



BOROUGH
OF
KEYPORT

COASTAL VULNERABILITY ASSESSMENT



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Introduction

Superstorm Sandy caused extensive damage to the Borough of Keyport including extremely high flood levels of 6.7 feet above the Borough's waterfront promenade and wind damage to 113 properties and to Keyport's critical infrastructure. This damage accumulated a total of \$5,976,300 in property value loss. According to the Borough's Strategic Recovery Planning Report (SRPR) the Borough's wooden boardwalk and bulk heading were heavily damaged or lost during the storm. A total of 53 residential properties reported damage by flooding or other hazards. Additionally, 38 businesses reported damage from Superstorm Sandy. A majority had flood damage and a handful of businesses experienced structural damage. Two established retail and business areas of the Borough experienced the most damage. These areas can be identified as the lower portion of Front Street and Broad Street where the Division Street basin lies near the heart of downtown, and marine commercial uses along Keyport's waterways. Overall, the damage caused by Superstorm Sandy has largely been repaired but has caused great concern for future storms. This has prompted a large planning effort to increase resiliency, minimize storm and flood damage, and to implement shore protection projects.

The Borough of Keyport is taking full advantage of the Post Sandy Planning Assistance Grant (PSPAG) and completed its Strategic Recovery Planning Report (SRPR) which thoroughly outlines all Superstorm Sandy damage in an impact assessment for the Borough. Completion of the SRPR has allowed the Borough to pursue further planning grant funding to prepare plans that can improve Keyport's preparedness, resiliency, and sustainability. In addition to the PSPAG work, Keyport was awarded a Municipal Public Access Plan grant to prepare a public access plan which included the preparation of a Getting to Resiliency Report (GTR) in conjunction with the Jacques Cousteau National Estuarine Research Reserve (JCNERR). The Municipal Public Access Plan has been reviewed by NJDEP and the document outlines the Borough's current public access features, locations, and amenities while providing a framework to continue public access, improve public access locations, and plan for additional public access to the Raritan Bay and waterways in the Borough. Financial assistance for the MPAP and CVA provided by The Coastal Management Act of 1972, as amended, administered by the Office of Coastal Management, National Oceanic and Atmospheric Administration (NOAA) through the New Jersey Department of Environmental Protection, Coastal Management Program.

The GTR report is the product of several municipal meetings with JCNERR professionals and key municipal officials to fill out an extensive questionnaire relating to Keyport's outreach, mitigation, preparedness, mapping, and planning for flooding and severe storm events. The answers to this questionnaire were used by JCNERR to prepare a GTR report including extensive recommendations to improve Keyport's efficiency in the previously stated areas. The GTR report's recommendations should be implemented to the most practical extent possible.

This leads to this Coastal Vulnerabilities Assessment, or CVA. This CVA will build off of the work done in the SRPR, PSPAG documents, the MPAP, and the GTR to fully catalog Keyport's biggest vulnerabilities, identify objectives to mitigate the known vulnerabilities, and to set forth an adaptation plan to implement in the future. The Borough of Keyport has recognized it is vulnerable to Hurricanes, or Northeasters, and their associated hazards that affect the Borough's coastline along the Raritan Bay. The Borough has

accepted the possibility that these types of storms will occur more frequently due to climate change impacts. This Coastal Vulnerabilities Assessment main purpose is to identify all vulnerabilities related to extreme precipitation events, storm surge, and flooding events in order to prepare a plan to reduce Keyport’s vulnerability to major storm events that are likely to increase in the near future due to climate change.



Aerial Photo of Keyport Borough from Bing Maps

Community Description

As of the 2010 Decennial Census, the Borough of Keyport had a population of 7,240 residents. According to the Master Plan, Keyport experienced a reduction of 4% in its population and housing units since the 2000 Census. Currently, it is estimated the Borough is home to 7,162 residents. The Borough is located on the southern shore of the Raritan Bay and is bordered by Aberdeen Township to the west, Hazlet to the south, and Union Beach to the east. New Jersey State Highways 35 and 36 run through the Borough near the southern border with Hazlet Township and provides easy access to the Garden State Parkway which is just outside the Borough’s southern border.

The Borough of Keyport is a Bayfront community, known as “The Pearl of the Bayshore”, that has thrived at the southern end of the Raritan Bay since its establishment in 1908. The Borough has a total of 2.5 miles of shoreline. In Keyport’s early years, the main economic driver was the oyster industry and was a major shipping center. The oyster industry eventually collapsed due to overfishing and pollution, but the Raritan Bay remains one of Keyport’s most important and precious assets. Keyport has endured many coastal storms, nor’easters, and hurricanes in its time including Hurricane Belle, Hurricane Floyd, Hurricane Irene, and Superstorm Sandy. Keyport has always recovered and bounced back from storm events, but Superstorm Sandy caused the most damage by far and has taken the longest recovery time.

Goals and Objectives

Vulnerability Assessment planning along coast lines is a relatively new planning tool that has really become prevalent in New Jersey in the aftermath of Superstorm Sandy. Improvements in GIS technology, data, and climate change research has given rise to excellent mapping tools that can assist municipalities in identifying its biggest threats from climate change events. The post Superstorm Sandy world of New Jersey has put an emphasis on climate change including how to deal or plan for more intense and frequent storm events, how to increase New Jersey's overall resiliency to major storm events that are expected to become more frequent, and how to implement an adaptation plan to mitigate coastal hazards to properly deal with the reality of a world in the mist of climate change. The main goal of this Coastal Vulnerability Assessment is to clearly identify and recognize Keyport's vulnerabilities to flooding, storm surge, and other coastal hazards associated with extreme precipitation events and have at least a preliminary plan to address those vulnerabilities. The following are the goals and objectives of this Coastal Vulnerability Assessment.

1

Identify Coastal Vulnerabilities in the Borough of Keyport:

Objective: *Using the latest scientific data, mapping protocols, and past documents Keyport can complete and effectively identify its vulnerabilities to extreme precipitation events, storm surge, and flooding to find which areas are most vulnerable.*

2

Identify Specific Areas and Sectors Most Vulnerable to Climate Change Events:

Objective: *After the Borough identifies vulnerable areas than each area can be analyzed to find specific vulnerable sectors for each area. This is key to understanding how to increase an area's resiliency to climate change events and implement hazard mitigation techniques. Within each area are sectors such as critical infrastructure or vulnerable populations that are susceptible to climate change events.*

3

Prioritize Vulnerabilities to Determine Future Actions that Mitigate Risk:

Objective: *Prioritize the mitigation or reduction of vulnerabilities for all sectors throughout the Borough. Achieving this goal can lay the path to determine and inform future actions that mitigate the risk of extensive damage for future storm events.*

4

Develop Adaptation Strategies:

Objective: *Develop Adaptation Strategies for vulnerable areas or sectors that are identified in previous objectives, such as projects or policies that decrease vulnerability, reduce or mitigate the risk of natural coastal hazard damage, or increase the overall resiliency within the Borough of Keyport. This should include exploring the feasibility and benefits of living shoreline techniques that can reduce vulnerable area's flood hazards and sectors. An engineer or qualified professional should be consulted to determine if living shorelines can be effective along Keyport's coastline.*

The process of creating this Coastal Vulnerability Assessment and determining the goals and objectives included extensive coordination with NJDEP and DCA's PSPAG program who provided the funding and framework to prepare this Assessment. A significant contribution from JCNERR was given to Keyport by preparing the Getting to Resiliency report. This was crucial in identifying how Keyport can improve by highlighting the Borough's weaknesses in preparedness and other areas when it comes to major storm events. Finally, the process included input from key municipal officials and the community to understand the impacts they personally went through which can present vulnerabilities not observed by other stakeholders.

Stakeholder Engagement

In addition to the extensive coordination with NJDEP, JCNERR, and DCA for this Coastal Vulnerability Assessment, the Borough created a local planning team that became the Resiliency Sub-committee. The main purpose of the Resiliency Sub-committee is to provide assistance in preparing the Post Sandy Assistance Grant projects including the Master Plan, this Coastal Vulnerability Assessment, the Hazard Mitigation Plan, and the Borough's Neighborhood Plans. This provides these projects with valuable citizen knowledge that are incorporated into the Borough's Superstorm Sandy recovery, which the Borough's citizens experienced first-hand. In coordination with the local planning team, a Community Resiliency Meeting was held on June 30th, 2016 at the consolidated Firehouse located at 34 First Street in the Borough of Keyport. At this meeting, many residents came to provide input regarding the community's needs and issues with respect to recovery, resiliency, and hazard mitigation for coastal and natural hazards. The input and recommendations from residents have been included not only within this Plan, but throughout Keyport's Post Sandy Planning documents such as the Master Plan.

Existing Planning Actions

Getting To Resilience Recommendations Report

As a result of the damages caused in New Jersey by Superstorm Sandy in 2012, the Department of Environmental protection made funding available for those communities interested in taking steps to prepare for major storm events in the future. In 2014 the Borough of Keyport received a Municipal Public Access Grant from the NJDEP. Under this grant, Keyport was tasked with developing a "Getting to Resiliency Report" aimed at providing recommendations for increasing community resiliency as well as outreach efforts, mitigation and preparedness, municipal organization, planning, and updating FEMA flood mapping.

The Getting to Resiliency Report, which was prepared by the Jacques Cousteau National Estuarine Research Reserve (JCNERR) with the help of Keyport's municipal officials and professionals, discusses the inclusion of Coastal Hazards Mitigation into the planning process. Ensuring that coastal hazards are incorporated into municipal planning is critical for coastal and waterfront communities. A Coastal Vulnerability Assessment is the first step in this process, and the Getting to Resilience Recommendation Report begins to explore these concepts in some detail. According to that document it is recommended

that coastal hazards are addressed throughout all major planning documents including the master plan and emergency management plans. Keyport has received second round Post Sandy Planning Assistance Grant funds to prepare neighborhood plans, assist in preparing this CVA, and update its Master Plan which will allow Keyport to incorporate coastal hazard mitigation into its most important planning documents.

Also included in the recommendations of the GTR report is a brief sea level rise and vulnerability assessment. According to this section, sea level rise of up to 1.3 foot is expected by 2050 which will have major impacts on natural ecosystems, industrial areas, and residential communities located in tidal areas and adjacent wetlands and creeks. Modeling for 1 foot sea level rise indicated that low lying wetlands in Keyport will experience regular inundation, however wetlands are able to withstand such flooding to a certain degree. The “Getting to Resilience” report also incorporates a variety of maps displaying the effects of certain coastal hazards on the Borough of Keyport. These maps include 1-3 foot sea level rise with critical facilities, category 1-3 storm surge maps, marsh migration maps, primary flood insurance maps, and the extent of the Superstorm Sandy storm surge.

In addition to the GTR report, Keyport is in the midst of completing Post Sandy Planning Assistance Grant projects. This CVA will coordinate with those projects including the Master Plan, Hazard Mitigation Plan, Capital Improvement Plan, Neighborhood Plans, and all related PSPAG projects.

Sectors and Vulnerable Areas

When Superstorm Sandy hit Keyport it was only considered a tropical cyclone meaning it’s conceivable that bigger, more powerful storms have the potential to cause more extensive damage in the future. Keyport’s SRPR estimated the assessed value of property in Keyport still at risk of flooding is between \$19,268,400 and \$109,451,100. These numbers are much higher than the actual damage caused by Superstorm Sandy. This is an important observation because Superstorm Sandy was technically not a Hurricane even though it caused \$36.8 billion in damage to New Jersey which is the most in recent history. A large portion of Keyport’s land area and overall property valuation is still vulnerable and at risk to flooding and storm surge events. These at risk areas could experience even more detrimental damage than Superstorm Sandy if a Category 2 or 3 Hurricane were to hit the Borough. Although the Hazard Mitigation Plan does note that the probability of a Category 2 or 3 Hurricane hitting the Borough is low, it is still a possibility. The following sections of this report will describe, outline, and map each vulnerable area within Keyport and identify vulnerable sectors within each area. Keyport has been delineated into four neighborhoods per the recommendations of the Strategic Recovery Planning Report. In addition to these four neighborhoods, this CVA identifies four additional areas that are vulnerable to storm surge from a Category 3 or weaker Hurricane, or Sea Level Rise. The map on the following page delineates the neighborhoods and vulnerable areas one through four.

Beers Street Basin Neighborhood

The Beers Street Basin Neighborhood is located in the center of the Borough slightly west of Borough Hall. The Luppataong Creek is the western border with West Front Street acting as the northern border, Elizabeth Street is the southern border, and the eastern border is Kearney Street. The neighborhood is

categorized as mostly residential with some commercial establishments along West Front Street. Large residential developments are within the neighborhood including the Sandpiper development, 50 Beers Street Senior Apartment Complex, the 15 unit townhouse development known as 45 Beers Street that took 6 feet of water during Hurricane Sandy, and a number of single family homes. Additionally, the Beers Street Neighborhood encompasses vacant land along the Luppataong Creek and the Keyport Fishery. The defining feature of this neighborhood is the Luppataong Creek which floods the neighborhood, specifically Beers Street, regularly during normal storm events or even moon tides. This common flooding on Beers Street happens quite frequently and usually impedes pedestrian and vehicular traffic. Also, the Beers Street Neighborhood experienced severe flooding during the 1991 and 1992 Nor-easters, Hurricane Irene, and Hurricane Sandy.

Division Street Basin Neighborhood

The Division Street Basin Neighborhood is located in the center of the Borough. Its Northern border is East Front Street, the eastern border runs along Church Street, the southern border is 3rd Street, and its western border is Broad Street. The neighborhood consists of mainly commercial establishments including the eastern end of the downtown commercial district. The Division Street Basin Neighborhood's defining feature is the low lying area that acts as a basin. This low lying area, or basin, is created by a significant dip in Division Street between 3rd Street and East Front Street which in fact used to be a pond. This creates common flooding during heavy rain fall and chronic flooding during Nor'easters or Hurricanes such as Superstorm Sandy. Approximately eight (8) businesses were subject to flooding during Superstorm Sandy and some of these properties are Repetitive Loss properties as they have previously experienced damage in past storm events.

First Street Basin Neighborhood

The First Street Basin Neighborhood is located along the Raritan Bay coastline starting from the Hans Pederson Marina all the way to Cedar Street Park. Its Northern border is the Raritan Bay, its eastern border runs along Cedar Street, its Southern border is West Front Street into East Front Street and finally into First Street, and its western border is Broadway. The neighborhood encompasses the majority of the downtown commercial district, the Hans Pedersen Marina, Fireman's Park, the Waterfront Promenade including the municipal boat launch, Beach Park, Keyport Yacht Club, and the residential condo complexes and single family homes along or near the Raritan Bay. Approximately twenty properties were damaged during Superstorm Sandy with some of these properties being repetitive loss properties from prior storm events. This neighborhood includes many of the defining public waterfront areas and downtown commercial district that Keyport is known. Identifying coastal hazards in the neighborhood and making the First Street Neighborhood as resilient as possible is one of Keyport Borough's highest priorities.

Walnut-Oak Street Basin Neighborhood

The Walnut-Oak Street Basin Neighborhood is located in the eastern portion of the Borough along the Bayfront and bordered by the Chingarora Creek. This neighborhood includes the developed portion of the Aeromarine site which is a critical area due to the presence of brownfields. The open space to the northeast of the Aeromarine Site is included outside this neighborhood and will be known as Vulnerable Area 4.



Aberdeen Township

Union Beach Borough

Hazlet

Matawan Borough

Legend

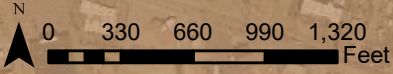
Neighborhood Boundaries

SRPR Neighborhoods

- Beers Street Basin Neighborhood
- Division Street Basin Neighborhood
- First Street Waterfront Neighborhood
- Walnut-Oak Street Basin Neighborhood

CVA Vulnerable Areas

- Vulnerable Neighborhood 1
- Vulnerable Neighborhood 2
- Vulnerable Neighborhood 3
- Vulnerable Neighborhood 4



The neighborhood's northern border is the Raritan Bay, the eastern border is the Chingarora Creek, its western border runs along Cedar Street and Fulton Street, and its southern border is 2nd Street. The neighborhood is defined by Cedar Street Park, the Bay frontage, the Chingarora Creek, and the former Aeromarine Redevelopment Area. The neighborhood mainly consists of residential uses, the Aeromarine site, open space, and wetlands along the Chingarora Creek. This neighborhood is very susceptible to flooding due to its low elevation and proximity to the Raritan Bay and Chingarora Creek. Approximately thirty (30) properties experienced damage during Superstorm Sandy and the neighborhood is prone to flooding along the creek due to poor stormwater management facilities. Also, the neighborhood lost its beach access at the terminus of Walnut Street due to Superstorm Sandy which should be restored for public access along the Raritan Bay. The ultimate goal of this neighborhood is to improve resiliency to the maximum extent possible and to redevelop the Aeromarine Redevelopment Area in the most resilient way that reflects the goals and objectives of the Aeromarine Redevelopment Plan.

Vulnerable Areas of Keyport Borough

In addition to the four neighborhoods delineated within the Borough's SRPR, there are additional areas of the Borough that are vulnerable to storm surge from a Category 3 or weaker hurricane and Sea Level Rise up to 3 feet. In order to include these areas in the vulnerability assessment, they were broken into four separate vulnerable areas. The following sections below describe each vulnerable area.

VULNERABLE AREA 1

The first vulnerable area encompasses a large land area within the western section of the Borough. Vulnerable Area 1 includes all land north of Route 35 and/or the Henry Hudson Trail and west of the First Street Neighborhood, Beers Street Neighborhood, and Kearney Street all the way to the western border of the Borough. The area is mainly comprised of residential single family homes and marinas along the Matawan Creek. There are some commercial entities along Route 35. This vulnerable area is mainly susceptible to storm surge from a Category 1, 2, or 3 Hurricane due to the proximity to the Luppatawong Creek and Matawan Creek. Two redevelopment areas are included in this vulnerable area, Brown's Point Marina Redevelopment Area and Longview/Boatworks Redevelopment Area. These redevelopment areas will conform to appropriate FEMA and Borough requirements for base flood elevations, but should be wary of Sea Level Rise increasing the threat of flooding. The main goal of Vulnerable Area 1 is to increase resiliency and ensure all redevelopment projects are resilient with sea level rise being accounted for as appropriate.

VULNERABLE AREA 2

The second vulnerable area is east of the first vulnerable area in the center of the Borough. This area is mainly comprised of residential uses with interspersed commercial uses at key intersections and closer to the downtown commercial district. The western boundary is Kearney Street and the Beers Street Neighborhood, the northern boundary includes West Front Street, Division Street Neighborhood, and First Street. The eastern boundary is Fulton Street and the Henry Hudson Trail runs along the entire southern boundary of Vulnerable Area 2. This vulnerable area is susceptible to storm surge from a Category 1, 2, 3, or 4 Hurricane. A small portion of this area is not vulnerable to any storm surge while a majority is vulnerable to the surge of a Category 3 Hurricane. Category 4 hurricanes are almost statistically impossible to hit Keyport Borough due to the fact that a storm loses its potency as it travels from the

ocean to the eastern seaboard. A Category 3 is possible but still statistically low. Regardless, it's important that this assessment identify all potential hazards so that the Borough residents are aware of these vulnerabilities and are able to adapt accordingly with the help of the Borough of Keyport.

VULNERABLE AREA 3

The third vulnerable area is located in the eastern part of Keyport Borough bordering Hazlet Township and the Chingarora Creek. This area is almost entirely residential with several large apartment or condo complexes, open space including a park and cemetery, and some commercial properties along Route 36. The western boundary is shared between a number of streets including Broad Street, Main Street, and Atlantic Street. The southern and eastern border is the Chingarora Creek which is also the border with Hazlet Township. The northern border is the Henry Hudson Trail and 2nd Street. This area is vulnerable to storm surge from a Category 3 Hurricane.

VULNERABLE AREA 4

The fourth and final vulnerable area is located in the very northeastern portion of the Borough which is the open space area of the Aeromarine Redevelopment Area. No uses currently exist in this vulnerable area. It consists of open space, a landfill, beaches, and vegetation. The borders include the Chingarora Creek, the Raritan Bay, and the developed portion of the Aeromarine Redevelopment Area. The entire area is vulnerable to storm surge for Category 2 or stronger Hurricane. A Category 2 will flood all areas closest to the Bay and creek with 6 to 9 feet or more and the uplands will flood with between 0 and 3 feet of water. A Category 3 would flood the entire Redevelopment Area with 6 feet or more of water. Storm surge would likely come over the hill and flood down to the developed portion of Aeromarine like it did in Sandy. Any redevelopment project should be prepared for such a scenario. Sea Level Rise will impact the entire area with the back portion adjacent to the Chingarora Creek being more affected than the Bay frontage due to the elevation changes. Although there are no uses that are vulnerable, this area may have future development and these future uses will be vulnerable.

Vulnerable Sectors

With the neighborhoods and vulnerable areas defined and set, the vulnerability assessment now identifies all possible sectors that may be affected by extreme precipitation events, sea level rise, storm surge, or common flood events. The six categories of vulnerable infrastructure, known as sectors, that may be located in any given neighborhood or area are critical buildings & infrastructure, community/emergency facilities, energy, stormwater, transportation, and vulnerable populations. It should be noted there are no hospitals within the Borough. The following table identifies all sectors in Keyport and what components are included within each sector.

| VULNERABLE SECTORS | COMPONENTS | |
|-------------------------------------|---|--|
| Critical Buildings & Infrastructure | <ul style="list-style-type: none"> • Borough Hall • Emergency Shelter/Operations Center • Water/Sewer Infrastructure | <ul style="list-style-type: none"> • Existing Hazard Mitigation Structures (Breakwaters, Bulkhead, etc.) • Water Treatment Plant |
| Community/Emergency Facilities | <ul style="list-style-type: none"> • Police • Fire | <ul style="list-style-type: none"> • EMS • Schools |
| Energy | <ul style="list-style-type: none"> • Electricity Supply including Substations • Renewable Energy Installations • Emergency Back-up Power | |
| Stormwater | <ul style="list-style-type: none"> • Stormwater Outfall Pipes • Drainage Areas/Common Flooding • Retaining Walls | |
| Transportation | <ul style="list-style-type: none"> • Evacuation Routes • Main Roadways • Bus Routes | |
| Vulnerable Populations | <ul style="list-style-type: none"> • Elderly and Disabled • Low-Income | |

The vulnerable sectors and each individual component in the table above will be reviewed throughout Keyport to determine the degree of vulnerability to sea level rise, storm surge, and overall flooding. This analysis is found in the Coastal Vulnerability Index section of this report. Prior to this analysis, an overall risk assessment is conducted below to identify all risks to coastal flooding, sea level rise, storm surge, and much more. Once all risks have been identified, vulnerable sectors and components will be added to identify degree of risk for each.

Risk Assessment

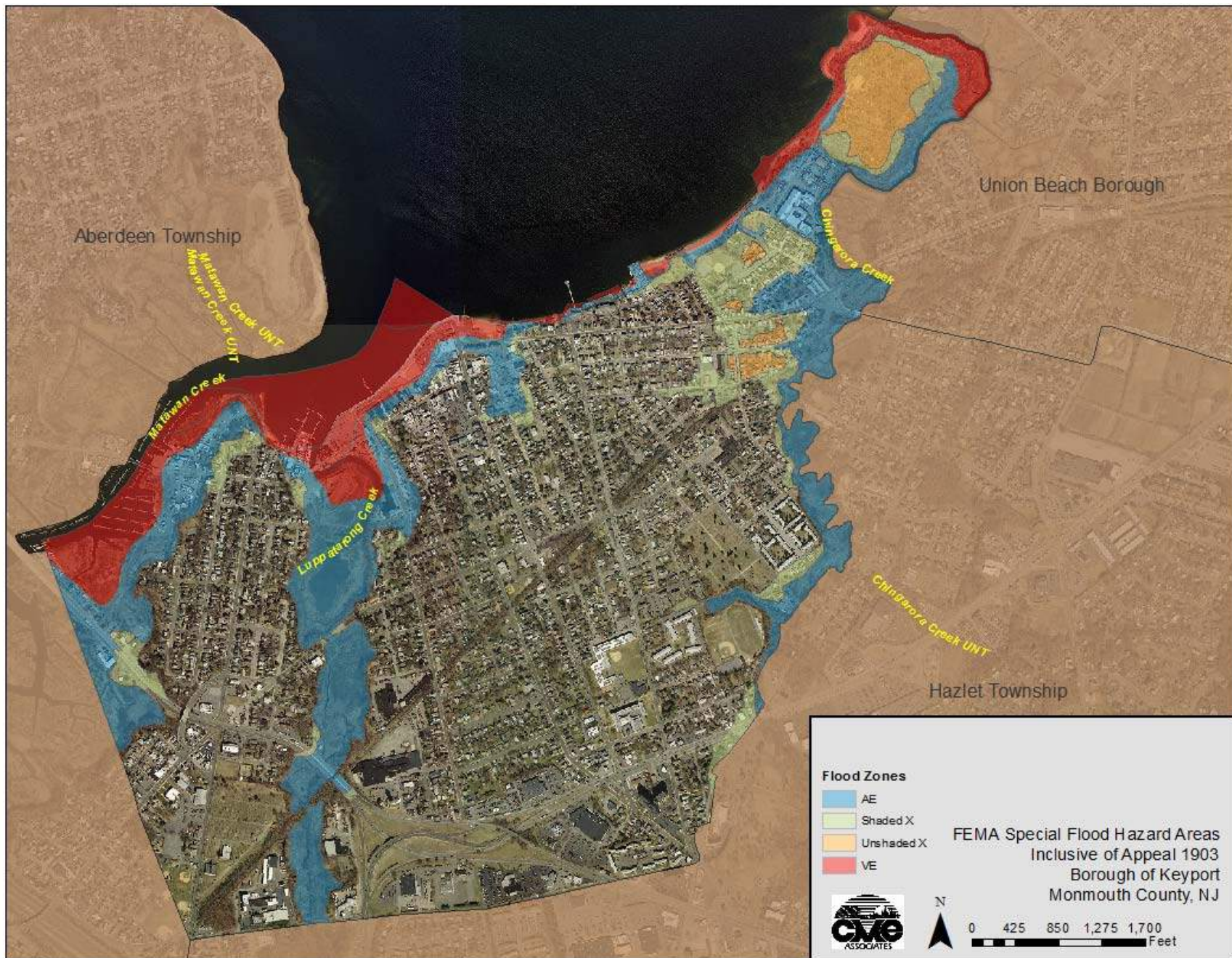
The National Oceanic and Atmospheric Administration, Office for Coastal Management provides coastal communities with the Coastal Flood Exposure Mapper. The Coastal Flood Exposure Mapper is an extremely informative GIS mapping tool which can show a variety of flood hazards that can impact coastal communities. This GIS tool was used extensively to produce maps, shown below, of Keyport’s different flood hazards and how it impacts the Borough’s sectors such as infrastructure, community facilities, and populations. In addition to the Coastal Flood Exposure Mapper, the New Jersey Flood Mapper and the Nature Conservancy’s Coastal Resilience Mapping Portal were also used for Keyport’s risk assessment. The Risk Assessment is broken down into different categories or flood hazards for Keyport.

Extreme Precipitation Events

One of the major effects of climate change is the increase in frequency and intensity of storms and extreme precipitation events. As evidenced by Superstorm Sandy, Keyport is susceptible to coastal flooding as a result of extreme precipitation. The map on page 12 shows high-risk (1% annual chance, or 100-year floodplain) flood zones included the VE Zone which includes wave action and the AE coastal flood zone. The map also shows Shaded X which is between the 100 year floodplain and the moderate-risk (0.2% annual chance, or 500-year floodplain) flood zone. Unshaded X is the 0.2% annual chance, or 500-year floodplain as designated by the Federal Emergency Management Agency (FEMA). It should be noted

that the 2015 PFIRMs were challenged by the Borough through appeal number 1903 which was accepted by FEMA. Official FEMA maps should be used to confirm flood zone designations and not the recreated map on page 12. The appeal included several properties along the Raritan Bay on 1st Street, between Broad Street and Cedar Street. These properties are now in the AE flood zone rather than the VE zone. However, these properties should still be fully prepared in the event of major storms or flood events. Portions of these flood zones may experience frequent flooding while other areas are only affected by severe storms such as Superstorm Sandy or Hurricanes. Areas outside of mapped zones are not exempt from risk as development throughout the Borough may have altered the flow of water and adjusted the flood zones after this map was made. Looking at the flood hazard map of Keyport below it is clear that the Borough is at risk of major flooding due to many factors including extreme precipitation events. Not surprisingly, the coastal and waterway areas are entirely within the “high risk” 100-year flood plain. It is important to keep in mind that flood zones will continue to increase in land area covered as sea level rise continues to ascend which may increase the intensity of future storms in terms of damage.

Figure 1 FEMA Flood Zones



Sea Level Rise and Storm Surge

Experts and climatologists anticipate that sea level rise could reach up to over one foot by the year 2050. Taking climate change into effect, sea levels could rise to as high as 3 feet by 2100. Even if these predictions are not accurate, the hard fact is that sea level will continue to rise as it has over the centuries. The question now is how fast, not if. Sea level rise and the resulting increased storm surges has the potential to have very significant effects on the Borough of Keyport, particularly in the low lying neighborhoods near streams and waterways that are vulnerable to flooding. Keyport's waterfront is obviously the most vulnerable to sea level rise and storm surge. A large portion of Keyport surrounding Chingarora Creek is very vulnerable to storm surge from any Hurricane or Nor'Easter. It's important to understand that increases in sea level rise simultaneously increases the amount of land affected by flooding and storm surge by a significant amount. Sea level rise can be very slow and gradual but its negative effects can be exponential. The neighborhoods or vulnerable areas of Keyport that would suffer the most from sea level rise are beaches, marinas, and homes along the Raritan Bay or the waterways that lead to the Raritan Bay. As shown in the Sea Level Rise map below, most of Keyport's existing neighborhoods would not be negatively affected. However, with sea level rise, even more of Keyport's land area will be susceptible to increased flooding and damage from major storm surges. Keyport's wetland network would likely absorb some of the expected sea level rise. However the mean high water line would migrate much closer to existing residential neighborhoods. This will dramatically increase the risk of significant damage from flooding because rising sea water will destroy freshwater wetlands and the ability to absorb the increased sea level will diminish. The following map below shows Sea Level Rise scenarios from 1 to 6 feet. This map was created using the Coastal Flood Exposure Mapper operated and funded by the National Oceanic and Atmospheric Administration. Other mapping tools such as NJ Flood Mapper show the same Sea Level Rise scenarios.

Figure 2 Sea Level Rise Scenarios

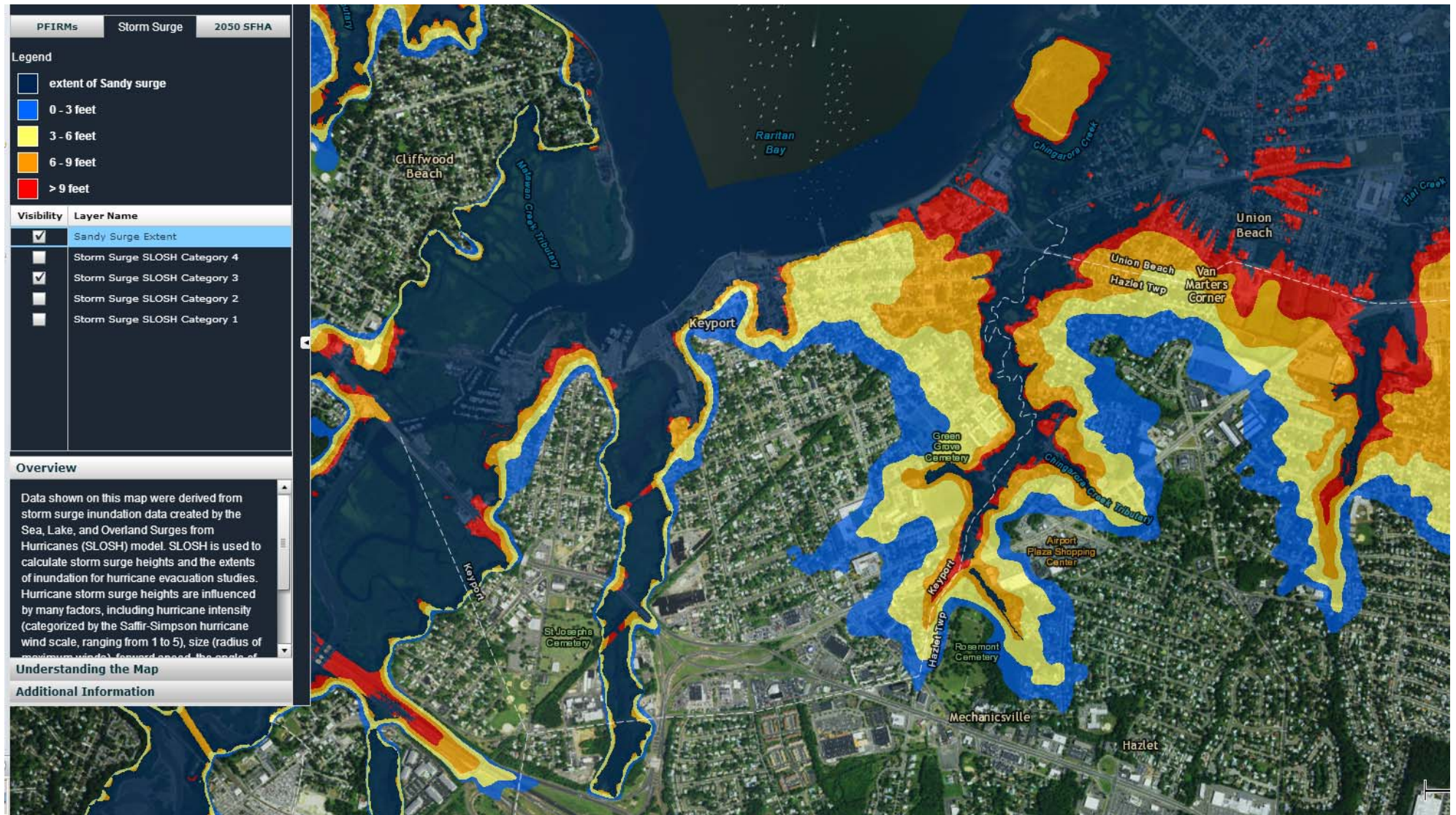


Within the Borough of Keyport, storm surge has the potential to affect all property along tidal creeks, wetlands, along the Raritan Bay, and beyond. Storm surge caused by a Category 2 storm or greater, may impede the Garden State Parkway (GSP) and roads that access the GSP. This would cause difficulty accessing Keyport during emergency situations and would make late evacuations nearly impossible. The map below presents storm surge scenarios for the Borough based on the severity of storm surge from a Category 3 Hurricane as stronger storms are almost statistically improbable. Additionally, another map (Figure 4) is presented that compares approximately where Superstorm Sandy's storm surge affected Keyport and how much more area can be affected by a more intense storm event. As shown in the second map, the dark blue is Superstorm Sandy's surge, and the other colors show the amount of flooding that can be expected during a Category 3 Hurricane. Figure 3 came from The Nature Conservancy's Coastal Resilience Mapping Tool and Figure 4 was created using Rutgers University's NJ Flood Mapper.

Figure 3 Storm Surge Scenarios



Figure 4 Comparisons of Superstorm Sandy and Category 3 Hurricane Storm Surges



Coastal Vulnerability Index

The Coastal Vulnerability Index is a tool used to rate the vulnerability of coastal areas throughout the State of New Jersey. This tool is meant to combine potential inundation scenarios and natural features of the landscape with historic flooding and erosion to determine a baseline of risk. This Coastal Vulnerability Index (CVI) is composed of six vulnerability attribute layers:

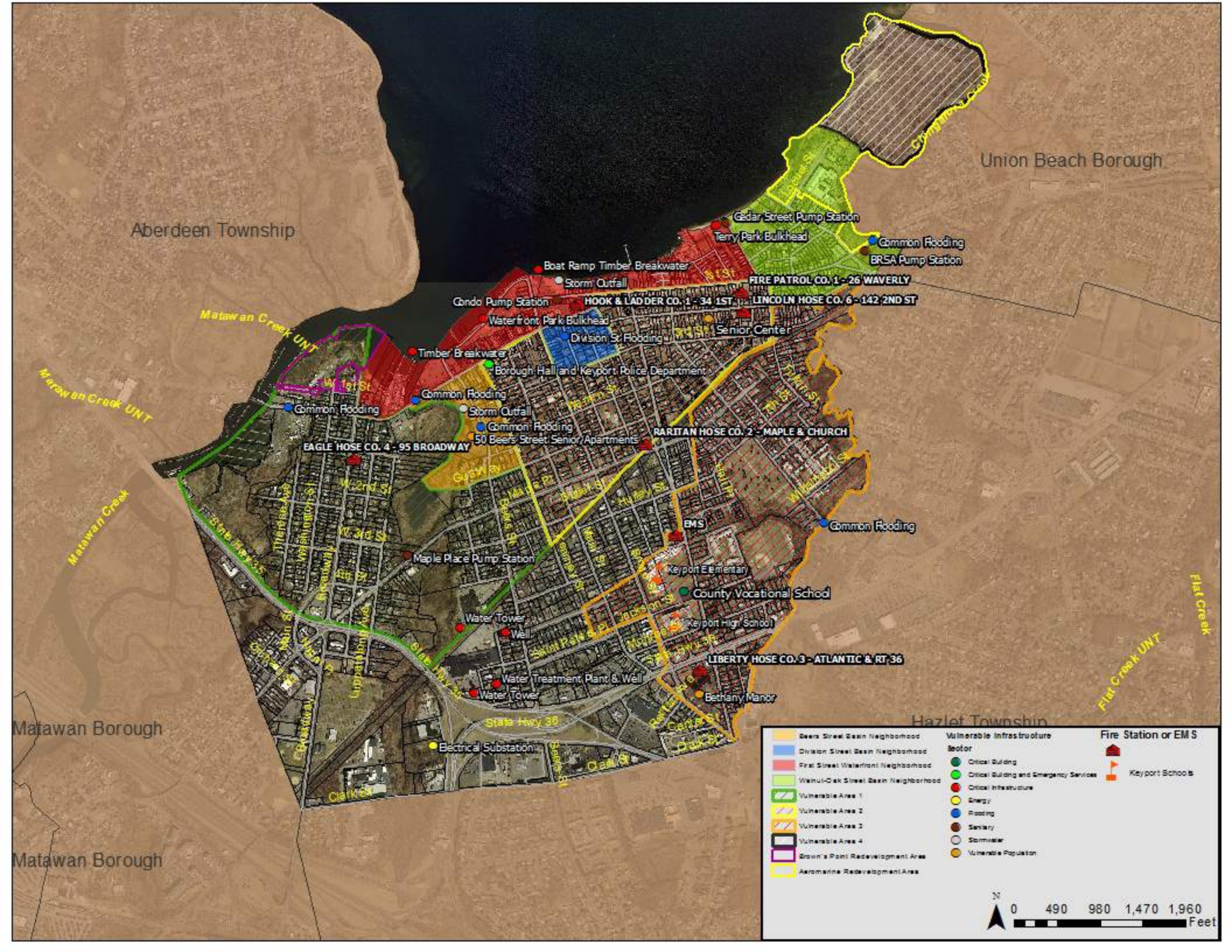
1. Flood prone areas (FEMA mapping)
2. Inundation (NOAA SLOSH Category 1-4, monthly mean higher high water, sea level rise)
3. Geomorphology (Type of shoreline)
4. Slope of the land (Steep or gentle grade)
5. Soil drainage
6. Soil erosion

The NJ Department of Environmental Protection, Coastal Management Program provides a variety of online tools available to New Jersey communities to review how vulnerable they may be to various coastal hazards. Restoration Explorer, discussed later, is a good tool that can be used to look at the geomorphology, slope, soil, and erosion of Keyport's coastline. Additionally, NOAA's Coastal Flood Exposure Mapper takes into account all of the above layers. The mapping within this Assessment therefore depicts Keyport's Coastal Vulnerability Index.

Vulnerability of Built Environment

The table on page 18 displays all vulnerable sectors, components, and critical facilities within the four identified neighborhoods and four identified vulnerable areas in the Borough of Keyport. The vulnerability assessment of the built environment was methodically created by using GIS layers of critical infrastructure, emergency facilities, and other crucial sectors of Keyport and comparing those locations with predicted sea level rise between one and three feet, and storm surges for Category 1, 2, and 3 Hurricanes. Sea Level Rise is predicted to rise to 1.3 feet as of 2050 according to the average of best case and worst case scenarios. By 2100, the average of the best and worst case scenarios predict 3 feet of Sea Level Rise. Therefore, Sea Level Rise above three feet was not included in the build environment vulnerability analysis. As for storm surge, SLOSH Models above a Category 3 Hurricane were not included in the analysis because the statistical probability of a CAT4 Hurricane hitting Keyport is impossibly low or very unlikely. Therefore, Storm Surge predictions were kept to a Category 3 or weaker Hurricane.

In conducting the Vulnerability Analysis of the Built Environment in Keyport, several sources were used to identify vulnerabilities of critical infrastructure and emergency facilities. The first source was for Sea Level Rise which can be found in Figure 2. This map was created using the Coastal Flood Exposure Mapper operated and funded by the National Oceanic and Atmospheric Administration. The assessment for SLOSH models or storm surge in Figure 3 was created from the Coastal Resilience Mapping Tool provided by the Nature Conservancy. Figure 4 was created from NJ Floodmapper which was put together by Rutgers University. Comparing the two figures, one will notice that Figure 3 from the Nature Conservancy includes more land area vulnerable to storm surge than Figure 4 from NJ Floodmapper by Rutgers. This



Aberdeen Township

Union Beach Borough

Matawan Borough

Hazlet Township

Matawan Borough

Matawan Creek
Matawan Creek UNT

Flat Creek
Flat Creek UNT

| | | |
|--------------------------------------|--|---------------------|
| Beers Street Basin Neighborhood | Vulnerable Infrastructure | Fire Station or EMS |
| Division Street Basin Neighborhood | Critical Building | Keyport Schools |
| First Street Waterfront Neighborhood | Critical Building and Emergency Services | |
| Walnut-Oak Street Basin Neighborhood | Critical Infrastructure | |
| Vulnerable Area 1 | Energy | |
| Vulnerable Area 2 | Flooding | |
| Vulnerable Area 3 | Sanitary | |
| Vulnerable Area 4 | Stormwater | |
| Brown's Point Redevelopment Area | Vulnerable Population | |
| Aeromarine Redevelopment Area | | |



Cedar Street Pump Station
 Terry Park Bulkhead
 Common Flooding
 BRSA Pump Station
 Boat Ramp Timber Breakwater
 Storm Outfall
 FIRE PATROL CO. 1 - 26 WAVERLY
 Condo Pump Station
 HOOK & LADDER CO. 1 - 34 1ST
 LINCOLN HOSE CO. 6 - 142 2ND ST
 Waterfront Park Bulkhead
 Senior Center
 Division St. Flooding
 Timber Breakwater
 Borough Hall and Keyport Police Department
 Common Flooding
 Storm Outfall
 Common Flooding
 50 Beers Street Senior Apartments
 RARITAN HOSE CO. 2 - MAPLE & CHURCH
 EAGLE HOSE CO. 4 - 95 BROADWAY
 Maple Place Pump Station
 BMS
 Common Flooding
 Keyport Elementary
 County Vocational School
 Keyport High School
 Water Tower
 Well
 Water Treatment Plant & Well
 Water Tower
 Bethany Manor
 LIBERTY HOSE CO. 3 - ATLANTIC & RT. 36
 Electrical Substation
 State Hwy 36

is due to differences in coastal resiliency data used. Regardless of the small differences, both were consulted to be sure any possible vulnerability was identified. The table below corresponds with the maps above. Appendix B has a key defining the levels of vulnerability for low, medium, and high for both Sea Level Rise and Storm Surge.

| COMPONENT NAME | SECTOR | VULNERABILITY RATING | | EXPOSURE & CONSEQUENCES |
|---|-------------------------------------|----------------------|-------------|---|
| | | Sea Level Rise | Storm Surge | |
| BEERS STREET BASIN NEIGHBORHOOD | | | | |
| 50 Beers Street | Vulnerable Population | Low | High | Surprisingly sea level rise will not place 50 Beers Street, known as Keyport Leisure Apartments for seniors, underwater so long as no more than 3 feet of SLR occurs before 2100. However, it will exacerbate the common flooding around the structure and increase the exposure to storm surge. Evacuation of this building should be immediate if a strong storm threatens the Borough given the high exposure to storm surge for a CAT1 or CAT2 event. |
| Stormwater Outfall | Stormwater | Medium | High | Given the proximity to the Luppataong creek, this storm outfall will be underwater if sea level rises to 2 feet. It's exposure to only a CAT1 event means the outfall will not be operational during a major storm. |
| Common Flooding (Residential Access) | Critical Area/Stormwater | Medium | High | Common flooding occurs during normal tide events and a full moon on Beers Street near 50 Beers Street and the Storm Outfall. The flooding will be exacerbated and is vulnerable to 2 feet of sea level rise and is exposed to any level of storm surge. Consequences include the road becoming impassible from sea level rise or during a Hurricane. |
| FIRST STREET BASIN NEIGHBORHOOD | | | | |
| Timber Breakwater | Critical Buildings & Infrastructure | High | High | The breakwater will be effective for lower strength storms but will be completely inundated and not functional during a CAT1 or greater. Sea level rise of 1 foot may bring the breakwater below the surface. |
| Common Flooding (County Road, Repetitive Loss Area) | Critical Area/Stormwater | High | High | Common flooding at Fireman's park near the Keyport Fishery will only be exacerbated or worsened by sea level rise of 1 foot or greater. The roadway may become impassible due to sea level rise and definitely will be flooded during any Hurricane, Nor'easter, or Tropical Storm. |
| Waterfront Park Bulkhead | Critical Buildings & Infrastructure | High | High | Sea level rise of 1 foot will diminish the waterfront bulkhead effectiveness. 2 feet or higher of sea level rise will bring almost the entire bulk head and the parking lot near Fireman's Park underwater. The bulkhead will flood 6 to 9 feet from a CAT 2 event. Sea Level Rise may cause the waterfront park to be unusable. |
| Boat Ramp Timber Breakwater | Critical Buildings & Infrastructure | High | High | The Boat Ramp breakwater will be underwater from 1 foot of sea level rise and will not be functional during any storm surge. Sea Level Rise may make the boat ramp unusable in the future. |
| Stormwater Outfall | Stormwater | Low | High | Sea level rise of 3 feet will not reach the storm outfall at Beach Park but may affect its functionality. The outfall will be inundated during a CAT1 event and will not be functional. Need to prevent back flow. |
| First Street Condo Pump Station | Critical Buildings & Infrastructure | N/A | Medium | Sea level rise will exacerbate storm surge threatening the condos and its pump station but will not reach the pump station itself. The medium exposure to storm surge may cause the pump station to fail or overflow if a CAT2 event occurs. |
| Hook & Ladder Company Station | Emergency Facilities | N/A | Medium | Exposure to storm surge may cause damage to the structure. All crucial equipment should be moved upland to avoid damage during a CAT2 or stronger storm. Sea level rise will not impact the station and the consequences are increased storm surge exposure. |
| Terry Park Bulkhead | Critical Buildings & Infrastructure | High | High | The bulkhead at Terry Park is exposed to both sea level rise and storm surge. One foot of sea level rise may bring the water above the bulk head and reduce its effectiveness during hurricane events and its usefulness to protect nearby land uses. Storm surge from a CAT2 event will flood the entire bulkhead and may cause damage. |
| Cedar Street Pump Station | Critical Buildings & Infrastructure | High | High | The pump station has the same exposures as the Terry Park bulkhead. Storm surge from a CAT2 may cause the pump station to fail and possibly overflow. Rising sea levels will increase the pump stations exposure to flooding and storm surge. |

DIVISION STREET BASIN NEIGHBORHOOD

| | | | | |
|--------------------------|--------------------------|-----|------|---|
| Division Street Flooding | Critical Area/Stormwater | N/A | High | Division Street already floods during normal storm events and has several unreported repetitive loss properties. There is no exposure to sea level rise but storm surge exposure is very high. Hazard mitigation is required for this neighborhood to avoid future damage and reduce the consequences from normal & strong flooding events. |
|--------------------------|--------------------------|-----|------|---|

WALNUT-OAK STREET BASIN NEIGHBORHOOD

| | | | | |
|---|-------------------------------------|------|------|--|
| BRSA Pump Station | Critical Buildings & Infrastructure | High | High | The BRSA pump station is very close to the Chingarora Creek and will experience inundation from a one foot sea level rise. It is also very exposed to storm surge and will fail during a major storm event. If not addressed relatively quickly, overflow may occur. Relocation to a less exposed area should be discussed as well as resiliency measures. |
| Common Flooding (County Road link to Union Beach) | Critical Area/Stormwater | High | High | The common flooding is at the bridge into Union Beach. The County plans to raise the bridge to alleviate the common flooding & exposure to sea level rise. It will still be exposed to storm surge but this route is not an evacuation route and consequences may be minimal. |

VULNERABLE AREA 1

| | | | | |
|--|-------------------------------------|--------|------|--|
| Maple Place Pump Station | Critical Buildings & Infrastructure | Low | High | Although the exposure to sea level rise is minimal, as water levels increase over time, the pump stations exposure to storm surge will only get worse. If the pump station is flooded, it may fail and possibly overflow if the failure is not corrected in a timely manner. It will take 3 feet of sea level rise to expose the pump station but only a CAT1 event will expose the pump station to flood waters from the creek. Relocation should be considered for this pump station and resiliency and hardening measures are planned for this critical pump station. |
| Common Flooding (County Road link to Aberdeen) | Critical Area/Stormwater | Medium | High | Common flooding occurs on West Front Street when leaving Keyport to Aberdeen. The raising of the bridge and road elevation should eliminate exposure to sea level rise and the common flooding. The bridge which leads to the GSP evacuation route will still be exposed to storm surge. A fast evacuation should keep consequences at a minimum. |
| Water Tower | Critical Buildings & Infrastructure | N/A | Low | Given the ground elevation and height of the water tower, consequences are minimal. Structural soundness of the footings should be inspected in case flood waters do reach the water tower if a CAT3 event occurs. |
| Eagle Hose Co. Fire Station | Emergency Facilities | N/A | Low | An exceptionally strong storm and very specific conditions would be needed for flood waters to reach the fire station. Consequences are minimal. If a storm threatens the station, all critical equipment should be moved upland. |

VULNERABLE AREA 2

| | | | | |
|-------------------------------|--|-----|--------|--|
| Borough Hall & Police Station | Critical Building & Emergency Facility | N/A | Low | According to SLOSH models, Borough Hall would only take on a maximum of 3 feet of water during a CAT3 event. The consequences should be only for the first floor. This can cause extensive damage but it is unlikely given the building is slightly elevated and surge is between 0 and 3 feet. Any sensitive equipment or information such as servers or files should be stored upstairs to avoid any major consequences. |
| Lincoln Hose Co. Fire Station | Emergency Facilities | N/A | Medium | A CAT2 or CAT3 event storm surge would reach the Lincoln Hose Company Station. The consequences could be substantial for the building itself but if crucial equipment is moved upland than consequences can be mitigated. No exposure to Sea Level Rise. |
| Keyport Fire Patrol Station | Emergency Facilities | N/A | Medium | Consequences for the Fire Patrol Station are similar to those of Lincoln Hose Company Station. Consequences may be worse as the Fire Patrol Station is closer to the Bay. No exposure to Sea Level Rise. |
| Raritan Hose Company Station | Emergency Facilities | N/A | Low | An exceptionally strong storm and very specific conditions would be needed for flood waters to reach the fire station. Consequences are minimal. If a storm threatens the station, all critical equipment should be moved upland. |

VULNERABLE AREA 3

| | | | | |
|------------------------------------|---|-----|------|---|
| Common Flooding (Evacuation Route) | Critical Area/Stormwater | N/A | High | Where Green Grove Avenue meets the border of Hazlet Township exists an area that commonly floods and provides an evacuation route. Sea level rise should not bring any consequences but storm surge will always flood this road making it impassable. This road leads to evacuation routes so consequences could be significant if evacuation is not efficient and quick. |
| Liberty Hose Company Station | Emergency Facilities | N/A | Low | The Liberty Hose Company is exposed to CAT3 storm surge of between 0-3 feet. Consequences of flooding could damage the structure and any equipment inside. Equipment should be moved upland prior to a CAT3 event. No exposure to Sea Level Rise. |
| First Aid Squad | Emergency Facilities | N/A | Low | The First Aid Squad is exposed to storm surge from a CAT3 event with 0 to 3 feet of water. It is on the edge of SLOSH models for a CAT3 event and consequences should be minimal. No exposure to Sea Level Rise. |
| Keyport High School | Community Facilities/ Emergency Shelter | N/A | Low | The High School is vulnerable to a CAT3 storm surge of between 0 and 3 feet. Damage to the structure is possible during a CAT3 event. No Sea Level Rise exposure. This structure may be used as an emergency shelter. |
| Keyport Elementary School | Community Facilities/ Emergency Shelter | N/A | Low | The Elementary School is vulnerable to a CAT3 storm surge of between 0 and 3 feet. Damage to the structure is possible during a CAT3 event. No Sea Level Rise exposure. This structure may be used as an emergency shelter. |
| Monmouth County Vocational School | Community Facilities/ Emergency Shelter | N/A | Low | The Vocational School is vulnerable to a CAT3 storm surge of between 0 and 3 feet. Damage to the structure is possible during a CAT3 event. No Sea Level Rise exposure. This structure may be used as an emergency shelter. |
| Bethany Manor | Vulnerable Population | N/A | Low | Bethany Manor is not exposed to Sea Level Rise and is vulnerable to a CAT3 event with 0-3 feet of water possible. This would only affect the first floor but would still cause damage. Evacuations should occur prior to a CAT3 event. |

VULNERABLE AREA 4

| | | | | |
|--------------------------|---------------|------|------|---|
| Aeromarine Redevelopment | Critical Area | High | High | The Aeromarine Redevelopment area has high exposure to both Sea Level Rise and storm surge. Any new development should be built in a resilient manner to mitigate risk. Additionally, living shoreline techniques and tidal marsh retreat areas should be considered. |
|--------------------------|---------------|------|------|---|

OTHER

| | | | | |
|-------------------------------|--------------------------|-----|--------|---|
| JCP&L Clark Street Substation | Energy/Critical Facility | N/A | Medium | The JCP&L Clark Street Substation is outside the Vulnerable neighborhoods and areas of Keyport but is near a creek that is prone to storm surge. The Borough is recommended to work with JCP&L to harden the substation and increase its resiliency to storm surge. |
| Water Treatment Plant & Well | Critical Infrastructure | N/A | Low | The Water Treatment Plant & Well is outside the storm surge area but flooding may infiltrate the system. This should be monitored during an emergency event to ensure the water supply is safe for residents. |











Vulnerability of Transportation Infrastructure

The map on the following page delineates Keyport Borough’s main evacuation routes and the NJ Transit Bus Route 817. The evacuation routes for the Borough include Route 35, Route 36, Madison Street, and Maple Place which all lead to the Garden State Parkway and beyond. Local roadways leading to the evacuation routes have the potential to flood during major precipitation events. Evacuation should occur well before a storm hits. Bus Route 817 runs through or near all four of Keyport’s vulnerable neighborhoods and has several stops along Broadway, West Front Street, and 1st Street. In the event of a major storm event, NJ Transit service may be delayed or suspended. Evacuations should happen as soon as possible if using public transit or before roads leading to evacuation routes become flooded. Citizens choosing not to evacuate should take advantage of emergency shelters. Emergency management plans and transportation plans should address evacuation issues if a major evacuation is needed. The map below displays Keyport’s evacuation routes and bus routes.


Aberdeen Township

Union Beach Borough

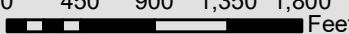
Hazlet Township

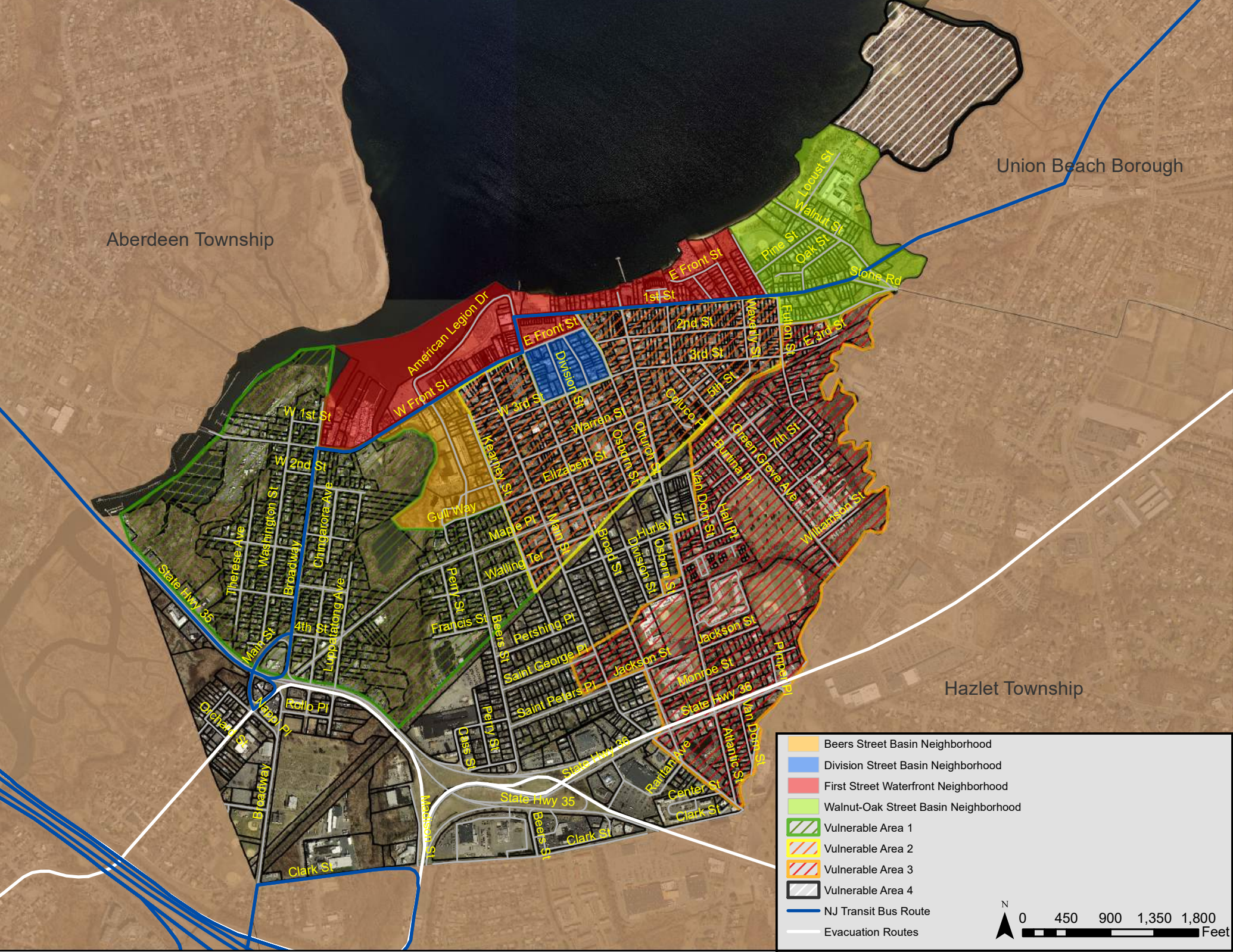
-  Beers Street Basin Neighborhood
-  Division Street Basin Neighborhood
-  First Street Waterfront Neighborhood
-  Walnut-Oak Street Basin Neighborhood
-  Vulnerable Area 1
-  Vulnerable Area 2
-  Vulnerable Area 3
-  Vulnerable Area 4
-  NJ Transit Bus Route
-  Evacuation Routes

N



0 450 900 1,350 1,800 Feet





Vulnerability of Natural Environment

Scenic and Recreational Resources

This map shows wetlands, beaches, and other natural areas or open space that is exposed to flood hazards. These areas are generally able to adapt to flooding, but if floodwaters are too powerful it can damage wetlands, beaches, and other natural areas. Additionally, sea level rise can cause change in habitat types or a complete loss of habitat. Freshwater wetlands may experience dieback from saltwater intrusion, and salt marsh may convert to open water unless sedimentation and growth can keep pace and the natural systems have inland areas in which to migrate. According to NOAA's Coastal Flood Exposure Mapper, Keyport does not have any retreat zones. This may cause tidal marshes & wetlands to disappear from sea level rise and impact Keyport through increased flooding of tidal marshes.

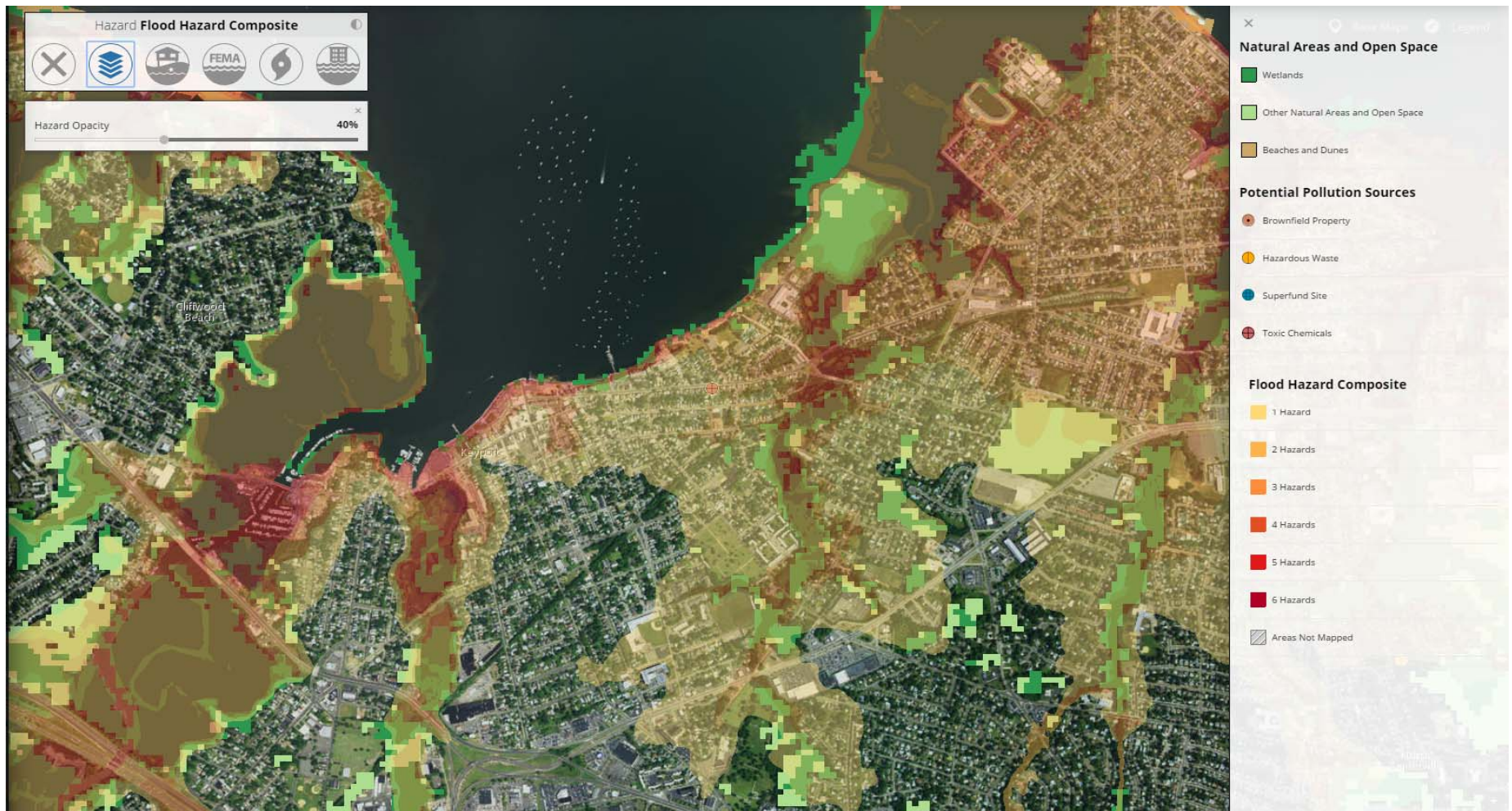
Figure 5 Natural Areas and Open Space



Hazardous Waste and Sewage Treatment Plants

This map shows both natural areas and potential pollution sources that are exposed to flood hazards. When water flows over a polluted area such as a brownfield or hazardous waste site, the pollution can be transferred to other areas. These harmful pollutants can result in an increase of nutrients in the soil that kill plant and negatively affect animal species. According to the map below from the Coastal Flood Exposure Mapper, Keyport has two sites that may have toxic chemicals from a past use. One is located near Keyport Fire Patrol and does not appear to have any hazardous waste that are vulnerable. The other is Aeromarine which may spread pollution during storm events.

Figure 6 Potential Pollution Sources

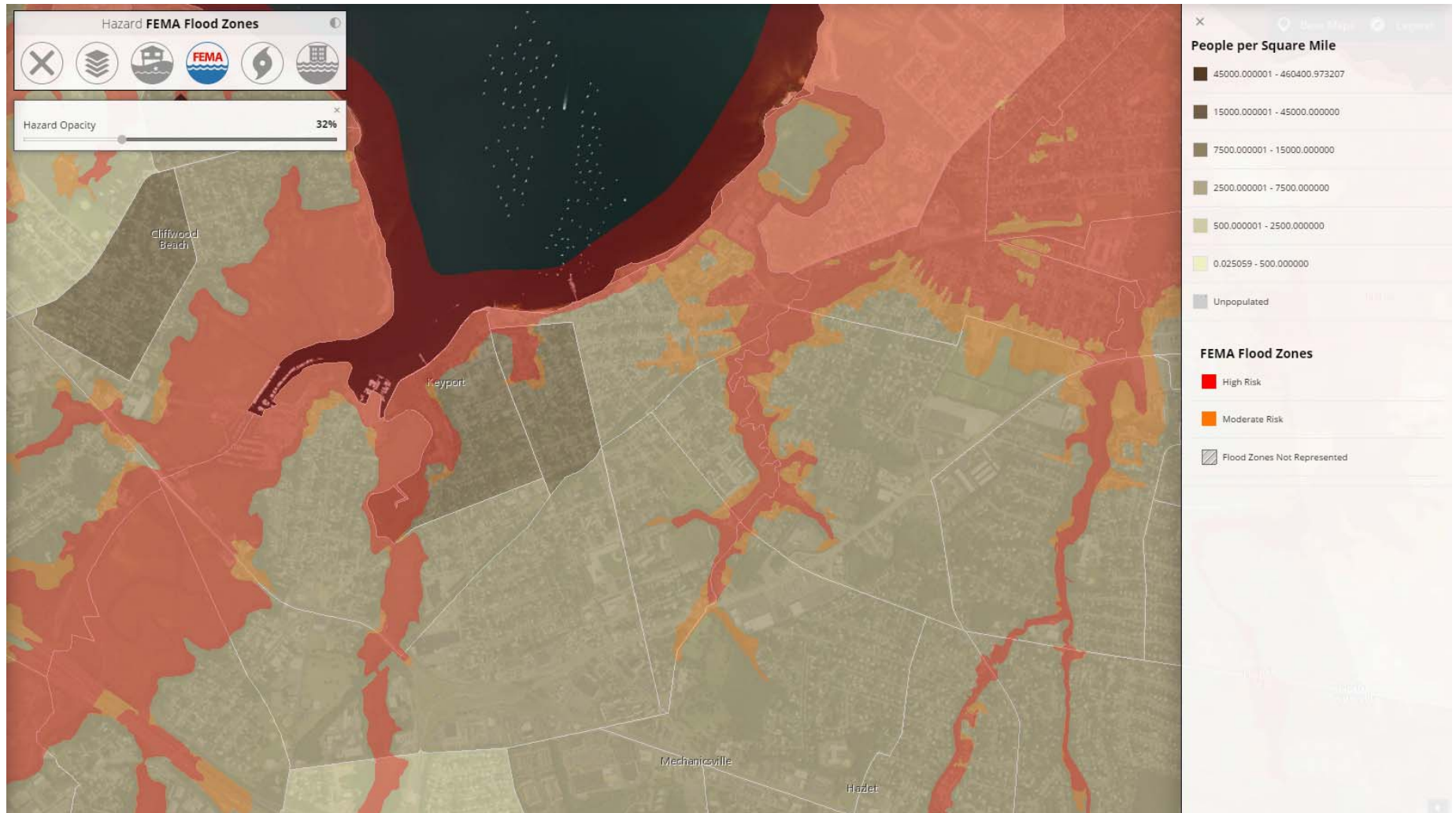


Social Vulnerability

Population Density

This map shows population density in people per square mile for areas within FEMA flood zones. These areas contain large amounts of development, including public services and infrastructure, which compounds the impacts on the community. A map of existing buildings was not able to be produced.

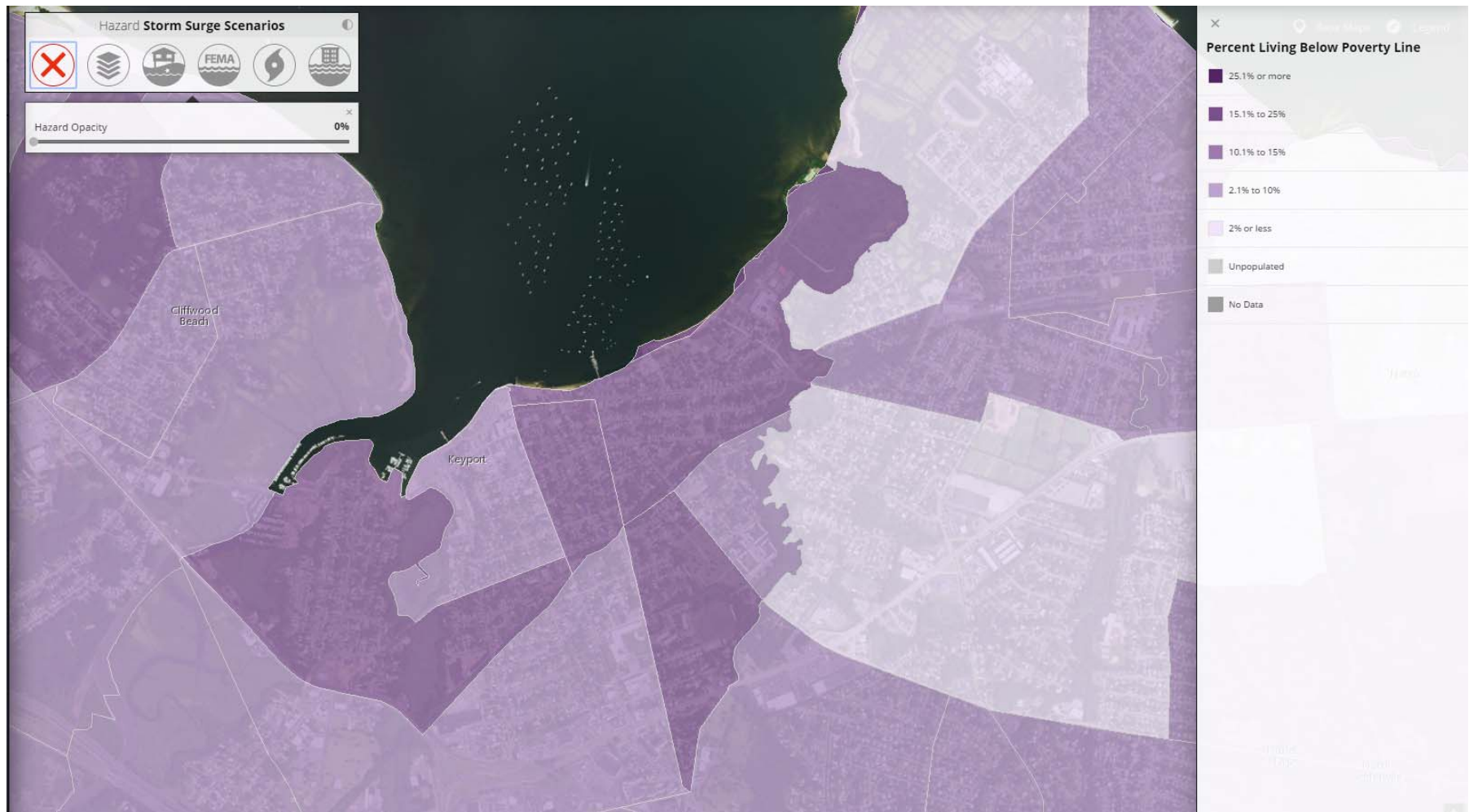
Figure 7 Population Density



Low-Income Families

This map shows the percentage of people living below the poverty line by Census block. People in poverty may not have the necessary resources to evacuate or prepare for major storm events and thus are impacted on a greater scale. These limitations include, but are not limited to substandard housing, lack of transportation to evacuate, and incomes that limit their ability to afford temporary lodging, relocation, or housing improvements enabling them to better weather a major storm event. The areas with higher percentages of those living below the poverty line are along the coast and near waterways that are susceptible to flooding including storm surge.

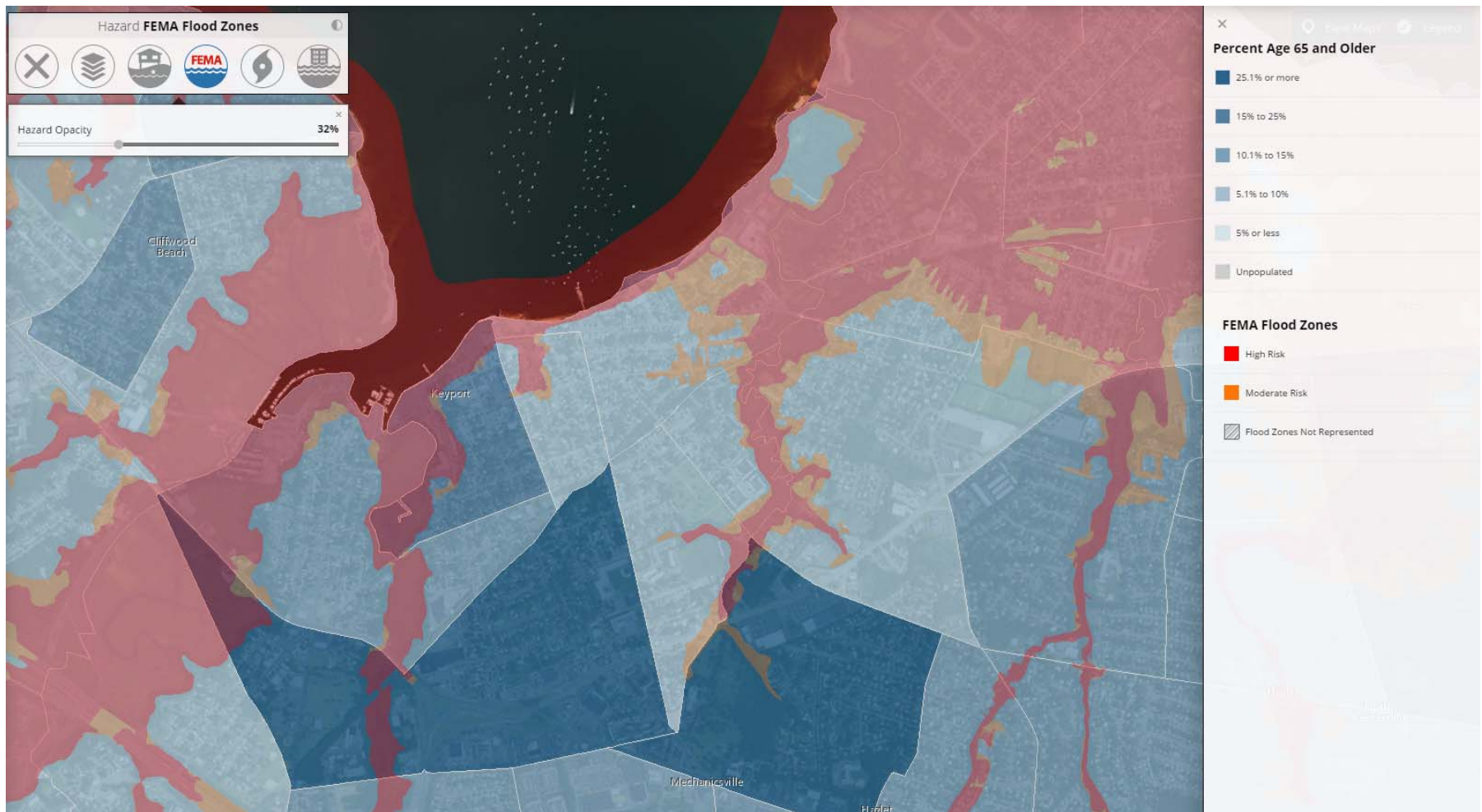
Figure 8 Low-Income Populations



Nursing Homes/Elderly Populations

This map shows the percentage of people age 65 and older for Census block groups that live in or near coastal flood-prone areas. Elderly people may be more susceptible to hazard impacts because they have limited access to transportation and are thus less mobile, have additional medical needs that do not enable them to leave, limited incomes decreasing their adaptability and resilience, and a need for special care facilities which may or may not be available if they leave. Based on the map below are no nursing homes but there are two age-restricted developments that cause the darker blue to appear which are the locations of Bethany Manor and 50 Beers Street. Both are vulnerable to SLR and storm surge.

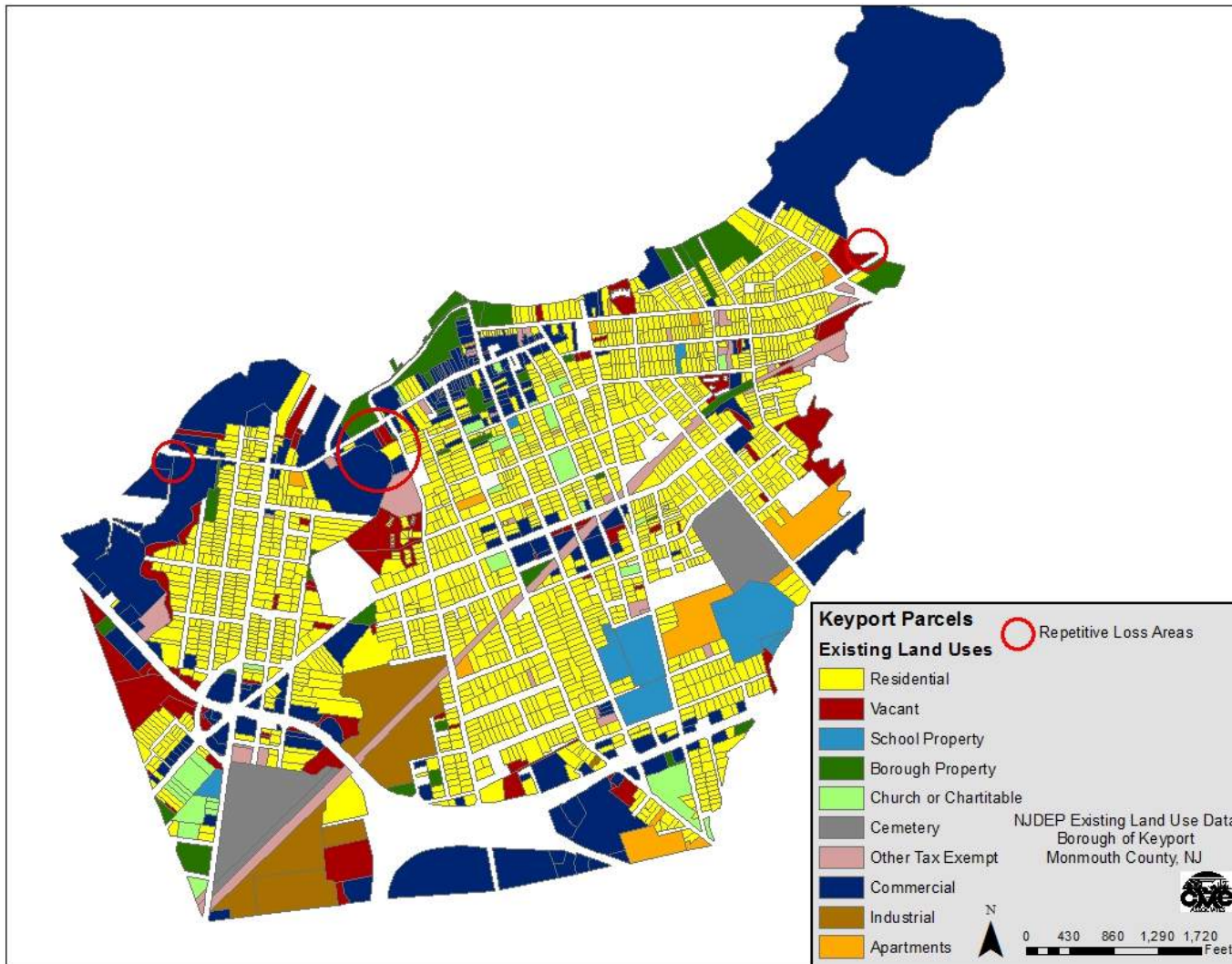
Figure 9 Elderly Populations



Existing Land Uses

Keyport has approximately 937 acres of land area with about a quarter of that being in the flood zone and even more within storm surge areas. Many of these land uses are vulnerable to flooding, storm surge, or sea level rise if they are along the coast or creeks. The map below shows the Borough's existing land uses according to NJDEP land use data and the Borough's repetitive loss areas as reported through the NFIP are circled in red.

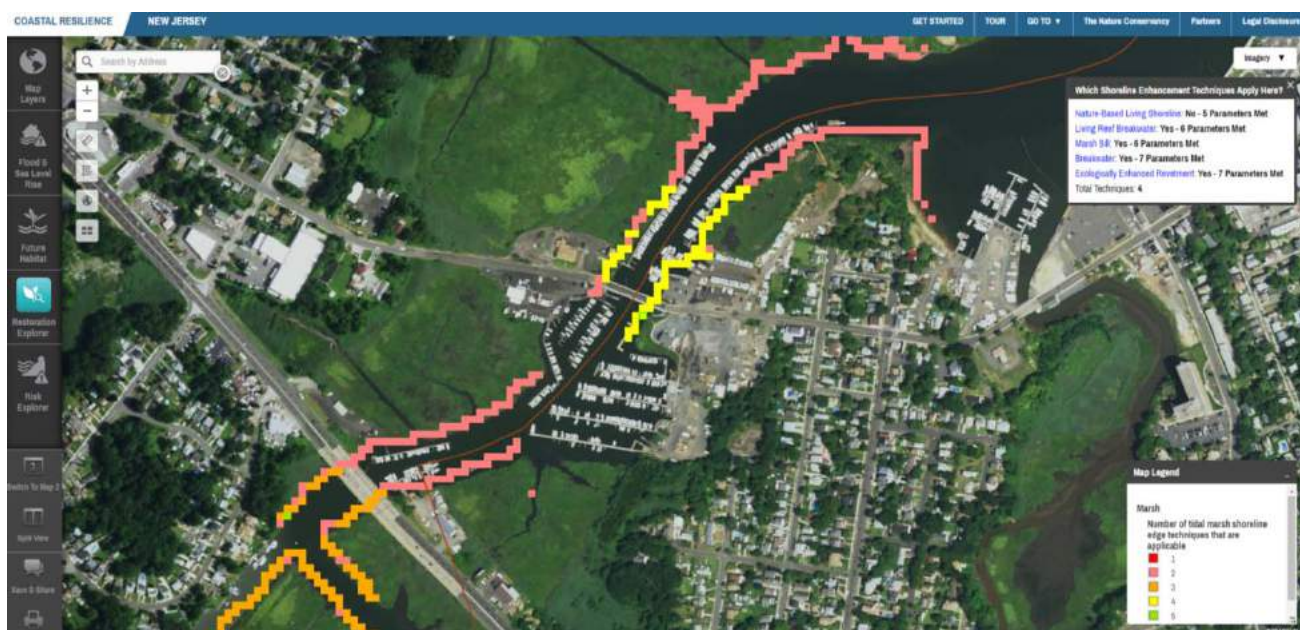
Figure 10 Existing Land Uses with Repetitive Loss Areas



Restoration Explorer

The Nature Conservancy has developed an interactive GIS Mapping tool, known as coastal resilience mapping, that identifies potential restoration projects and risk assessments along a community's shoreline or waterfront. The data and methodology to produce such a tool is complex. The creation of the tool analyzes observed data on wind, waves, surge potential, habitat type, shoreline type, and sea level rise. The tool is able to take the observed data and overlay it with different population information, demographics, and locations. The Coastal Resilience Mapping tool is used to show restoration and risk within the Borough in its entirety. For the purposes of this Assessment, the restoration aspect was utilized and risk more thoroughly analyzed using the Coastal Flood Exposure mapping tool from NOAA. It is important to note that an ecological expert should be consulted to ensure potential restoration projects can be efficiently implemented and be successful. According to the Restoration Explorer, the following restoration projects could be implemented by Keyport to improve the quality and resiliency of the Borough's waterfront. The lower energy Bayfront of Keyport is ideal for living shoreline projects and could be a good option to protect the shoreline from erosion and flooding. Local groups such as the NY/NJ Baykeeper and the Nature Conservancy may be interested in partnering with the Borough for such projects. Additionally, NJDEP is looking for municipalities to participate in a program that would build ecological solutions such as living shorelines. Brown's Point and Aeromarine Redevelopment areas may be good candidates for such a program. Additional information can be found at these websites; <http://www.state.nj.us/dep/cmp/docs/living-shorelines-engineering-guidelines-final.pdf> and <http://www.nj.gov/dep/cmp/docs/living-shorelines2011.pdf>

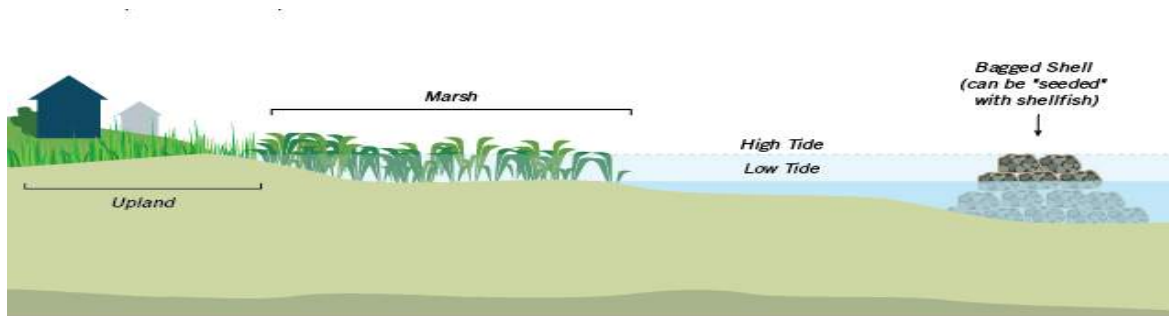
The Restoration Explorer provided through the Coastal Resilience Mapping tool shows two separate areas where shoreline enhancement techniques may be utilized. The first focus area is along Matawan Creek from Keyport Marine Basin to Brown's Point Marina and then to the northern point of the peninsula where the Matawan Creek meets the Bay. The map below shows this area in question.



The map shows two different colors. The Pink area from Brown's Point Marina, north along the coast almost to Hans Pederson's Marina shows the potential for two types of shoreline enhancement techniques. Also a small portion next to Route 35 has the same Pink color. The two techniques that have the potential for success in the pink areas are Breakwater and Ecologically Enhanced Revetment. The remainder of the shoreline has the potential for 4 shoreline enhancement techniques as shown by the yellow color on the map. The yellow colored area meets the parameters for Living Reef Breakwater, Marsh Sill, Breakwater, and Ecologically Enhanced Revetment.

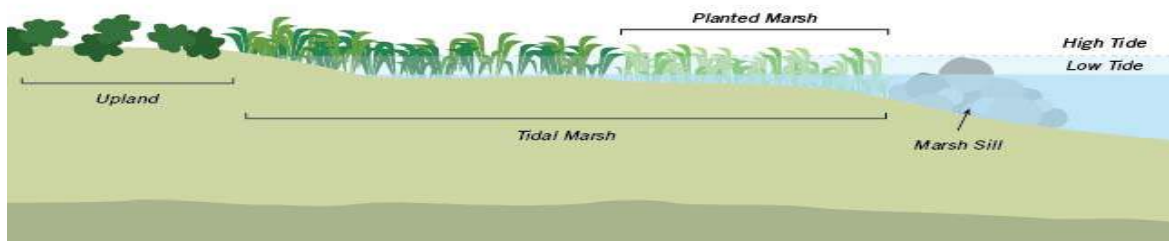
Implementing any of these strategies has the potential to increase the Beers Street Basin Neighborhood and Vulnerable Area 1's resiliency from all sides except for east of the Luppataong Creek. Natural shoreline enhancement techniques can reduce flooding and retain large amounts of precipitation. Additionally, natural shoreline techniques may be more efficient, less expensive, and have aesthetic or health benefits such as habitat enhancement or improved water quality when compared to man-made structural hardscape techniques. The following is a description of each technique.

1. **Living Reef Breakwaters** function very similarly to man-made breakwaters but are built to provide a habitat to shellfish such as baby oysters, mussels, and other reef species. Creating reef balls, oyster castles, bagged shells, and other reef structures can provide a durable and heavy weighted substrate. Overtime living reef breakwaters become large reef structures that serve both as a natural breakwater and a critical aquatic habitat.



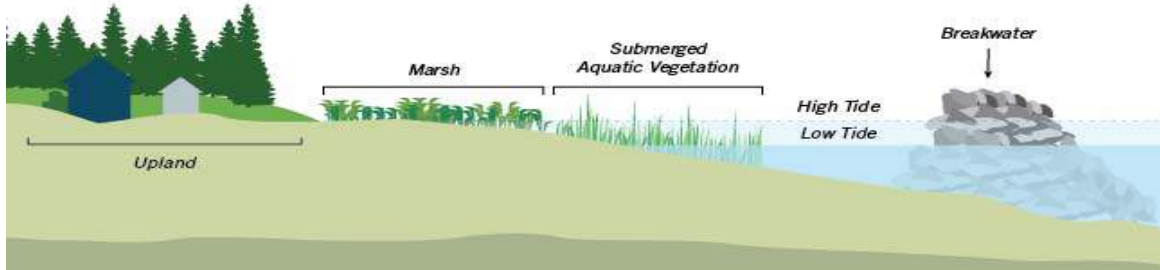
*Image from Coastal Resilience Tool by The Nature Conservancy

2. **Marsh Sills** are low elevation structures such as rocks or bagged oyster shells that run along the shoreline and are below the water line at high tide. The area between the sill and the marsh is often filled and planted with marsh vegetation to speed up shoreline stabilization.



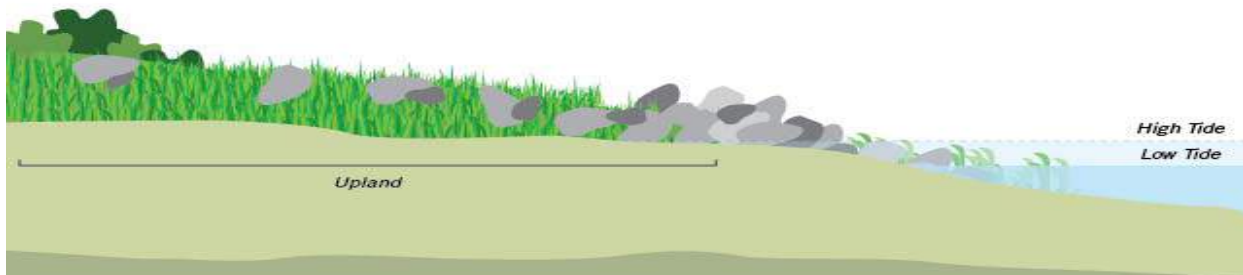
*Image from Coastal Resilience Tool by The Nature Conservancy

3. **Breakwaters** are usually constructed parallel to the shoreline and are designed in such a way to reduce the amount of wave energy the shoreline experiences. On occasion, a vegetated marsh shoreline is established behind the breakwater. Breakwaters are usually constructed in deeper water with more energetic waves and tend to be slightly larger which makes them visible during high tide.



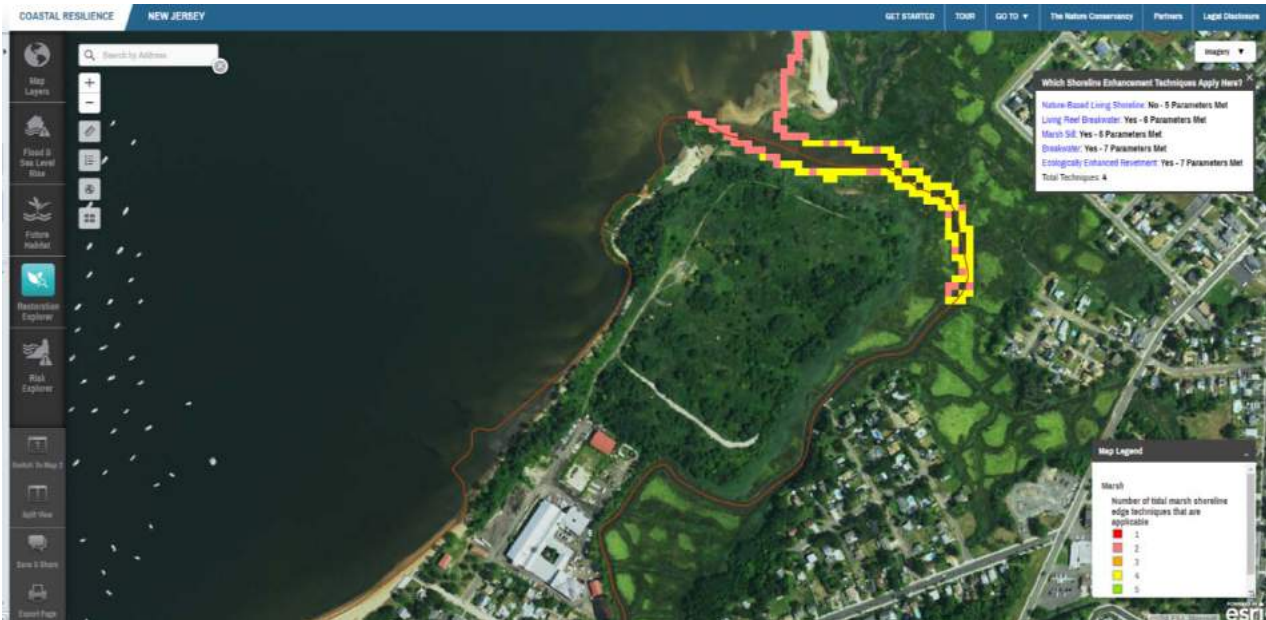
*Image from Coastal Resilience Tool by The Nature Conservancy

4. **Ecologically Enhanced Revetments** are porous, vegetated structures that are attached to the shore itself. Usually an ecologically enhanced revetment is constructed using rocks or broken concrete. Other materials may be used such as gabion baskets, fallen trees, or even miscellaneous rubble and debris. They can be used at open coastal locations and lower energy sheltered areas.



*Image from Coastal Resilience Tool by The Nature Conservancy

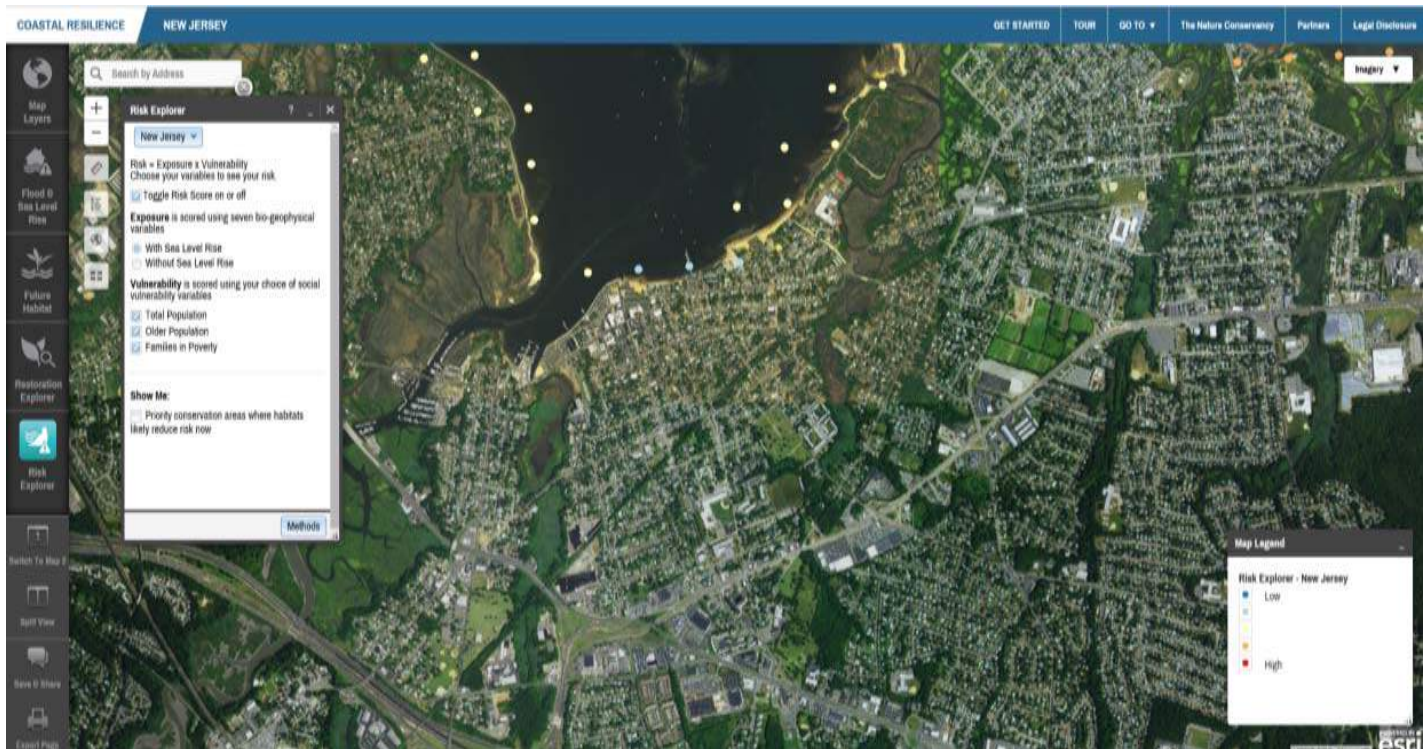
The second area with the potential for shoreline enhancement techniques is the Aeromarine Site. However, this site is currently undeveloped with the potential for redevelopment. The Borough of Keyport should consider working with the redeveloper and NJDEP to implement shoreline techniques to mitigate flooding to any new development. The Aeromarine Site has the potential for the same shoreline techniques previously mentioned above including Living Reef Breakwater, Marsh Sill, Breakwater, and Ecologically Enhanced Revetment.



In conclusion Keyport has the opportunity to review these enhancements and decide which are the most feasible. Implementing any of these solutions has the potential to greatly increase resiliency to certain neighborhoods of the Borough, improve the environment, and add aesthetics to Keyport’s shoreline. Additionally, creating living shorelines can bring an opportunity for eco-tours in Keyport as recommended in the Municipal Public Access Plan.

Risk Explorer

The Nature Conservancy’s Risk Explorer is found within its Coastal Resiliency Mapping tool similar to the Restoration Explorer. The Risk Explorer analyzes all of New Jersey’s coast line. Each section of shoreline within a coastal community is given a score. This is that area’s risk score which is calculated by multiplying exposure by vulnerability. An area’s exposure is scored using seven bio-geophysical variables such as wave energy, wind, and sea level rise. Vulnerability is scored by looking at total population, older population, and families in poverty that are affected by the exposure. The map below shows ten different sections of Keyport’s shoreline. The table below the map shows each section’s risk score from left to right.



As the map above shows, Keyport’s Bayfront has medium to low scores for risk which equals exposure and vulnerability. According to the Risk Explorer almost every section of shoreline has the potential for habitats to reduce risk. This is especially important for the Aeromarine Site since it has the highest risk score and is slated for redevelopment.

Findings and Recommendations

Vulnerability Prioritization

Now that the vulnerability assessment is complete and all risks and locations have been analyzed, this section will review the sectors and components with the highest vulnerability’s and prioritize which need mitigation the most to avoid serious consequences or failure. The sectors and components are ranked to determine which vulnerabilities pose the biggest risk or threat to the Borough and need immediate action. The ranking system will look at sensitivity to flooding and the difficulty to increase its resiliency. For example, if a fire station has a high sensitivity to flooding and a low adaptive capacity which means it is difficult to increase its resiliency, that fire station would have a high vulnerability. Therefore, in this example, the hypothetical fire station’s high vulnerability indicates that immediate action is needed to reduce its risk to flooding or other impacts. Not all components were evaluated. Those with low exposure or vulnerability were not included because their vulnerability rankings would be low. However, this is not to say components with low vulnerability should not improve their resiliency if possible. Those with low vulnerability are only lower on the priority list.

Vulnerability Prioritization

| Rank | Neighborhood | Sector | Component | Sensitivity | Adaptive Capacity | Vulnerability Ranking |
|------|-------------------|--------------------------|--|-------------|-------------------|-----------------------|
| 1 | First Street | Critical Infrastructure | Waterfront Bulkhead | High | Low | High |
| 2 | Division Street | Critical Area/Stormwater | Common Flooding in Basin | High | Low | High |
| 3 | First Street | Stormwater | Common Flooding near Fireman’s Park | High | Low | High |
| 4 | First Street | Critical Infrastructure | Terry Park Bulkhead | High | Low | High |
| 5 | Beers Street | Vulnerable Population | 50 Beers Street Apartments | Moderate | Low | Moderate |
| 6 | Vulnerable Area 2 | Emergency Facilities | Keyport Fire Patrol & Lincoln Hose Company | Moderate | Low | Moderate |
| 7 | Beers Street | Critical Area/Stormwater | Common Flooding on Beers | High | Moderate | Moderate |
| 8 | First Street | Critical Infrastructure | Cedar Street Pump Station | High | Moderate | Moderate |
| 9 | Walnut-Oak Street | Critical Infrastructure | BRSA Pump Station | High | Moderate | Moderate |
| 10 | Walnut-Oak Street | Critical Area/Stormwater | Flooding on 1 st Street | High | Moderate | Moderate |
| 11 | Vulnerable Area 1 | Critical Infrastructure | Maple Place Pump Station | Moderate | Moderate | Moderate |
| 12 | Vulnerable Area 4 | None | Aeromarine Area | High | High | Moderate |
| 13 | First Street | Critical Infrastructure | Timber & Boat Ramp Breakwaters | High | High | Moderate |
| 14 | Vulnerable Area 3 | Community Facilities | Keyport High School & Elementary School | Low | Low | Low |
| 15 | Vulnerable Area 3 | Emergency Facilities | First Aid Station & Liberty Hose Company | Low | Low | Low |
| 16 | Vulnerable Area 3 | Vulnerable Population | Bethany Manor | Low | Low | Low |
| 17 | Vulnerable Area 1 | Critical Area/Stormwater | Flooding on West Front Street | High | High | Low |

HIGH VULNERABILITY RANKING

The most vulnerable areas to Sea Level Rise and Storm Surge in Keyport are the Waterfront Bulkhead, the entire Division Street flood basin, the low-lying section of West Front Street near Fireman’s Park, and the Terry Park Bulkhead. Each component’s vulnerability is high because Sea Level Rise or storm surge will completely inundate it and their adaptive capacity is low to very low. For example, it would take a very large capital project to remove all vulnerability to storm surge flooding for the Division Street Neighborhood or raise the bulkhead at Waterfront Park to remove vulnerability to Sea Level Rise. Stormwater improvements may help the Division Street basin, but will not completely alleviate the issue unless combined with other projects such as the levee proposal for the Hook and Ladder parking lot. Either way it will take a significant effort to remove such a vulnerability which is why it receives a low adaptive capacity.

Both the Waterfront and Terry Park Bulkheads are critical infrastructure that provides the Borough protection from flood waters and erosion. Losing these components to sea level rise or continued damage from storms could result in severe consequences for Borough residents and businesses. Also Sea Level Rise near Fireman’s Park could create a situation where West Front Street is no longer passible. The most at risk component is the entire Division Street Neighborhood. It has several unreported repetitive loss properties and will require a major project to improve resiliency that can be challenging given the existing

topography. All of these components are important to both Keyport's flood resiliency and everyday use by residents and businesses. Given their low adaptive capacity, increasing each component's resiliency will be challenging fiscally, but the benefit should outweigh the cost. Finding solutions for the Waterfront Bulkhead, the entire Division Street flood basin, the low elevation of West Front Street near Fireman's Park, and the Terry Park Bulkhead should be the highest priority to mitigate future storm events.

MODERATE VULNERABILITY RANKING

Many components in Keyport's neighborhoods were found to have a moderate vulnerability ranking including 50 Beers Street, Keyport Fire Patrol, the Lincoln Hose Company, the Cedar Street and BRSA pump stations, 1st Street flooding near the Chingarora going towards Union Beach, the Maple Place pump station, the Aeromarine Redevelopment Area, and Keyport's timber breakwaters. All of these components have high to moderate sensitivity to Sea Level Rise and storm surge, and low to high adaptive capacity. 50 Beers Street, the Lincoln Hose Company, and Keyport Fire Patrol have low adaptive capacity given the challenges for mitigation. 50 Beers Street is a large structure while both emergency facilities are older structures. Mitigating the risks to storm surge and other coastal hazards may present structural and fiscal challenges.

Areas with moderate adaptive capacity include critical areas that experience common flooding and all pump stations in exposed areas of the Borough. These components have moderate adaptive capacity because pump stations are smaller structures that may be relocated to higher ground or hardened to mitigate flood risk. Additionally critical areas of common flooding may be alleviated through road reconstruction/raising and storm water measures. For example, 1st Street is a County road that is currently in the design phase of eventually reconstruction to combat its proneness to flooding. 1st Street is a bus route that can provide low-income residents a means of evacuation during an emergency. Mitigating flood hazards here will assist during evacuations and reduce damage to structures. It is recommended these components be given medium priority for capital projects and those that have already begun should be continued until completion.

Finally, there are three components with high adaptive capacity including both of Keyport's breakwaters and the Aeromarine Redevelopment Area. They all have high sensitivity to Sea Level Rise and storm surge but have the advantage of high adaptive capacity. For example, the breakwaters can be reconstructed to be higher as the sea level rises and to be more effective during major storm events. Additionally, the Aeromarine Redevelopment Area has a clean slate for redevelopment. Resiliency measures can be incorporated into the Redevelopment's design to avoid consequences from sea level rise and storm surge.

LOW VULNERABILITY RANKING

Six components in Keyport were found to have low vulnerability rankings including Keyport Elementary School, Keyport High School, Liberty Hose Company, the First Aid Station, Bethany Manor, and West Front Street flooding leaving towards Aberdeen. All of these components except flooding on West Front Street have low vulnerability to sea level rise and storm surge but also have low adaptive capacity. They were given low vulnerability rankings because it would take a Category 3 Hurricane event in order to have the potential for flooding. Even though they may have low adaptive capacity for mitigation or resiliency because of fiscal challenges to raise large structures like the schools, the probability of a Category 3

Hurricane striking Keyport Borough is low. Finally, the flooding on West Front Street between Keyport and Aberdeen has high sensitivity but high adaptive capacity. This is because the roadway is currently being reconstructed to reduce vulnerability and mitigate coastal hazard risks. This reconstruction should alleviate flood risk and provide an alternative evacuation route.

Relationship to County Hazard Mitigation & Borough Strategic Recovery Planning Report

Monmouth County's 2015 Multi-Jurisdictional Hazard Mitigation Plan (County HMP) and the Borough's Strategic Recovery Planning Report (SRPR) were reviewed for additional information and consistency with respect to Keyport's vulnerabilities and adaptation plans. The County's HMP calculates the Borough of Keyport has a total assessed value of improvements of \$422,424,400. The County HMP takes this total assessed value and models many different natural disasters with respect to damage estimates. As this CVA focuses on Sea Level Rise and major storm events, the following damage estimates for Keyport Borough are as follows:

- Modeled Nor'easter Wind Losses 12/11/1992: **\$645,507**;
- Coastal Erosion:
 - Estimated Population at Risk: **80**
 - Damage to buildings within 200 feet of beach/erodible shoreline: **\$2,883,941**;
- Buildings/Improvements located in all Flood Zones (X/AE/VE) **\$177,943,600 (42.1%)**
- 2050 with SLR 2 Feet above SFHA: **\$16,438,040**;
- Exposure in Storm Surge:
 - Estimated Population at Risk: **3,548**
 - Total Assessed Value located in Category 1-4 Storm Surge: **\$162,876,900 (38.56%)**.

The above damage estimates suggest that wind from a Nor'easter and coastal erosion will have minimal fiscal consequences when compared to the Borough as a whole but still disastrous to private home owners. Those affected by coastal erosion are recommended to address the issue to avoid damage to their homes. The value of buildings in current flood zones is 42%. As flood zones increase over time this value is expected to also increase. The most alarming statistic is that close to 40% of all buildings and almost half of Keyport's total population is vulnerable to storm surge in Keyport Borough. However, it should be noted that a Category 3 event is estimated to have \$80,824,100 in damage. Regardless, a significant portion of the Borough is vulnerable to storm surge according to the County HMP and this CVA is consistent with the County's assessment. Much less property is vulnerable to Sea Level Rise and this CVA is also consistent with the County's assessment. It is very important to remember that as Sea Level Rise continues, storm impacts will only worsen. These findings show that Keyport must continue its work to make all properties more resilient to storm surge and protect its critical facilities.

With respect to consistency to the Borough's SRPR, this CVA is consistent with the SRPR. The SRPR recommended to elevate Green Grove Avenue, Division Street Stormwater Improvements, Beers Street Stormwater Improvements, and to elevate Maple Place and First Street. The SRPR also recommended several other hazard mitigation projects that can be found on the Post Disaster Recovery Project Matrix.

Recommendations

The following are recommendations based on the entire vulnerability assessment and analysis herein and various findings in the Getting to Resilience Report and other planning efforts.

1. The Borough of Keyport should increase its mitigation efforts in the short term for critical facilities that have high vulnerability and low adaptive capacity. For example, working to reduce the flooding to the Division Street neighborhood should be a high priority through mitigation such as improved stormwater facilities, mapping the watershed drainage field to properly address common flooding issues, and implementing the Hook and Ladder parking lot levee. Critical facilities with medium or low vulnerability should have more priority towards the long term. All resiliency efforts for vulnerable critical facilities are recommended to be addressed and implemented through the Capital Improvement Plan.
2. Promote disaster resistant development, avoid excessive development in flood zones and storm surge areas, reduce damages from coastal erosion and wave action through implementation of V Zone construction requirements in Coastal A Zones, and implement other recommendations in the Hazard Mitigation Plan related to coastal hazards and threats.
3. Implement FEMA mitigation techniques outlined in the Hazard Mitigation Plan for coastal hazards including coastal erosion, wave action, flooding, storm surge, and sea level rise. Also Hazard Mitigation should be incorporated into local planning such as the Borough Zoning Ordinance.
4. It is recommended to create a Program for Public Information (PPI) committee. A committee on Hurricane awareness already exists, however, it is recommended to expand the committee to provide more public information regarding vulnerable areas of the Borough to home owners and business owners.
5. It is recommended to implement recommendations from the Borough's "Getting To Resiliency" Report to further cement the Borough's resiliency.
6. It is recommended to incorporate living shoreline techniques at Aeromarine and Brown's Point to increase flood resiliency. The Borough may reference engineering design guidelines for living shorelines published by Stevens Institute of Technology. It is also recommended to amend the ordinance to increase the likelihood of creating living shorelines, ecological buffer zones, and ecosystem protection, creation, and enhancement.
7. It is recommended to create a special needs database to assist vulnerable populations within the Borough during major storm events and to ensure all those with special needs are able to be evacuated safely and quickly.

8. It is recommended to implement the SRPR recommendations for stormwater management and hazard mitigation that have not already been implemented.
9. It is recommended to review and update the Borough ordinance to reduce impervious surfaces in the Borough and require more open space.
10. The Borough is recommended to encourage green building design such as green roofs through a bonus density in specific areas of the Borough such as the Downtown Business district. This would assist in reducing impervious coverage in the Borough and also reduce the effects of climate change that contributes to greater storm intensity.

Mitigation Action Strategies

In light of Keyport's vulnerabilities and the recommendations herein and in the Borough's Master Plan, Neighborhood Plans, and Hazard Mitigation Plan, an Adaptation Plan should be implemented for constructing mitigation and resiliency projects, prioritize the need for each project, and create an implementation schedule for each project. This Adaptation Plan should manifest itself in the Borough's Capital Improvement Plan. The Capital Improvement Plan can effectively allocate funds for highly prioritized capital projects and the Hazard Mitigation Plan can expand on what is required for each project such as how a project will improve resiliency for the Borough and overall costs or funding mechanisms. Those projects that will reduce flood exposure and increase vulnerability of components with high vulnerability rankings should be prioritized first. Cost and vulnerability will assist in prioritizing projects in the Capital Improvement Plan.

It should be noted the cost of living shoreline techniques and man-made infrastructure (green vs. grey projects) can vary substantially. Green infrastructure has the added advantage of usually being less expensive while providing aesthetic and environmental benefits. Grey infrastructure can be more expensive but may be more effective or efficient in reducing flooding. Cost/benefit analyses can be very effective in determining which type of infrastructure is more effective or if both simultaneously will provide the most benefit for the cost. It is recommended to favor green infrastructure as it has been found that for every dollar spent on living shorelines such as vegetative stabilization, around \$1.75 is returned to the economy through increased habitats and vegetation. Additionally, natural wetlands or shorelines have the ability to absorb water to reduce flooding instead of pumping it elsewhere and can improve the Borough's waterfront. The Borough should seek funding sources listed in the Hazard Mitigation Plan to assist paying for mitigation projects. The Borough will implement the Capital Improvement Plan to the extent possible over the next six years but a more comprehensive hybrid strategy should be incorporated for the long term. This hybrid strategy will combine natural and built defenses to mitigate coastal hazard risk to public and private properties in Keyport. Efforts should continue well into the next coming decades to evaluate all potential mitigation and resiliency projects through cost/benefit analyses and updates to the Capital Improvement Plan to implement said projects. If Keyport is able to implement hazard mitigation and resiliency improvements year after year, it will be ready for the next major disaster.

Appendix A: Borough of Keyport Coastal Vulnerability Assessment Matrix

| Location | Component Name | Sector | Depth Projections | | Exposure | Vulnerability Rating | | Consequences |
|---------------------------|-------------------------------|-------------------------------------|-------------------|-----------------|---|----------------------|-------------|---|
| | | | Sea Level Rise | Storm Surge | | Sea Level Rise | Storm Surge | |
| Beers Street Neighborhood | 50 Beers Street Senior Apts. | Vulnerable Population | 3 Feet | >9 Feet (CAT2) | 50 Beers Street Apartments has low exposure to sea level rise and high exposure to storm surge. | Low | High | Surprisingly sea level rise will not place 50 Beers Street underwater so long as no more than 3 feet of SLR occurs before 2100. However, it will exacerbate the common flooding around 50 Beers Street and make it even more exposed to storm surge than it already is. Evacuations of this building should be immediate if a strong storm threatens given the high exposure to storm surge for a CAT1 or CAT2 event. |
| Beers Street Neighborhood | Storm Outfall | Stormwater | 2 Feet | 6-9 Feet (CAT1) | Medium exposure to sea level rise and high exposure to storm surge | Medium | High | Given the proximity to the Luppataong creek, this storm outfall will be underwater if sea level rises to 2 feet. It's exposure to only a CAT1 event means the outfall will not be operational during a major storm. |
| Beers Street Neighborhood | Common Flooding | Stormwater | 2 Feet | 6-9 Feet (CAT1) | Medium exposure to sea level rise and high exposure to storm surge | Medium | High | Common flooding occurs during normal tide events and a full moon on Beers Street near 50 Beers Street and the Storm Outfall. The flooding will be exacerbated and is vulnerable to 2 feet of sea level rise and is exposed to any level of storm surge. Consequences include the road becoming impassible from sea level rise or during a Hurricane. |
| First Street Neighborhood | Timber Breakwater | Critical Buildings & Infrastructure | 1 Foot | >9 Feet (CAT2) | High exposure to both sea level rise and storm surge | High | High | The breakwater will be effective for lower strength storms but will be completely inundated and not functional during a CAT1 or greater. Sea level rise of 1 foot may bring the entire breakwater below the bay surface. |
| First Street Neighborhood | Common Flooding | Stormwater | 1 Foot | 6-9 Feet (CAT2) | High exposure to both sea level rise and storm surge | High | High | Common flooding at Fireman's park near the Keyport Fishery will only be exacerbated or worsened by sea level rise of 1 foot or greater. The roadway may become impassible due to sea level rise and definitely will be flooded during any Hurricane, Nor'easter, or Tropical Storm. |
| First Street Neighborhood | Waterfront Park Bulkhead | Critical Buildings & Infrastructure | 1-2 Feet | 6-9 Feet (CAT2) | High exposure to both sea level rise and storm surge | High | High | Sea level rise of 1 foot will bring portions of the waterfront bulkhead underwater. 2 feet or higher of sea level rise will bring almost the entire bulk head and the parking lot near Fireman's Park underwater. The bulkhead will flood 6 to 9 feet from a CAT 2 event. Sea Level Rise will make the waterfront park unusable. |
| First Street Neighborhood | Boat Ramp Timber Breakwater | Critical Buildings & Infrastructure | 1 Foot | >9 Feet (CAT1) | High exposure to both sea level rise and storm surge | High | High | The Boat Ramp breakwater will be underwater from 1 foot of sea level rise and will not be functional during any storm surge. Sea Level Rise may make the boat ramp unusable in the future. |
| First Street Neighborhood | Storm Outfall | Stormwater | 3 Feet | 6-9 Feet (CAT1) | Low exposure to sea level rise and high exposure to storm surge. | Low | High | Sea level rise of 3 feet will not reach the storm outfall at Beach Park but may affect its functionality. The outfall will be inundated during a CAT1 event and will not be functional. |
| First Street Neighborhood | Condo Pump Station | Critical Buildings & Infrastructure | N/A | 6-9 Feet (CAT2) | No exposure to sea level rise and medium exposure to storm surge. | N/A | Medium | Sea level rise will exacerbate storm surge threatening the condos and its pump station but will not reach the pump station itself. The medium exposure to storm surge may cause the pump station to fail or overflow if a CAT2 event occurs. |
| First Street Neighborhood | Hook & Ladder Company Station | Emergency Facilities | N/A | 0-3 Feet (CAT2) | No exposure to sea level rise and medium exposure to storm surge. | N/A | Medium | Exposure to storm surge may cause damage to the structure. All crucial equipment should be moved upland to avoid damage during a CAT2 or stronger storm. Sea level rise will not impact the station and has no consequences except increased storm surge exposure. |
| First Street Neighborhood | Terry Park Bulkhead | Critical Buildings & Infrastructure | 1 Foot | 6-9 Feet (CAT2) | High exposure to both sea level rise and storm surge | High | High | The bulkhead at Terry Park is exposed to both sea level rise and storm surge. One foot of sea level rise may bring the water above the bulk head and reduce its effectiveness during hurricane events and usefulness to protect nearby uses. Storm surge from a CAT2 event will flood the entire bulkhead likely to cause damage. |
| First Street Neighborhood | Cedar Street Pump Station | Critical Buildings & Infrastructure | 1 Foot | 6-9 Feet (CAT2) | High exposure to both sea level rise and storm surge | High | High | The pump station has the same exposures as the Terry Park bulkhead. Storm surge from a CAT2 may cause the pump station to fail and possibly overflow. Rising sea levels will increase the pump stations exposure to flooding and storm surge. |

| | | | | | | | | |
|--------------------------------|-------------------------------|--------------------------------------|----------|------------------------------------|--|--------|--------|--|
| Division Street Neighborhood | Division St. Flooding | Stormwater | N/A | >9 Feet (CAT2) | No exposure to sea level rise and high exposure to storm surge | N/A | High | Division Street already floods during normal storm events and has several repetitive loss properties. There is no exposure to sea level rise but storm surge exposure is very high. Hazard mitigation is required for this neighborhood to avoid future damage and the consequences from normal or strong flooding events. |
| Walnut-Oak Street Neighborhood | BRSA Pump Station | Critical Buildings & Infrastructure | 1 Foot | 6-9 Feet (CAT1) | High exposure to both sea level rise and storm surge | High | High | The BRSA pump station is very close to the Chingarora Creek and will experience more flooding from a one foot sea level rise. It is also very exposed to storm surge and will fail during a major storm event. If not addressed relatively quickly, overflow may occur. Relocation to a less vulnerable area should be discussed. |
| Walnut-Oak Street Neighborhood | Common Flooding | Stormwater | 1 Foot | >9 Feet (CAT1) | High exposure to both sea level rise and storm surge | High | High | The common flooding is at the bridge into Union Beach. The County has plans to raise the bridge to alleviate the common flooding and exposure to sea level rise. It will still be exposed to storm surge but this route is not an evacuation route and the consequences should be minimal. |
| Vulnerable Area 1 | Maple Place Pump Station | Critical Buildings & Infrastructure | 3 Feet | >9 Feet (CAT3), 3-6 Feet (CAT1) | The Maple Place Pump Station is exposed to several feet of water during a CAT1 event and even more water during a CAT 3 event. Sea level rise exposure is minimal The common flooding is located at the w | Low | High | Although the exposure to sea level rise is minimal, as water levels increase over time, the pump stations exposure to storm surge will only get worse. If the pump station is flooded, it may fail and possibly overflow if the failure is not corrected in a timely manner. It will take 3 feet of sea level rise to expose the pump station but only a CAT1 event will expose the pump station to flood waters from the creek. |
| Vulnerable Area 1 | Common Flooding | Stormwater | 1-2 Feet | >9 Feet (CAT3) | Front Street bridge leaving Keyport to the west. The exposure to sea level rise is a concern as flooding will get worse if not permanent. The County is raising the bridge which should alleviate the issue. Exposure to storm surge will still be | Medium | High | Common flooding occurs on West Front Street when leaving Keyport to Aberdeen. The raising of the bridge and road elevation should eliminate exposure to sea level rise and the common flooding. The bridge will still be exposed to storm surge, but this is not an evacuation route and consequences should be minimal. |
| Vulnerable Area 1 | Water Tower | Critical Buildings & Infrastructure | N/A | 0-3 Feet (CAT3) | The water tower has no exposure to sea level rise and minimal exposure during a strong storm. | N/A | Low | Given the ground elevation and height of the water tower, consequences are minimal. Structural soundness of the footings should be inspected in case flood waters do reach the water tower if a CAT3 event occurs. |
| Vulnerable Area 1 | Eagle Hose Co. Fire Station | Emergency Facilities | N/A | 0-1 Feet (CAT3) | The Eagle Hose Company has no exposure to sea level rise and very minimal exposure to storm surge | N/A | Low | An exceptionally strong storm and very specific conditions would be needed for flood waters to reach the fire station. Consequences are minimal. If a storm threatens the station, all critical equipment should be moved upland. |
| Vulnerable Area 2 | Borough Hall & Police Station | Critical Building/Emergency Facility | N/A | 0-3 Feet (CAT3) | Borough Hall and the Borough Police Department are not susceptible to sea level rise and they have low exposure to even a CAT3 storm surge event. | N/A | Low | According to SLOSH models, Borough Hall would only take on a maximum of 3 feet of water during a CAT3 event. The consequences should be only for the first floor. This can cause extensive damage but it is unlikely given the building is slightly elevated and surge is between 0 and 3 feet. Any sensitive equipment or information such as servers or files should be stored upstairs to avoid any major consequences. |
| Vulnerable Area 2 | Lincoln Hose Co. Fire Station | Emergency Facilities | N/A | 6-9 Feet (CAT3) | No exposure to sea level rise and medium exposure to storm surge. | N/A | Medium | A CAT2 or CAT3 event storm surge would reach the Lincoln Hose Company Station. The consequences could be substantial for the building itself but if crucial equipment is moved upland than consequences can be mitigated. No exposure to Sea Level Rise. |
| Vulnerable Area 2 | Keyport Fire Patrol Station | Emergency Facilities | N/A | 6-9 Feet (CAT3) | No exposure to sea level rise and medium exposure to storm surge. | N/A | Medium | Consequences for the Fire Patrol Station are similar to those of Lincoln Hose Company Station. Consequences may be worse as the Fire Patrol Station is closer to the Bay. No exposure to Sea Level Rise. |
| Vulnerable Area 2 | Raritan Hose Company Station | Emergency Facilities | N/A | 0-1 Feet (CAT3) | No exposure to sea level rise and low exposure to storm surge | N/A | Low | An exceptionally strong storm and very specific conditions would be needed for flood waters to reach the fire station. Consequences are minimal. If a storm threatens the station, all critical equipment should be moved upland. |
| Vulnerable Area 3 | Common Flooding | Stormwater | N/A | >9 Feet (CAT2) | No exposure to sea level rise and high exposure to storm surge | N/A | High | Where Green Grove Avenue meets the border of Hazlet Township exists an area that commonly floods. Sea level rise should not bring any consequences but storm surge will always flood this road making it impassable. This road leads to evacuation routes so consequences could be severe if evacuation is not efficient and quick. |

| | | | | | | | | |
|-------------------|------------------------------|-----------------------|----------|----------------------------|--|--------|------|--|
| Vulnerable Area 3 | Liberty Hose Company Station | Emergency Facilities | N/A | 0-3 Feet (CAT3) | No exposure to sea level rise and low exposure to storm surge | N/a | Low | The Liberty Hose Company is exposed to CAT3 storm surge of between 0-3 feet. Consequences of flooding could damage the structure and any equipment inside. Equipment should be moved upland prior to a CAT3 event. No exposure to Sea Level Rise. |
| Vulnerable Area 3 | First Aid Squad | Emergency Facilities | N/A | 0-3 Feet (CAT3) | No exposure to sea level rise and low exposure to storm surge | N/A | Low | The First Aid Squad is exposed to storm surge from a CAT3 event with 0 to 3 feet of water. It is on the edge of SLOSH models for a CAT3 event and consequences should be minimal. No exposure to Sea Level Rise. |
| Vulnerable Area 3 | Keyport High School | Community Facilities | N/A | 0-3 Feet (CAT3) | No exposure to sea level rise and low exposure to storm surge | N/A | Low | The High School is vulnerable to a CAT3 storm surge of between 0 and 3 feet. Damage to the structure is possible during a CAT3 event. No Sea Level Rise exposure. |
| Vulnerable Area 3 | Central Elementary School | Community Facilities | N/A | 0-3 Feet (CAT3) | No exposure to sea level rise and low exposure to storm surge | N/A | Low | The Elementary School is vulnerable to a CAT3 storm surge of between 0 and 3 feet. Damage to the structure is possible during a CAT3 event. No Sea Level Rise exposure. |
| Vulnerable Area 3 | Bethany Manor | Vulnerable Population | N/A | 0-3 Feet (CAT3) | No exposure to sea level rise and low exposure to storm surge | N/A | Low | Bethany Manor is not exposed to Sea Level Rise and is vulnerable to a CAT3 event with 0-3 feet of water possible. This would only affect the first floor but would still cause damage. Evacuations should occur prior to a CAT3 event. |
| Vulnerable Area 4 | Aeromarine Redevelopment | None | 1-3 Feet | 6-9 feet or greater (CAT3) | Medium exposure to sea level rise and high exposure to storm surge | Medium | High | The Aeromarine Redevelopment area has high exposure to both Sea Level Rise and storm surge. Any new development in that area should be built in a resilient manner to reduce consequences. Additionally, living shoreline techniques and tidal marsh retreat areas should be considered. |
| None | Well | Critical Buildings & | N/A | N/A | No exposure to SLR or storm surge. | N/A | N/A | No Consequences. |
| None | Water Treatment | Critical Buildings & | N/A | N/A | No exposure to SLR or storm surge. | N/A | N/A | No Consequences. |
| None | Water Tower | Critical Buildings & | N/A | N/A | No exposure to SLR or storm surge. | N/A | N/A | No Consequences. |
| None | Electrical Substation | Energy | N/A | N/A | No exposure to SLR or storm surge. | N/A | N/A | No Consequences. |

Appendix B: Vulnerability Rating Key

| Level | Vulnerability Rating Based on Exposure |
|--------|---|
| N/A | No exposure to both Sea Level Rise and Storm Surge and the asset is out of harm's way. No damage, disruption, or accessibility issues are predicted. |
| Low | <p>Exposure to Sea Level Rise: Component is exposed to Sea Level Rise of 3 Feet or higher. 3 feet is the worse case scenario for 2100. Only if this happens, the community asset will be in harm's way.</p> <p>Exposure to Storm Surge: It will take storm surge from a CAT3 Hurricane or stronger to threaten this community asset. Usually it may be susceptible to 0 to 3 feet of water. The asset may still be accessible, disruption should be minimal, and minor structural damage can occur.</p> |
| Medium | <p>Exposure to Sea Level Rise: Component or asset is exposed to Sea Level Rise of 2 Feet or higher. The asset will only be exposed to 2 Feet of SLR. If this occurs, the asset will likely be compromised and normal operations may be disrupted.</p> <p>Exposure to Storm Surge: It will take storm surge from a CAT2 Hurricane or stronger to threaten this community asset. This may involve between 3 to 9 feet of water. The asset will likely not be accessible, disruption will occur to typical operations and involve a moderate level of interruptions if not overall failure. Structural damage will be sustained and may compromise the structure itself.</p> |
| High | <p>Exposure to Sea Level Rise: Component is exposed to Sea Level Rise of 1 Foot or higher. This will likely compromise the asset or at a minimum disrupt normal operations by 2050 when 1 foot of Sea Level Rise is expected to be reached.</p> <p>Exposure to Storm Surge: It will take storm surge from a CAT1 Hurricane or stronger to threaten this community asset. This will involve between 6 to 9, or more, feet of water. The asset will not be accessible, disruption will occur to all operations and involve a high level of interruptions and failure is highly likely. Structural damage will be severe and could compromise the structure itself.</p> |