Stations)	Columbus Park Pump Station	Pump station located at Mount Rd.	0 ft - 7.4 ft	No flooding is expected from coastal flooding or sea level rise.	<p>More information is needed concerning the elevation of key infrastructure at the pump stations, and their resistance to floodwaters.</p>	Insignificant	<p>If the pumping station equipment were flooded, then homes and businesses in the affected neighborhoods would not have access to a main water source for days or weeks.</p>	Minor to Moderate
87		Fawn Hollow Pump Station	Pump station located at Bisbee Rd.	0 ft - 3.0 ft	No flooding is expected from coastal flooding or sea level rise.		Insignificant		Minor to Moderate
88		Mitchell Ave. Pump Station	Pump station located at Mitchell Ave.	0 ft - 4.4 ft	The pump station may experience between 2 and 3 ft of flooding.		Low to High		Minor to Moderate
89	Utility (Wastewater Treatment Plant)	Wastewater Treatment Plant (Burlington Township)	Located in Burlington Township along W. Broad St. and Devlin Ave. Treats wastewater for the township.	0 ft - 4.5 ft	The majority of the site may be flooded by approximately 0-2 ft.	<p>More information is needed on the durability of the building's materials, the degree to which the building is elevated above floodwaters, and the presence of any sensitive equipment. Burlington Township should match the elevation of each structure to its projected flood depths.</p>	Moderate to High	<p>The consequences to Burlington City depend on the degree to which Burlington City and Burlington Township rely on each other's water treatment plants as an emergency source for treating wastewater. Reciprocal agreements would reduce the consequences to Burlington City if its own plant failed, but such an agreement could potentially increase consequences to the city if Burlington Township's plant failed.</p>	Minor to Moderate
90	Utility (Water Treatment Plant)	Water Plant	Water treatment plant located at 601 E. Pearl St.	0 ft - 10.0 ft	The structures onsite may experience up to 3 ft of flooding, while the main building may be exposed to up to 1.5 ft.	<p>Many of the structures onsite are elevated, but more information is needed regarding the degree of elevation above potential flooding, the durability of structures that are in harm's way, and any vulnerable equipment stored onsite. However, the depths predicted onsite would not likely cause significant long-term damage. Increased depths near the entrance to the site may make egress a difficulty.</p>	Low to Moderate	<p>As a result of flooding, the residents and businesses who rely on municipal water would not have access to this particular water source for several days or weeks until the flooding abated and the city was able to adequately treat the water. The city would be required to seek an alternative source for those buildings during the period of reconstruction.</p>	Minor to Moderate

NATURAL ENVIRONMENT									
Map #	Asset Category	Asset Name	Asset Description	Flood Depths on Parcel	Exposure	Sensitivity	Vulnerability Rating	Consequences	Consequences Rating
91	Open Space and Habitat	Riparian Open Space and Habitat	Wetlands, shrubland, and forested areas located along the Assiscunk Creek.	0 ft - 9.1 ft	Much of the open space that will face coastal flooding is in the form of wetlands. These wetlands will continue to be flooded with increased depths, likely through 2100.	Most of the open space that may be affected by sea level rise and storm surge is already in the 100-year/1 percent floodplain, and wetland plant and animal species already in that floodplain should be somewhat adapted to flooding conditions, though not as much as species immediately on the waterfront.	Low to Moderate	<p>With most species likely to be reasonably tolerant of this extent of flooding, the basic functioning of ecosystems in the city will not likely be disrupted. However, if certain areas are permanently flooded that were not previously so, the change could disrupt normal ecosystem processes.</p> <p>Erosion of habitat, often wetlands, reduces the amount of open space that serves as a buffer between water bodies and neighborhoods, making the flooding of inland structures more probable.</p>	Insignificant to Moderate
VULNERABLE POPULATIONS & HOUSING FACILITIES									
92	Neighborhoods with Previous Flooding Issues	Columbus Park Neighborhood	Neighborhood that historically floods, located along the Assiscunk Creek. Malfunctioning of the existing levee currently causes flooding in the neighborhood.	0 ft - 5.7 ft	<p>Buildings on properties closest to the Assiscunk Creek, particularly along Duser Rd. and Valentine Rd., may experience up to 3 ft of flooding. Moving northeast inside the neighborhood, the elevation of the land increases, and buildings in that area will experience less flooding. Homes along the north sections of Holmes Dr., Columbus Rd., and Independence Dr., as well as Memorial Rd. and Armistice Rd., will experience little to no flooding. Roads in the neighborhood will be flooded about 1 ft more than parcels along them, making egress from the neighborhood a potential challenge during the storm.</p> <p>Repair to the levee would likely decrease this neighborhood's exposure to floodwaters.</p>	<p>In the Columbus Park neighborhood, homes do not contain basements, which reduces their sensitivity to flood damages.</p> <p>More information is needed on the durability of the buildings' materials, the degree to which they are elevated above floodwaters, and the demographics of the residents. If any residents do not have cars to evacuate, if they speak English as a second language, if they are a lower-income household, or if they have limited mobility, they may need additional resources from the city or a partner entity to evacuate before a storm.</p>	Low to High	While the storm may make some of the individual homes vulnerable, flood damages to these properties would be less likely to affect the city as a whole.	Minor to Moderate
93		Repetitive Loss Properties	Four clusters of properties that historically flood frequently, and have had two or more claims of more than \$1,000 that were paid by the National Flood Insurance Program (NFIP) within a ten-year period.	0 ft - 7.2 ft	All of the properties that Burlington City has previously recorded as Repetitive Loss Properties are anticipated to be flooded. For the properties between NJ-130 and Bordentown Rd., two structures will be entirely flooded while the remainder will only be partially flooded. Typical flood depths are expected to be up to 1 ft. For the properties along Columbus Rd., typical depths range from 0.5 to 2 ft. For the properties between Federal St. and Belmont St., typical depths are expected to be between 1.5 and 2.5 ft. For the properties between Juniper St. and Federal St., typical depths are between 4 and 5 ft, with some properties in the block bounded by Wood St. and Engle Ave. receiving above 7 ft of flooding.		Moderate to High		Minor

VULNERABLE POPULATIONS & HOUSING FACILITIES (CONTINUED)									
Map #	Asset Category	Asset Name	Asset Description	Flood Depths on Parcel	Exposure	Sensitivity	Vulnerability Rating	Consequences	Consequences Rating
94	Retirement Home and Institutional/Cultural/Gov't (Place with Historical Significance)	Blue Anchor Inn/Metropolitan Inn	Private historic site that was a well-known inn for over a century and is now a community for seniors aged 62 and older, located at the southwest corner of High and Broad Sts.	0 ft - 2.4 ft	The structure may experience flooding of up to 2.4 ft. As the flooding is in the front of the building, egress may be difficult for people with limited mobility.	<p>More information is needed on the durability of the buildings' materials and the degree to which the buildings are elevated above floodwaters.</p> <p>The location of the flooding in the New Yorkshire/Ward 1 neighborhood makes egress from the ward as much a challenge as potential property damage.</p> <p>Burlington City's Office of Emergency Management center uses Reverse 911, the Nixle subscription system, social media, and relationships with facilities in the floodplain in order to ensure that vulnerable individuals have evacuated prior to a storm.</p>	Moderate	<p>From a citywide standpoint, these properties do not make up a large portion of the residential population. While the storm may make some of the individual homes vulnerable, flood damages to these properties would be less likely to affect the city as a whole. However, flooding could cause substantial damage to some of the properties within the affected areas, and floods could more deeply effect these vulnerable residents.</p>	Minor
95	Retirement Homes	Burlington Manor Apartments	Affordable housing for seniors, people with disabilities, and families, located at 255 E. Pearl Blvd.	0 ft - 5.8 ft	The north extremities of the building may experience flooding of up to 1.5 ft; the east parking lot may experience flooding of up to 1 ft. The driveway onto Pearl Blvd. may have up to 1 ft of flooding, making egress a concern, particularly for residents with limited mobility.		Low to Moderate		Minor
96		J. Frank Budd	Retirement home for seniors aged 62 and older, located at 240 E. Pearl Blvd.	0 ft	No flooding is expected from coastal flooding or sea level rise.		Insignificant		Minor
97	Vulnerable Populations	New Yorkshire Neighborhood	This neighborhood is bordered by High St. to the west, the Assiscunk Creek to the east, Broad St. to the north and NJ-130 to the south. Many of the households contain people who are elderly and/or do not own cars.	0 ft - 6.6 ft	The majority of the neighborhood will likely be flooded. Typical flooding depths range from 3 ft to 5 ft.		Moderate to High		Minor to Moderate



Appendix B

Appendix B: Vulnerability and Consequences Rating Keys

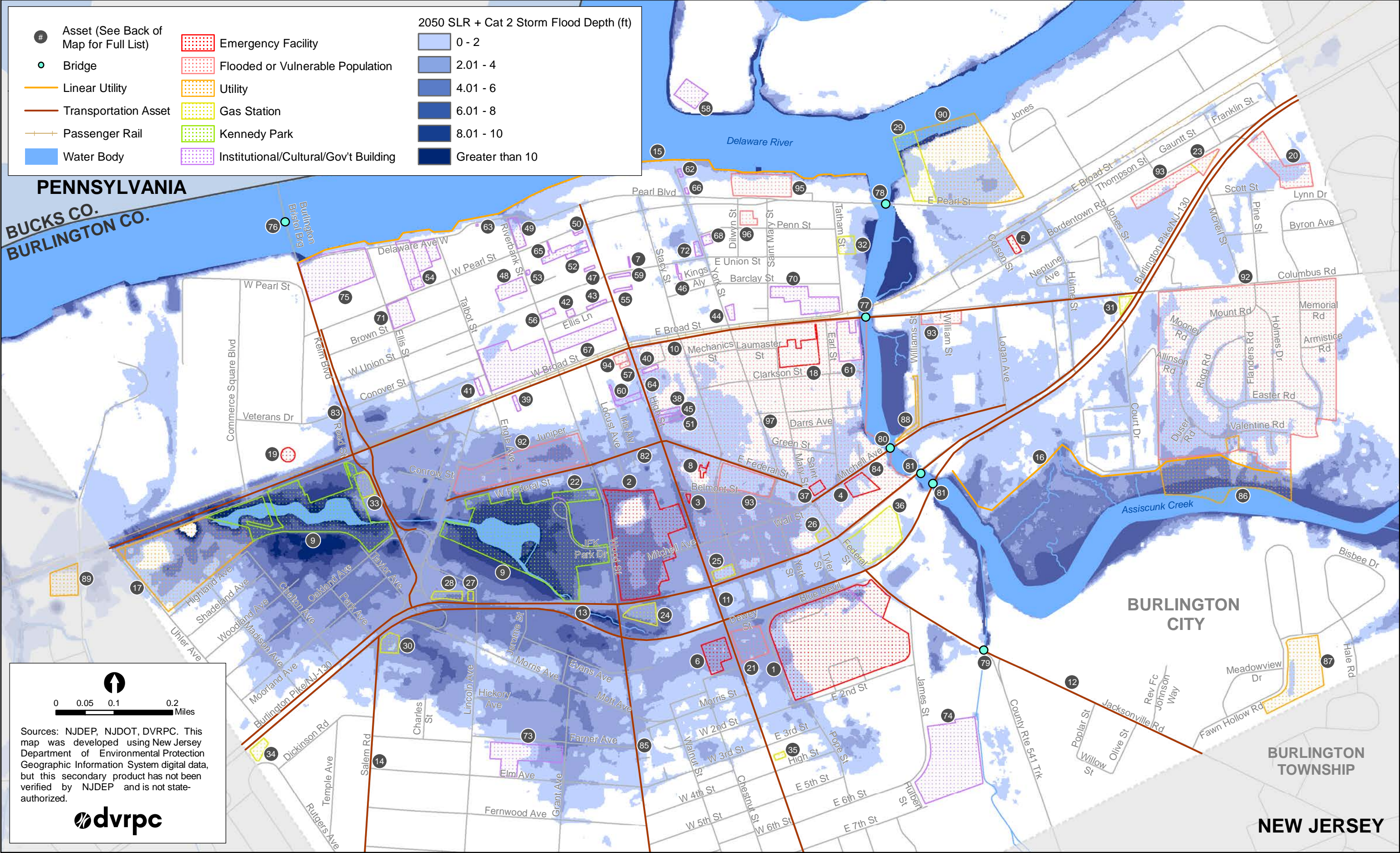
Vulnerability Rating Key	
Level	Vulnerability Rating Given Hazard Exposure and Sensitivity
Insignificant	<p><i>Exposure to Flooding:</i> This community asset is located out of harm's way.</p> <p><i>Physical/Structural Damage:</i> No physical or structural damages expected.</p> <p><i>Disruption/Impairment:</i> No disruption in function, accessibility, or development and delivery of basic services and supplies. No apparent impacts to services, typical operations, routine, or daily life.</p> <p><i>Accessibility:</i> Key staff members are able to access facilities or locations without interruption.</p>
Low	<p><i>Exposure to Flooding:</i> Majority of this community asset is located out of harm's way.</p> <p><i>Physical/Structural Damage:</i> Minor physical or structural damages expected.</p> <p><i>Disruption/Impairment:</i> Limited disruption in function, accessibility, or development and delivery of basic services and supplies. Limited impacts to typical operations, routine, or daily life, if any.</p> <p><i>Accessibility:</i> Key staff members are able to access facilities or locations with minimal interruption.</p>
Moderate	<p><i>Exposure to Flooding:</i> Significant portion of this community asset is located in harm's way.</p> <p><i>Physical/Structural Damage:</i> Moderate physical or structural damages are sustained.</p> <p><i>Disruption/Impairment:</i> Moderate level of disruption to accessibility or mobility of asset, amenity, or population. Moderate level of interruptions to development and delivery of basic services and supplies. Typical operations, routine, or daily life are moderately affected by flood hazard scenario.</p> <p><i>Accessibility:</i> Secondary evacuation and access routes available for use if or when primary systems fail.</p>
High	<p><i>Exposure to Flooding:</i> Majority of this community asset is located in harm's way.</p> <p><i>Physical/Structural Damage:</i> Severe level of harms (destruction of property, degradation of function, and/or injury) expected, resulting in high degree of loss. Asset, amenity or population is unable to withstand flood impacts.</p> <p><i>Disruption/Impairment:</i> Severe, potentially irreparable challenges faced, requiring significant changes to asset functioning and community's daily life, yielding a "new normal." Production, provision of services, or daily routine expected to sustain high degree of disruption. Significantly reduced operational capacity of community assets and amenities; long-term or permanent relocation of asset, amenity, or population.</p> <p><i>Accessibility:</i> Severe disruptions to accessibility of asset, amenity, or population, or the disruption of this asset, cause accessibility issues to other community assets. Key individuals, material supplies, core operating systems, and functioning interrupted or unavailable.</p>

Consequences Rating Key		
Level		Given Vulnerability of Assets, Rate the Magnitude or Severity of Consequences
1	Insignificant	<p><i>Injuries & Fatalities:</i> Only minor injuries, if any.</p> <p><i>Property Damages:</i> Only minor property damage.</p> <p><i>Population Displacement:</i> No population displacement.</p> <p><i>Public Health:</i> Human health impacts are negligible or not measurable.</p> <p><i>Economy:</i> Little to no impacts to major and local businesses. No loss of services.</p> <p><i>Typical Operations/Daily Life:</i> No impacts or disruptions to typical operations, routine, or daily life.</p> <p><i>Environment:</i> No lasting environmental degradation.</p> <p><i>Emergency Response:</i> No adverse effects to emergency response.</p> <p><i>Hazardous Materials:</i> No increase or change in community or ecosystem exposure to toxins or hazardous materials.</p> <p><i>Municipal Budget:</i> Negligible operational costs.</p>
2	Minor	<p><i>Injuries & Fatalities:</i> Minor injuries, limited in geographic scope and/or affected population(s).</p> <p><i>Property Damages:</i> Limited property in narrow affected area damaged or destroyed.</p> <p><i>Population Displacement:</i> Temporary displacement of a small portion of the population.</p> <p><i>Public Health:</i> Measurable but minor adverse human health effects and increase of disease.</p> <p><i>Economy:</i> Minor impacts to major and local businesses. Minor interruption of supply and services.</p> <p><i>Typical Operations/Daily Life:</i> Limited disruption to typical operations, routine, or daily life.</p> <p><i>Environment:</i> Minor damage or loss to habitat and species or functioning of the systems as a component of "green" infrastructure of the community. Small loss of natural resource base. Increased, but tolerable, stress on ecosystem.</p> <p><i>Emergency Response:</i> Slight decrease in emergency response times and effectiveness.</p> <p><i>Hazardous Materials:</i> Limited hazardous materials spill, manageable cleanup and remediation.</p> <p><i>Municipal Budget:</i> Additional but tolerable operational costs.</p>
3	Moderate	<p><i>Injuries & Fatalities:</i> Multiple deaths or injuries possible over a broad population.</p> <p><i>Property Damages:</i> Substantial property in affected area damaged or destroyed.</p> <p><i>Population Displacement:</i> Long-term population displacement over a broader segment of the population.</p> <p><i>Public Health:</i> Human health impacts are widespread, including increased risk of the spread of communicable diseases. Extended interruption of supply and services.</p> <p><i>Economy:</i> Disruptions to major and local businesses.</p> <p><i>Typical Operations/Daily Life:</i> Operations, routine, or daily life affected such that only redundant or alternative systems can be used for an extended duration. Highly vulnerable services, businesses, and populations suffer heavy adverse impacts while less sensitive systems seek alternative arrangements.</p> <p><i>Environment:</i> Major damage or loss of habitat or functioning of the systems as a component of "green" infrastructure of the community that may be permanent with adverse impacts. Large loss of natural resource base.</p> <p><i>Emergency Response:</i> Emergency response is strained and may result in significant degradation of response effectiveness and times.</p> <p><i>Hazardous Materials:</i> Large hazardous material spill with significant risk to humans and ecosystems.</p> <p><i>Municipal Budget:</i> High operational costs straining local budgets.</p>
4	High	<p><i>Injuries & Fatalities:</i> High number of deaths or injuries possible across a wide population.</p> <p><i>Property Damages:</i> Majority of property in affected area damaged or destroyed.</p> <p><i>Population Displacement:</i> Permanent and widespread population displacement.</p> <p><i>Public Health:</i> Widespread adverse and significant health impacts, possibly including spread of communicable disease.</p> <p><i>Economy:</i> Major loss of local businesses.</p> <p><i>Delivery of Services:</i> Long-term interruption of supply and services.</p> <p><i>Typical Operations/Daily Life:</i> Majority of community operations, routines, or daily life patterns intensely impacted for an extended period. Highly vulnerable services, businesses, and populations unlikely to bounce back from shock.</p> <p><i>Environment:</i> Permanent degradation of habitat and species or functioning of the systems as a component of "green" infrastructure of the community. Majority destruction of critical natural resources base.</p> <p><i>Emergency Response:</i> Need for emergency services exceeds full capacity, and/or services are degraded and not functioning.</p> <p><i>Hazardous Materials:</i> Hazardous material spill that requires multi-year cleanup and poses significant health or ecosystem risk.</p> <p><i>Municipal Budget:</i> Operational costs exceed funding and place local government into adverse long-term financial conditions.</p>



Appendix C

Figure C1: Burlington City with Flooding from Sea Level Rise in 2050 and a Category 2 Storm



Top Areas of Concern

Emergency Facilities (Designated Emergency Shelters) and Institutional/Cultural/Gov’t (Schools)

- 1: Burlington City High School
- 2: Wilbur Watts Intermediate School

Emergency Facilities (Fire Departments)

- 3: Fire Building
- 4: Mitchell Fire Company
- 5: Neptune Hose Company 5
- 6: Niagara Hose Company 6

Emergency Facility (Fire Department) and Institutional/Cultural/Gov’t (Place with Historic Significance)

- 7: Endeavor Emergency Squad and Fire Company - Brickwall Tavern

Emergency Facility (Police, Designated Emergency Shelter) and Institutional/Cultural/Gov’t (Civic Building)

- 8: Burlington City Municipal Building and Police Department

Park and Utility (Flood Control Structure)

- 9: Kennedy Park

Transportation (Designated Evacuation Routes)

- 10: Broad St.
- 11: High St./NJ Route 541
- 12: Jacksonville Rd.
- 13: NJ Route 130
- 14: Salem Rd.

Utility (Flood Control Structure)

- 15: Bulkhead
- 16: Levee

Utility (Wastewater Treatment Plant)

- 17: Wastewater Treatment Plant (Burlington City)

Built Environment

Communications Infrastructure

- 18: Cecchi Building (Installed Cell Antenna)
- 19: Veterans Drive Water Tower (Installed Cell Antenna)

Emergency Facilities (Hospitals)

- 20: Burlington North Dialysis
- 21: Southern Jersey Medical Centers

Institutional/Cultural/Gov’t

- 22: Keegan Recreation Center

Hazardous Sites (Gas and Oil Stations and Distributors)

- 23: American Tire
- 24: Burlington Getty
- 25: Burlington Gulf

26: Burlington Sunoco

- 27: Cenco Heating Oil
- 28: Citgo On the Go
- 29: Curtin Marina
- 30: Exxon
- 31: Gasko of Burlington
- 32: Lester Fellows
- 33: Lukoil
- 34: PEH Corp
- 35: US Gas IV
- 36: Wawa Fuel

Institutional/Cultural/Gov’t (Civic Building), Communications Infrastructure

- 37: Burlington City Public Works (and Installed Cell Antenna)

Institutional/Cultural/Gov’t (Current or Former Homes with Historic Significance)

- 38: Bard-How House
- 39: Biddle-Pugh House
- 40: Bloomfield-Birch House
- 41: Boudinot-Bradford House
- 42: Carriage House
- 43: Nathaniel Coleman House
- 44: Isaac Collins House
- 45: James Fenimore Cooper House
- 46: Oliver Cromwell House
- 47: Gardiner House
- 48: Gummere House
- 49: Grubb Estate
- 50: Hoskins House
- 51: Capt. James Lawrence House
- 52: Dr. Pugh House
- 53: Revell House
- 54: Riverbank Houses
- 55: Dr. Smith House
- 56: Ulysses Grant House

Institutional/Cultural/Gov’t (Other Place with Historic Significance)

- 57: Alcazar Building
- 58: Burlington Island
- 59: Burlington Pharmacy
- 60: H. T. Costello-Lyceum Hall
- 61: Old Barracks Site
- 62: Oneida Boat Club
- 63: Ship "Shield" Marker
- 64: Statue of Mercury
- 65: Temple B’Nai Israel (Former)

Institutional/Cultural/Gov’t (Religious Site with Historic Significance)

- 66: Bethlehem African Methodist Episcopal Church
- 67: Friends Meeting House
- 68: Friends School House
- 69: St. Mary's Church, St. Mary's Guild Hall

Institutional/Cultural/Gov’t (Schools)

- 70: Captain James Lawrence Elementary School
- 71: Elias Boudinot Elementary School
- 72: Holy Light Christian Academy
- 73: Samuel Smith Elementary School
- 74: St. Paul Elementary School

Institutional/Cultural/Gov’t (School and Place with Historical Significance)

- 75: Doane Academy

Transportation (Bridges)

- 76: Burlington-Bristol Bridge
- 77: E. Broad St./Columbus Rd. Bridge
- 78: E. Pearl St. Bridge
- 79: Jacksonville Rd. Bridge
- 80: Mitchell Ave. Bridge
- 81: NJ Route 130 Bridges

Transportation (Roadways)

- 82: Federal St.
- 83: Keim Blvd.
- 84: Mitchell Ave.
- 85: Wood St.

Utilities (Pump Stations)

- 86: Columbus Park Pump Station
- 87: Fawn Hollow Pump Station
- 88: Mitchell Ave. Pump Station

Utility (Wastewater Treatment Plant)

- 89: Wastewater Treatment Plant (Burlington Township)

Utility (Water Treatment Plant)

- 90: Water Plant

Natural Environment

Open Space and Habitat

- 91: Riparian Open Space and Habitat

Neighborhoods, Vulnerable Populations, and Housing Facilities

Neighborhoods with Previous Flooding Issues

- 92: Columbus Park Neighborhood
- 93: Repetitive Loss Properties

Senior Center and Institutional/Cultural/Gov’t (Place with Historical Significance)

- 94: Blue Anchor Inn/Metropolitan Inn

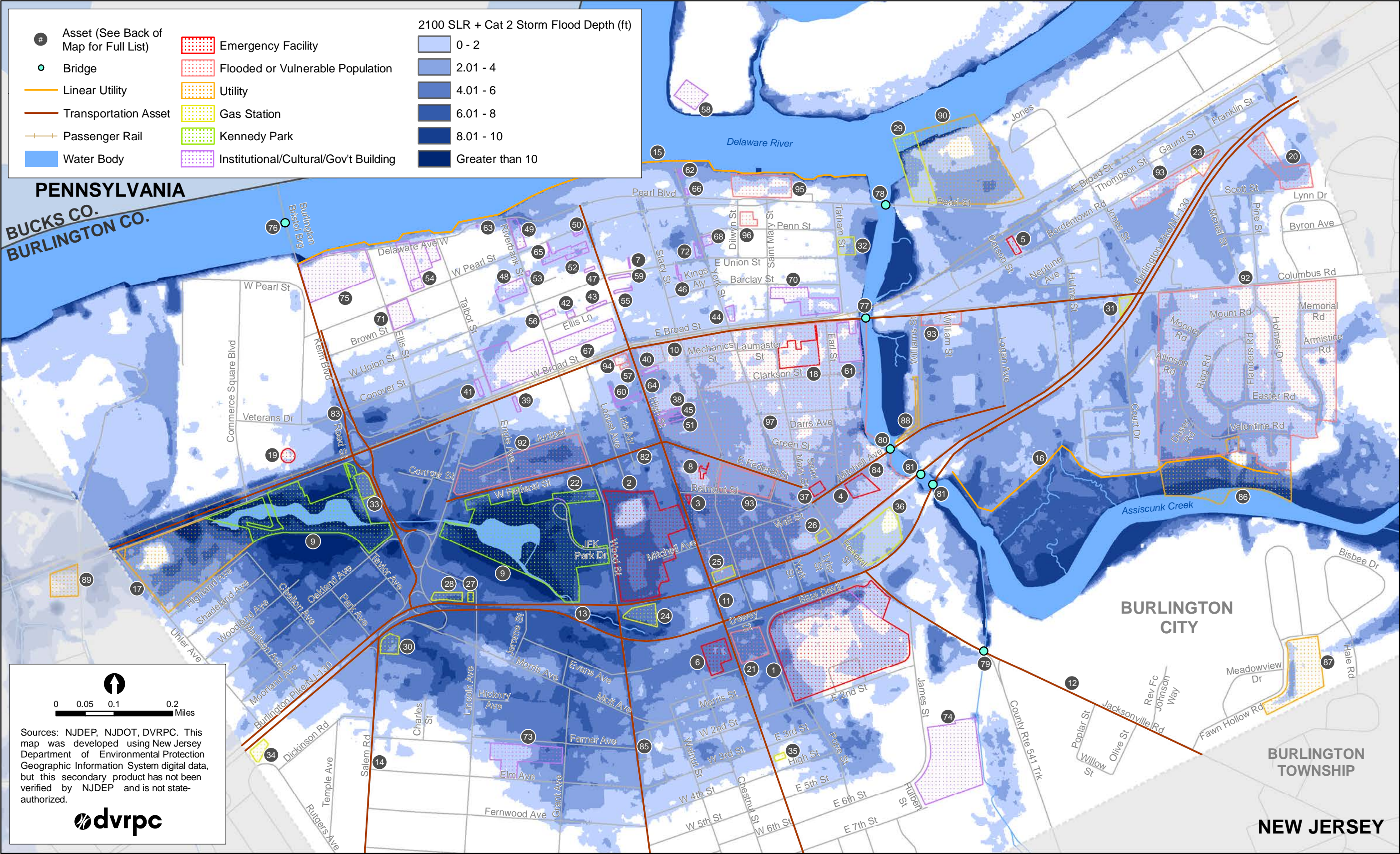
Retirement Homes

- 95: Burlington Manor Apartments
- 96: J. Frank Budd

Vulnerable Populations

- 97: New Yorkshire Neighborhood/Voting Ward 1

Figure C2: Burlington City with Flooding from Sea Level Rise in 2100 and a Category 2 Storm



Top Areas of Concern

Emergency Facilities (Designated Emergency Shelters) and Institutional/Cultural/Gov’t (Schools)

- 1: Burlington City High School
- 2: Wilbur Watts Intermediate School

Emergency Facilities (Fire Departments)

- 3: Fire Building
- 4: Mitchell Fire Company
- 5: Neptune Hose Company 5
- 6: Niagara Hose Company 6

Emergency Facility (Fire Department) and Institutional/Cultural/Gov’t (Place with Historic Significance)

- 7: Endeavor Emergency Squad and Fire Company - Brickwall Tavern

Emergency Facility (Police, Designated Emergency Shelter) and Institutional/Cultural/Gov’t (Civic Building)

- 8: Burlington City Municipal Building and Police Department

Park and Utility (Flood Control Structure)

- 9: Kennedy Park

Transportation (Designated Evacuation Routes)

- 10: Broad St.
- 11: High St./NJ Route 541
- 12: Jacksonville Rd.
- 13: NJ Route 130
- 14: Salem Rd.

Utility (Flood Control Structure)

- 15: Bulkhead
- 16: Levee

Utility (Wastewater Treatment Plant)

- 17: Wastewater Treatment Plant (Burlington City)

Built Environment

Communications Infrastructure

- 18: Cecchi Building (Installed Cell Antenna)
- 19: Veterans Drive Water Tower (Installed Cell Antenna)

Emergency Facilities (Hospitals)

- 20: Burlington North Dialysis
- 21: Southern Jersey Medical Centers

Institutional/Cultural/Gov’t

- 22: Keegan Recreation Center

Hazardous Sites (Gas and Oil Stations and Distributors)

- 23: American Tire
- 24: Burlington Getty
- 25: Burlington Gulf

26: Burlington Sunoco

- 27: Cenco Heating Oil
- 28: Citgo On the Go
- 29: Curtin Marina
- 30: Exxon
- 31: Gasko of Burlington
- 32: Lester Fellows
- 33: Lukoil
- 34: PEH Corp
- 35: US Gas IV
- 36: Wawa Fuel

Institutional/Cultural/Gov’t (Civic Building), Communications Infrastructure

- 37: Burlington City Public Works (and Installed Cell Antenna)

Institutional/Cultural/Gov’t (Current or Former Homes with Historic Significance)

- 38: Bard-How House
- 39: Biddle-Pugh House
- 40: Bloomfield-Birch House
- 41: Boudinot-Bradford House
- 42: Carriage House
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- 55: Dr. Smith House
- 56: Ulysses Grant House

Institutional/Cultural/Gov’t (Other Place with Historic Significance)

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- 59: Burlington Pharmacy
- 60: H. T. Costello-Lyceum Hall
- 61: Old Barracks Site
- 62: Oneida Boat Club
- 63: Ship "Shield" Marker
- 64: Statue of Mercury
- 65: Temple B’Nai Israel (Former)

Institutional/Cultural/Gov’t (Religious Site with Historic Significance)

- 66: Bethlehem African Methodist Episcopal Church
- 67: Friends Meeting House
- 68: Friends School House
- 69: St. Mary's Church, St. Mary's Guild Hall

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- 72: Holy Light Christian Academy
- 73: Samuel Smith Elementary School
- 74: St. Paul Elementary School

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Utility (Water Treatment Plant)

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Natural Environment

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- 91: Riparian Open Space and Habitat

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- 93: Repetitive Loss Properties

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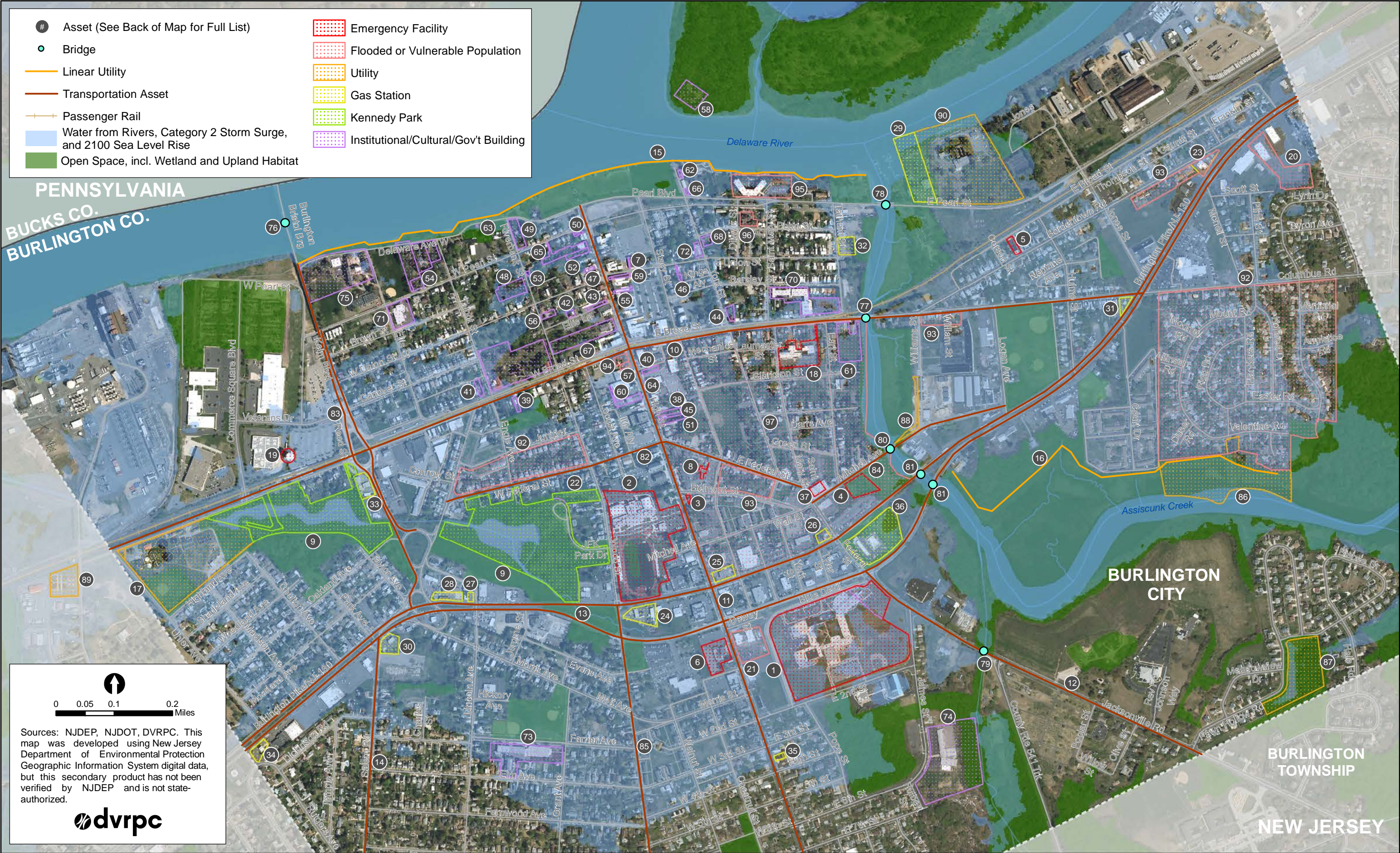
Retirement Homes

- 95: Burlington Manor Apartments
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Vulnerable Populations

- 97: New Yorkshire Neighborhood/Voting Ward 1

Figure C3: Burlington City with Aerials, Open Space, and a Flood Scenario of Sea Level Rise in 2100 with a Category 2 Storm (Extent Only)



Top Areas of Concern

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- 91: Riparian Open Space and Habitat

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Neighborhoods with Previous Flooding Issues

- 92: Columbus Park Neighborhood
- 93: Repetitive Loss Properties

Senior Center and Institutional/Cultural/Gov’t (Place with Historical Significance)

- 94: Blue Anchor Inn/Metropolitan Inn

Retirement Homes

- 95: Burlington Manor Apartments
- 96: J. Frank Budd

Vulnerable Populations

- 97: New Yorkshire Neighborhood/Voting Ward 1

Burlington City Coastal Vulnerability Assessment Report

Publication Number: 17033

Date Published: December 2017

Geographic Area Covered:

Burlington City, Burlington County, New Jersey

Key Words:

Assiscunk Creek, Burlington City, Burlington County, Climate Change, Coastal Vulnerability Assessment, Delaware River, Environment, Flooding, Getting to Resilience, Hazard Mitigation, Municipal Planning, Natural Resources, New Jersey, Sea Level Rise, Waterfront

Abstract:

This report documents two tools, the coastal vulnerability assessment and Getting to Resilience Questionnaire, that DVRPC used in partnership with municipal staff and residents from Burlington City in 2015 to 2016. The narrative outlines projected effects of climate change in New Jersey, records Burlington's historic flooding issues and the actions it has taken to increase its resilience to floods, discusses the tools' methods and findings, and offers recommendations and assistance to implement them.

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