



THE BOROUGH OF BAY HEAD



COASTAL VULNERABILITY ASSESSMENT REPORT

OCTOBER 2019

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EXECUTIVE SUMMARY

Located on the Barrier Island at the northern end of Barnegat Bay and bordered by the Atlantic Ocean on the east, the Borough of Bay Head remains susceptible to the effects of coastal flooding. Historically, Bay Head has experienced transient flooding in low lying areas as well as experiencing more severe flooding caused by extreme weather events. The combination of gradually rising tidal waters and continuing unpredictable extreme weather events will gradually increase the risk of coastal flooding events in the Borough over time.

In this project, a Working Committee of town officials and volunteers was formed under the direction of the Mayor of Bay Head to conduct a *Coastal Vulnerability Assessment* (CVA), during which the committee participants reviewed and prioritized future risks to the Borough from the combined effects of storm surge and sea level rise. The CVA analyzed three different scenarios:

- Observed current flooding conditions
- Flooding based upon 2050 sea level rise projections (a rise of 1.8 feet) and
- Projected flooding based upon a Category 1 hurricane striking Bay Head in 2050

The CVA results were presented to the Working Committee in two formal presentations. The Committee reviewed the impact of these “CVA scenarios” on 12 high-priority assets in Bay Head. These high-priority assets consist of properties, infrastructure, or natural resources that are of high value to the Bay Head community and/or facilities that might be particularly vulnerable to extreme events. A key element of the CVA findings was to determine whether each individual priority asset would get flooded using the previously described flooding scenarios, what would happen to the asset if it were to be flooded, and the consequences to the Borough if the asset were damaged or unable to function during a flood.

Overall, the Borough of Bay Head’s critical infrastructures will fare well in the various scenarios analyzed in this report. Given the overall experience the Borough gained during landfall of Superstorm Sandy, the majority of the critical infrastructures in Bay Head have either been elevated or retro fitted with flood limiting or preventing elements since the storm. As a result, these high priority assets should remain viable and return to normal operations once clean-up operations are complete, fulfilling their functions to the community even though several of the locations may be impacted during the storm event and the immediate aftermath.

BACKGROUND

On April 1, 2019, the Bay Head Council reaffirmed their participation in the New Jersey Sustainable Jersey program by appointing a Green Team through Resolution 2019-60. (Appendix 1.) This assessment was prepared by Robert Hein and Tom Charlton, members of the Borough of Bay Head Green Team.

One of the actions that the Green Team selected for implementation was the *Coastal Vulnerability Assessment* Action. (Appendix 2.) The Coastal Vulnerability Assessment is a tool for evaluating the degree to which a community's public services, infrastructure, economic centers, neighborhoods and natural areas will be impacted by projected sea level rise and tidal and storm-related coastal flooding, as well as the consequences those vulnerabilities pose to the community. With this information, a municipality can begin to identify and prioritize adaptation strategies to protect its assets.

Coastal Vulnerability Committee

One of the first steps in this assessment was to establish a *Coastal Vulnerability Assessment Committee* and to determine the membership of the committee. The Chair of the Committee is the Parks, Grounds, and Recreation Councilmember. Members of the committee are the Mayor, a Planning Board representative, members of the Office of Emergency Management, the Public Safety Official, the Borough Administrator, the Building Official, a Police Department representative, a Fire Department representative, a Public Works representative, a Bay Head Environmental representative, and the Borough Clerk. (Appendix 3.)

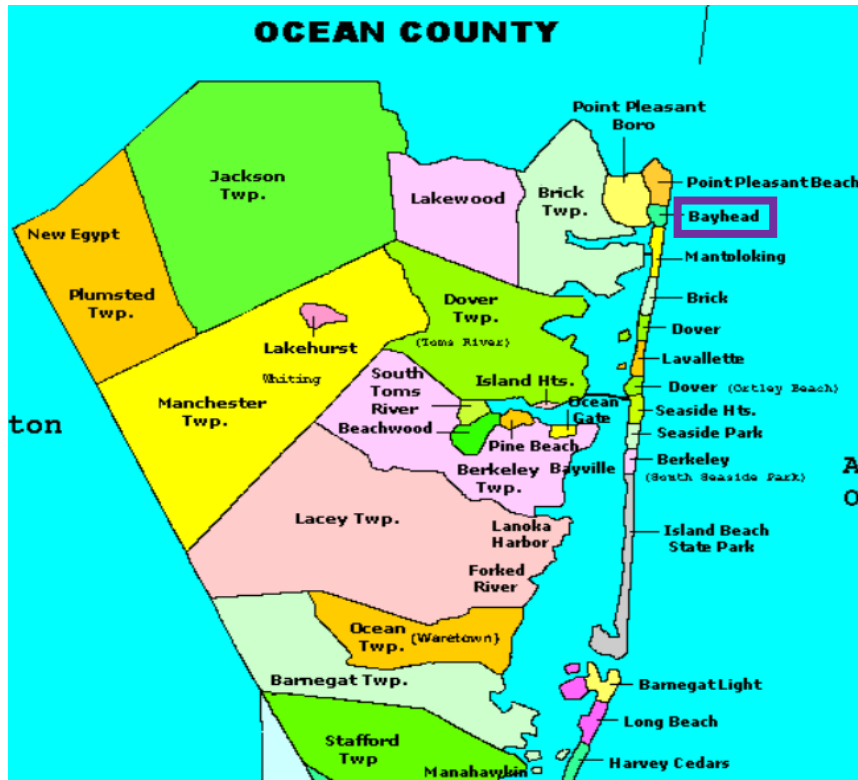
Methodology

The Bay Head Coastal Vulnerability Assessment Committee met for the first time at Borough Hall on Wednesday, August 28, 2019. The Committee reviewed a presentation (Appendix 4) that discussed the Sustainable Jersey program, Bay Head's past and present involvement with the program, and then explained the Coastal Vulnerability Assessment Action requirements. The presentation included a short background on the demographics, geography, climatology, and composition of the Borough and then discussed the current flooding issues that are already being experienced. The presentation concluded with some "homework" assignments for various individuals to review the areas of local flooding, determine the critical infrastructure for the Borough, and complete the *Getting to Resiliency Risk and Vulnerability Assessment* questionnaire. (Appendix 5.)

During the following month, the input was received and integrated with two potential scenarios – sea level rise projected for the year 2050 and the potential impacts of a category one hurricane landing in 2050. The new information integrated into the two flooding scenarios were then presented at the second meeting of the Coastal Vulnerability Assessment Committee on September 25, 2019. (Appendix 6.) This presentation led to significant discussion among the participants.

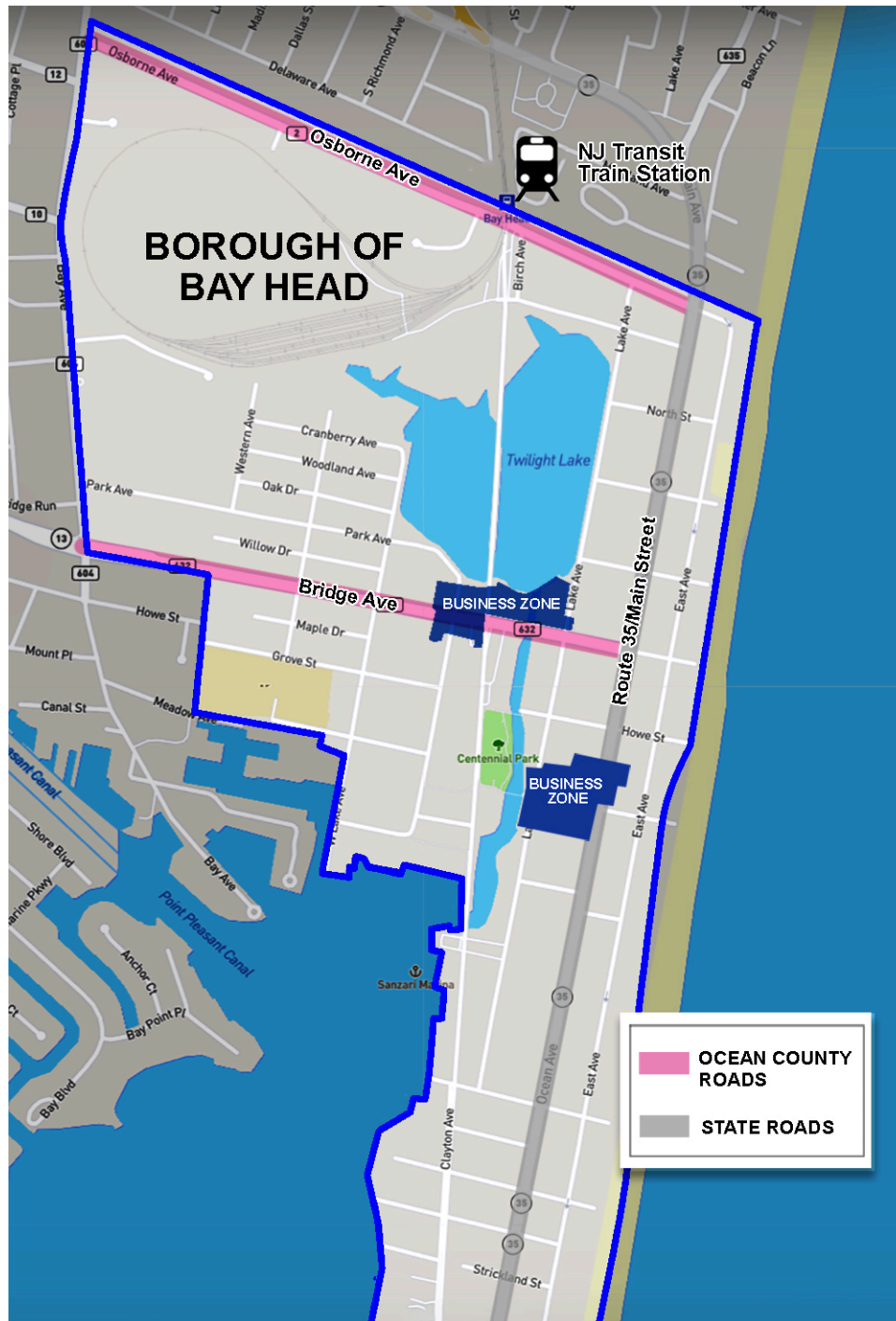
ABOUT BAY HEAD

The Borough of Bay Head was founded in 1886 and is a seasonal shore community situated on the Barnegat Peninsula, also known as the Island Beach Peninsula or Barnegat Bay Island and colloquially as "the barrier island". It consists of an area of approximately 0.7 square miles (1.814 km - 448 acres), including 0.582 square miles of land and 0.118 square miles (0.306 km) of water (which is 16.88% of the total area). Water frontage in the Borough is approximately 1.25 miles of Oceanfront along the eastern edge, .75 miles of Bayfront along parts of the western and southern edge, and 1.2 miles of Lake and Ditch frontage in the center of the Borough along Twilight Lake and Scow Ditch.



The Borough is situated at the northeastern corner of Ocean County at the head of Barnegat Bay with the Borough of Point Pleasant Beach to the north, the Borough of Point Pleasant and Barnegat Bay to the west, the Borough of Mantoloking and Bay Head Harbor to the south and the Atlantic Ocean to the east.

As shown on the map on the next page, there are approximately 11 miles of roadways in Bay Head of which a little over a mile is maintained by Ocean County (most of Bridge Avenue and Osborne Avenue) and 1.34 miles are maintained by the State (Main Street/NJ Route 35). The Borough is bisected east and west by Main Street, also known as New Jersey Route 35, which begins at the northern border with the Borough of Point Pleasant Beach to the southern border with the Borough of Mantoloking. Route 35 is a critical artery for all vehicular traffic coming from the north to the Barrier Island.



Bridge Avenue (Ocean County Road 632) bisects the Borough north and south and runs from New Jersey Route 13, also known as the Loveland Town Bridge, which crosses the Point Pleasant Canal and connects the barrier island with the mainland to the west. Bridge Avenue and is a critical artery for all vehicular traffic coming from the west to the Barrier Island.

There is also a New Jersey Transit Train Station located at the northern edge of the Borough that is the last, most southern stop on the New Jersey Coast Line. The NJ Coast Line connects to Trenton and all points west and north terminating in New York City and is a commuting hub and primary source of mass transit for the area.

Demographics

As of the 2010 United States census, the Borough's resident population was 968, a decline of 270 people from the 1238 people identified in the 2000 census. The summer seasonal population swells to approximately 8,000 to 10,000 people during the months of July through September. The 2010 census data breakout of the residents by age shows that 15.5% were under the age of 18, 17.2% were between 18 and 44 years of age, and 67.3% were over the age of 44 indicating an older population. Over 95% of the population is English speaking.

There are 1023 residences, 46 businesses, four churches, three hotels/B&B's, and a K through 8th grade elementary school located within the Borough. Bay Head maintains their own Police and Fire Departments as well as a Public Works and recycling center facility. The residences are primarily of detached single-family structures, many dating to before the mid-1900's.

Not surprisingly, the Bay Head Historic District, listed in the New Jersey and the National Registers of Historic places in 2005, included over 550 contributing structures (over half of the town's buildings at that time) making it one of the largest historic districts in New Jersey.

Bay Head has two business districts located along Bridge Avenue and Mount Street and depicted in blue in the map on the previous page.

Rainfall

The temperature and rainfall in the Borough of Bay Head is typical for the State of New Jersey. The two hottest months, July and August, correspond to the two wettest months. Rainfall in excess of an inch an hour exceeds the ability of the ground to absorb it and causes localized flooding in low-lying areas that lasts for various durations depending on the water table which in turn is dependent on the amount of rain that had occurred recently and the tides.

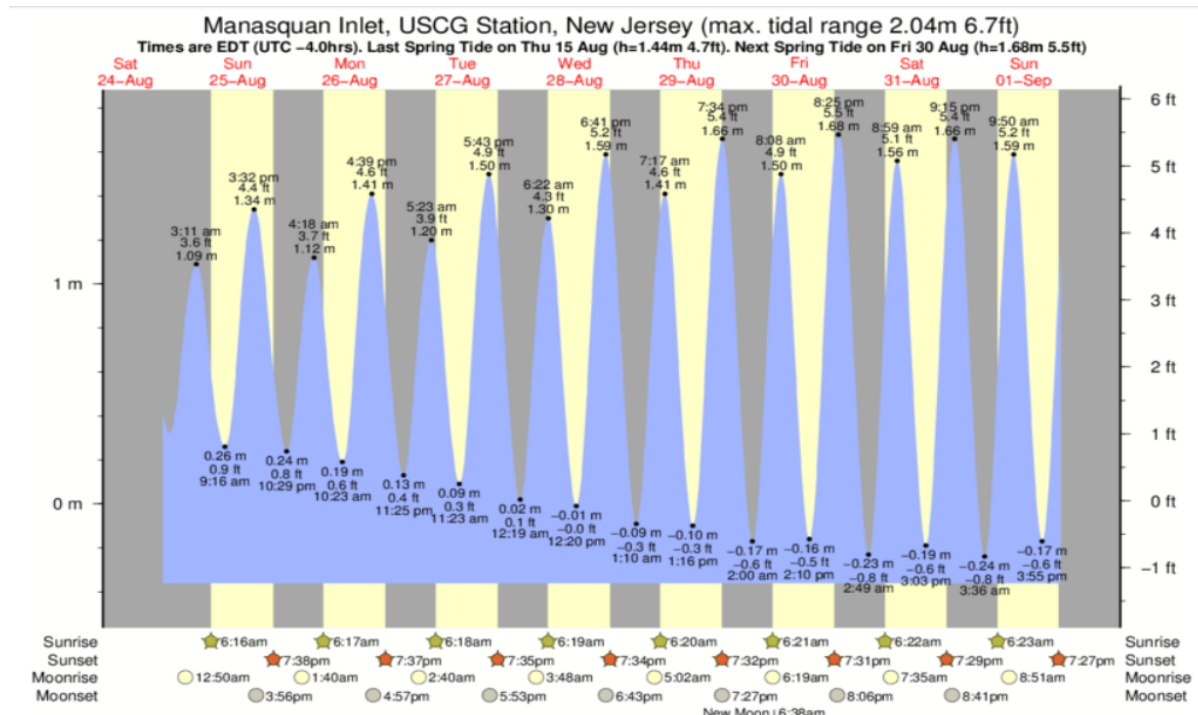
Climate data for Bay Head Beach, NJ (1981-2010 Averages)													
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average high °F (°C)	40.1 (4.5)	42.7 (5.9)	49.4 (9.7)	58.9 (14.9)	68.5 (20.3)	77.9 (25.5)	83.2 (28.4)	82.0 (27.8)	75.9 (24.4)	65.4 (18.6)	55.3 (12.9)	45.1 (7.3)	62.1 (16.7)
Daily mean °F (°C)	32.5 (0.3)	34.6 (1.4)	40.9 (4.9)	50.3 (10.2)	59.9 (15.5)	69.4 (20.8)	74.9 (23.8)	73.8 (23.2)	67.2 (19.6)	56.2 (13.4)	47.0 (8.3)	37.3 (2.9)	53.8 (12.1)
Average low °F (°C)	24.8 (-4.0)	26.4 (-3.1)	32.5 (0.3)	41.7 (5.4)	51.3 (10.7)	60.9 (16.1)	66.6 (19.2)	65.6 (18.7)	58.5 (14.7)	46.9 (8.3)	38.7 (3.7)	29.5 (-1.4)	45.4 (7.4)
Average precipitation in inches (mm)	3.66 (93)	3.10 (79)	4.19 (106)	3.98 (101)	3.49 (89)	3.67 (93)	4.68 (119)	4.45 (113)	3.47 (88)	3.75 (95)	3.98 (101)	4.01 (102)	46.43 (1,179)
Average relative humidity (%)	64.9	62.2	60.5	62.3	66.0	70.5	69.6	71.5	71.3	69.6	68.0	66.3	66.9
Average dew point °F (°C)	22.0 (-5.6)	23.0 (-5.0)	28.3 (-2.1)	37.9 (3.3)	48.5 (9.2)	59.4 (15.2)	64.3 (17.9)	64.0 (17.8)	57.6 (14.2)	46.4 (8.0)	37.0 (2.8)	27.1 (-2.7)	43.1 (6.2)

Tides

Approximately 17% of the Borough is bordered by water that is regularly subject to tidal flow and wind-forced movement. This localized flooding is exacerbated when the ground water table is high which occurs after a heavy rain or when a prolonged southern wind forces the waters of Barnegat Bay towards the northern end of the Bay and/or prevents the normal tide waters from flowing to the south.

Additionally, the Atlantic Ocean, Barnegat Bay, and Twilight Lake are all subject to normal tidal fluctuations. The highest tides occur every two weeks around the periods of full moon and new moon when the moon and sun are in alignment. Once a year, Bay Head experiences a king tide which occurs when the Earth, Moon and Sun are aligned. The king tide is further enhanced when the Earth is closest to the Sun around January 2 of each year.

Along the Atlantic shore, Bay Head can experience almost a seven-foot tide difference between high and low periods.



Historical Storms

Hurricanes, Tropical Storms, and northeasters all impact the Borough of Bay Head as they lead to wind-driven movement of the bodies of water, surges of water on top of normal tidal cycles, and overall higher water levels as a result of the decreased air pressures associated with the low-pressure systems. Excessive water surge caused by extreme weather events not only creates flooding, but also attacks our natural protection from future events by eroding dunes, shorelines and banks.

Bay Head has a long history of hurricanes and other tropical storms causing flooding and beach erosion as well as inflicting wind-related damage.

Between 1886, the founding of the Borough, and 1900, only two significant storms were recorded that negatively impacted the area. On September 10, 1889 a hurricane stalled offshore with the resultant high winds and beach erosion due to high tides, and on August 24, 1893 a hurricane passed along the coast producing strong winds and heavy rainfall and ultimately made landfall near New York City.

The first half of the 20th century brought a number of storm events to the Jersey coast.

On September 16, 1903 a hurricane made landfall at Atlantic City with winds of over 75 mph. Later named the Vagabond hurricane, the storm's strong surf caused erosion but only limited damage due to minimal construction in the area. On August 23, 1933 a hurricane making landfall in North Carolina produced heavy rainfall, high waves, and hurricane-force wind gusts in Atlantic City. An offshore Category 2 hurricane on September 19, 1936 flooded much of Long Beach Island and caused severe beach erosion along the coast, and two years later on September 21, 1938 a hurricane named The Long Island Express caused winds of up to 100 mph and powerful waves along the entire coastline. A tropical storm hit Cape May on August 1, 1944 after passing through the Delmarva Peninsula causing severe beach erosion and high tides. Finally on September 13 and 14, 1944, the Great Atlantic hurricane paralleled the coastline, causing severe flooding, a storm surge of up to 9.6 feet, and intense waves of up to 40 feet in height. Along the entire coastline, strong winds gusted to 125 mph which destroyed hundreds of homes and damaged thousands while the ferocious waves caused massive erosion along the beaches.

The 2nd half of the 20th century saw the start of hurricane naming in 1953. On August 31, 1954, Hurricane Carol brought gusty winds along the coastline and moderate damage. Hurricane Donna passed offshore New Jersey on

September 12, 1960, causing heavy damage along the coast. The hurricane produced 105 mph wind gusts and a storm surge of 6 feet near Atlantic City. On September 20, 1961, Hurricane Esther passed offshore and caused high surf and 70 mph winds along the beaches. Hurricane Doria caused minor damage along the coast on September 16, 1967. Prior to the arrival of Hurricane Belle, 250,000 people evacuated from the shore during the peak of the tourist season. Arriving on August 10, 1976 the hurricane caused winds of 65 mph and gusts of up to 90 mph as well as a storm surge of 8.85 feet in Atlantic City. On October 14, 1984, high surf from Hurricane Josephine caused minor damage and coastal flooding. Hurricane Gloria paralleled the New Jersey coastline just offshore on September 27, 1985 as a Category 2 hurricane, forcing 95,000 people to evacuate. It was being called the storm of the century because it was expected to become the first hurricane to hit the New Jersey coastline since the hurricane in 1903. Although a last-minute turn kept it offshore, it caused storm surges and strong winds. Hurricane Gabrielle also stayed offshore in September 1989 but produced large waves of up to 16 feet. On October 31, 1991, a northeaster called The Halloween Nor'easter, and also known as the Perfect Storm, caused strong waves of up to 30 feet. High tides along the shore were only surpassed by the 1944 hurricane, while significant bay flooding occurred. Strong waves and persistent intense winds caused extreme beach erosion. Tropical Storm Danielle passed inland but caused beach erosion and tidal flooding during a 7.2 ft high tide in Atlantic City. In mid-August, 1995, strong rip currents and persistent high winds from Hurricane Felix caused extensive beach erosion. Tracking offshore on August 23, 1998, Hurricane Bonnie produced rough waves and rip currents. On September 16, 1999, Hurricane Floyd, recently downgraded from a category 1 hurricane to a tropical storm produced an exceptionally high storm surge.

Although we are only less than a fifth of the way through the 21st century, we have already had a number of destructive weather events. On September 19, 2003, Hurricane Isabel passed well to the southwest of the state but caused storm surges of 10.6 feet and persistent strong waves that severely erode beaches along the coast. During the period August 11 through 16, 2005, Hurricane Irene passed offshore and caused rip currents and strong waves. On August 22, 2009, Hurricane Bill passed offshore and caused 10 ft waves and beach erosion. A week later on August 29, 2009, the remnants of Tropical Storm Danny produced high waves and beach erosion.

Two years later Tropical Storm Irene made landfall on August 27 and 28, 2011 as a strong tropical storm caused beach erosion and sustained winds of 59 mph in Cape May prompted residents of coastal communities to evacuate.

During the period of October 29 and 30, 2012, Hurricane Sandy moved to within 50 miles of the coastline before dropping to an extratropical cyclone. The storm brought hurricane-force winds, record low pressure, and a momentous storm surge along the coast estimated to be 13 – 18 feet along Bay Head. Widespread devastation is noted on the Barnegat Peninsula. All of New Jersey Transit's commuter rail operations was affected and New Jersey had its worst power outage in history. Hurricane Sandy was the most destructive hurricane ever recorded in New Jersey.

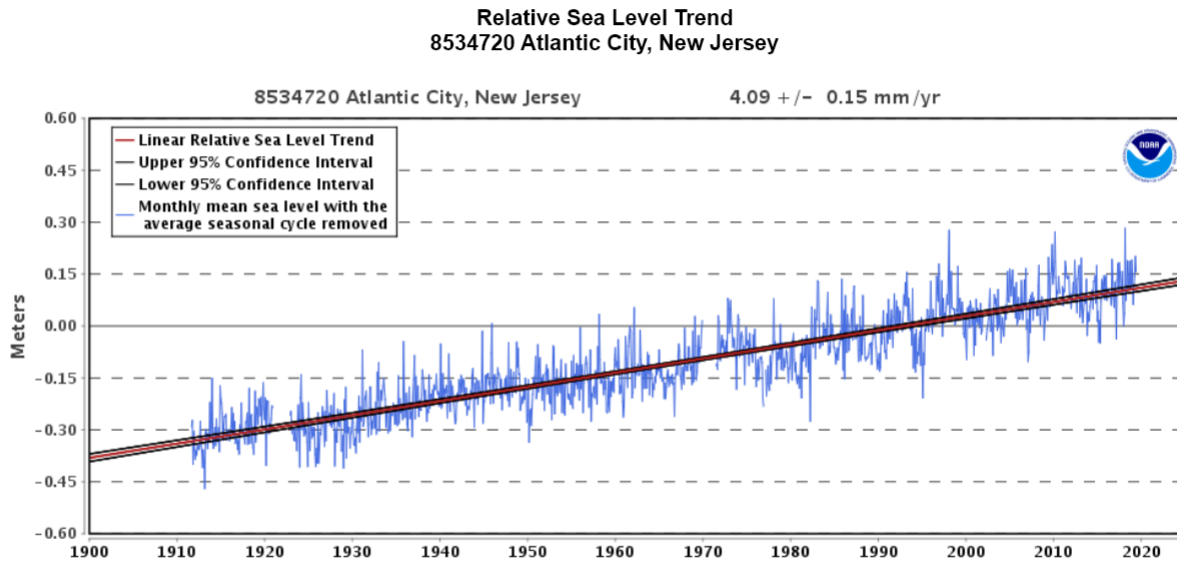
On July 4, 2014, Hurricane Arthur passed to the east of New Jersey producing strong waves that buffeted the coastline. The following month Hurricane Cristobal passed well offshore but again generates strong waves. On September 5, 2016, Hurricane Hermine passed off the coast as a powerful post-tropical cyclone generating strong waves and minor coastal flooding. Finally, on September 19, 2017, large waves from Hurricane Jose cause beach erosion.

Sea Level Rise

✓**NOTE:** This assessment does not attempt to address the reasons for sea level rise, nor explore options to slow, stop, or reverse the trend.

There are two sea-level height measuring sites along the Atlantic Coastline of New Jersey – Atlantic City and Cape May. This assessment uses the data from Atlantic City as it is closer to Bay Head, although the data from the two sites was similar.

Data regarding the sea level at Atlantic City is depicted below and was collected monthly from 1991 through 2018, A linear regression model was applied to the data points and is shown by the red line in the chart below. Over the period studied, the average rise in sea level was 4.09 millimeters (which is 0.16 of an inch) a year. This equates to 1.34 feet sea rise per hundred years.



Wetlands

This map, provided by the *Department of Environmental Protection*, shows that the majority of the wetlands in the Borough are located along the western edge of Twilight Lake, where there are few residences or structures, while the wind-driven flooding and tidal flooding traditionally comes from the south.

Although the Borough of Bay Head is surrounded by water and does contain areas of wetlands and marshes, the wetlands location in relationship to potential flooding negates their ability to impact them.



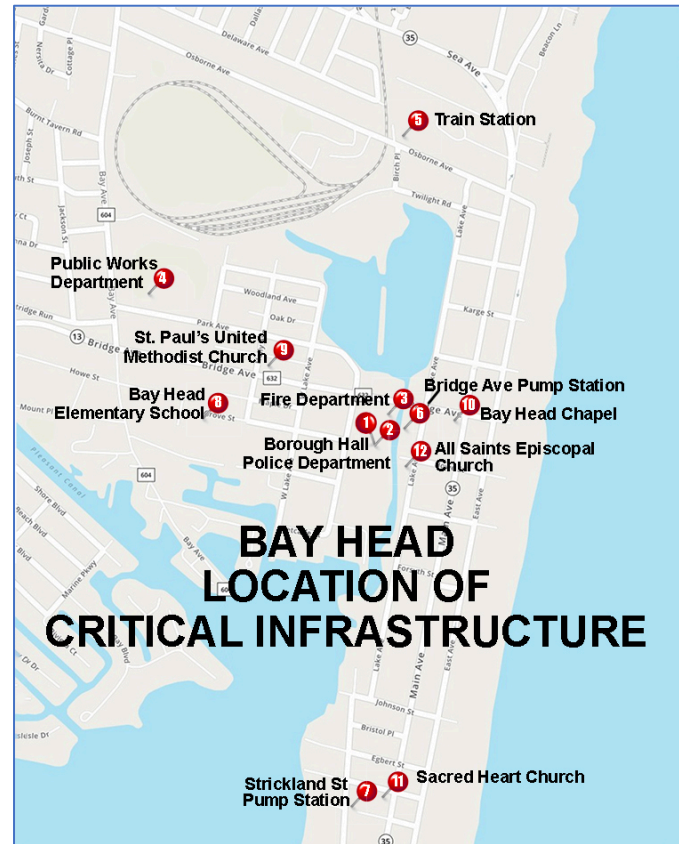
VULNERABILITY ANALYSIS

Critical Infrastructure

The Office of Emergency Management, in coordination with the Mayor, reviewed the structures and facilities in the Borough to determine which should be classified as critical to operations during pre or post incidents or the continued functioning of the Borough.

A list of twelve critical infrastructures, their function, and their location was developed as follows:

#	ASSET	FUNCTION
1	Borough Hall	Emergency Operations Center
2	Police Station	Law and order
3	Fire Company	Fire protection and rescue capabilities
4	Public Works	Equipment and resources
5	Bay Head Train Station	Transportation hub
6	Bridge Avenue Pump Station	Utility
7	Strickland Street Pump Station	Utility
8	Bay Head School	Place of last resort
9	St. Paul's United Methodist Church	Place of last resort
10	Bay Head Chapel Manse	Place of last resort
11	Sacred Heart Church	Place of last resort
12	All Saints Episcopal Church	Place of last resort



Flooding Under Current Conditions

The Borough of Bay Head experiences flooding in low lying areas based on rainfall, tides, southerly winds, and storms. These occurrences are somewhat predictable with knowledge of future weather conditions, tides, and existing conditions on the ground.

The map below indicates the areas of recent and recurring flooding (shown in turquoise blue) in relation to the critical infrastructure locations as well as the two business districts (pink areas) and is based on information obtained from the Bay Head Public Works Department.



Appendix 7 provides evaluation criteria for rating the severity of flooding over two different dimensions:

- *Vulnerability* which considers factors such as exposure to flooding and disruption of operation.
- *Consequence* which is the effect on the community if an asset is temporarily or permanently damaged or impaired and the extent or duration of that disruption.

Using this rating system, each of the 12 critical infrastructure assets were evaluated - first under the current flood condition and then under the two CVA flood scenarios described on the following pages. For each case, the critical assets were rated on a scale from “Insignificant” (e.g. little or no exposure/consequence, etc.) to “High” (e.g. majority of property destroyed, operation impaired for extended period, etc.). Please refer to Appendix 7 for additional information regarding the specific criteria for each rating.

The following chart summarizes the vulnerability of the 12 critical infrastructure assets in Bay Head under current flood conditions.

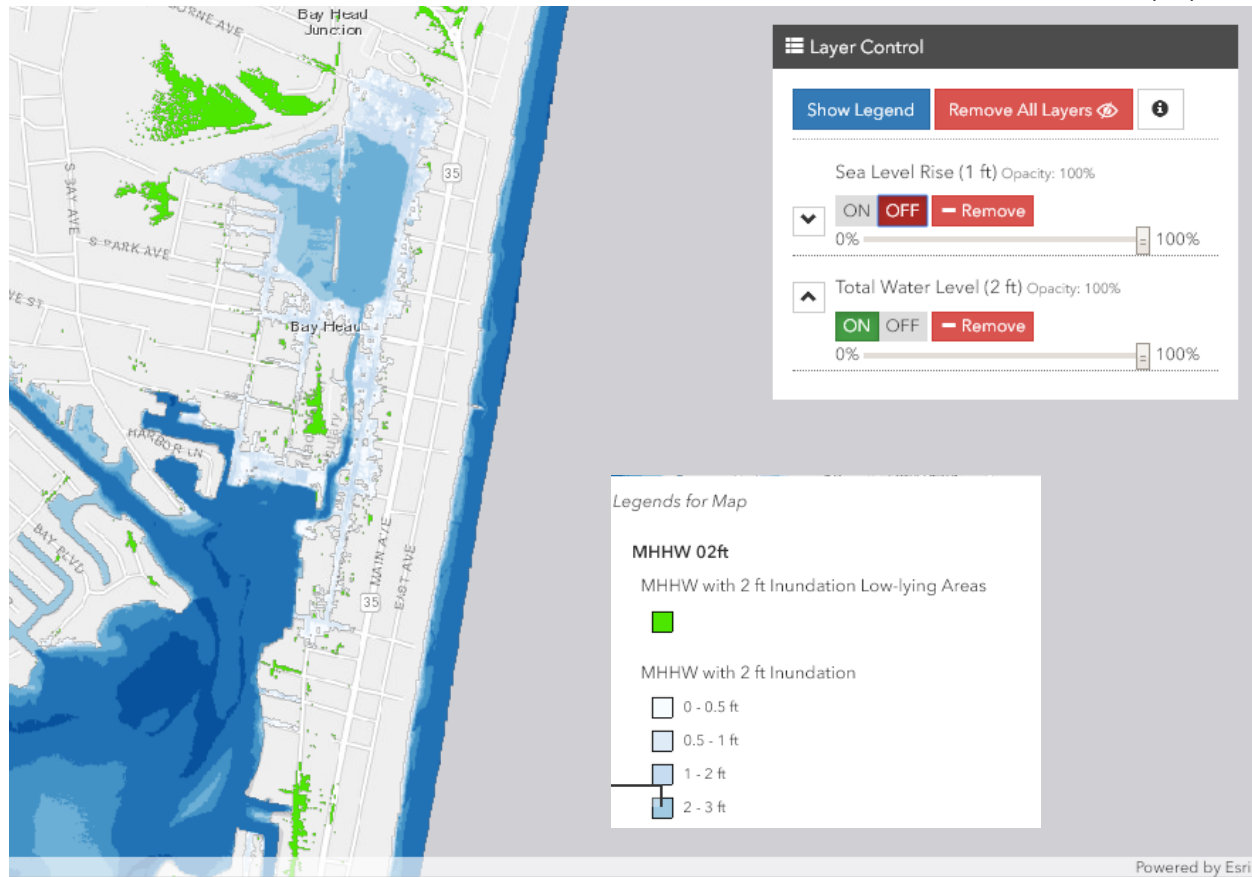
CRITICAL INFRASTRUCTURE ASSET	ASSET CATEGORIZATION/ FUNCTION	VULNERABILITY (APPENDIX 7)	CONSEQUENCES (APPENDIX 7)
1. BOROUGH HALL	Borough Hall	Insignificant	Insignificant
2. POLICE DEPARTMENT	Police Department	Insignificant	Insignificant
3. FIRE DEPARTMENT	Fire Department	Insignificant	Insignificant
4. PUBLIC WORKS DEPARTMENT	Public Works Department	Insignificant	Insignificant
5. BRIDGE AVE PUMP STATION	Utility	Insignificant	Insignificant
6. STRICKLAND AVE PUMP STATION	Utility	Insignificant	Insignificant
7. BAY HEAD TRAIN STATION	Transportation	Insignificant	Insignificant
8. BAY HEAD ELEMENTARY SCHOOL	School/Place of Last Resort	Insignificant	Insignificant
9. SACRED HEART CHURCH	Place of Last Resort	Insignificant	Insignificant
10. ST. PAUL'S UNITED METHODIST CHURCH	Place of Last Resort	Insignificant	Insignificant
11. BAY HEAD CHAPEL MANSE	Place of Last Resort	Insignificant	Insignificant
12. ALL SAINTS EPISCOPAL CHURCH	Place of Last Resort	Insignificant	Insignificant

In short, the conclusion reached is that the level of current flooding, while annoying and sometimes impacting a few roadways, does not negatively impact any of the identified critical infrastructures in the Borough of Bay Head.

Flooding Under Scenario 1 – Sea Rise 2050

The Coastal Vulnerability Action requires that the critical infrastructures be overlaid on the projected sea levels for the year 2050 and assessed.

While there are numerous studies, theories and predictions on how the rise will continue into the future, this analysis utilized the data prepared by Rutgers which predicted a sea level rise of between 1.6 to 1.8 feet by the year 2050. The available data and charts are only set in whole numbers of feet so the vulnerability analysis was conducted using a sea rise of 2 feet instead of the projected 1.8 feet.

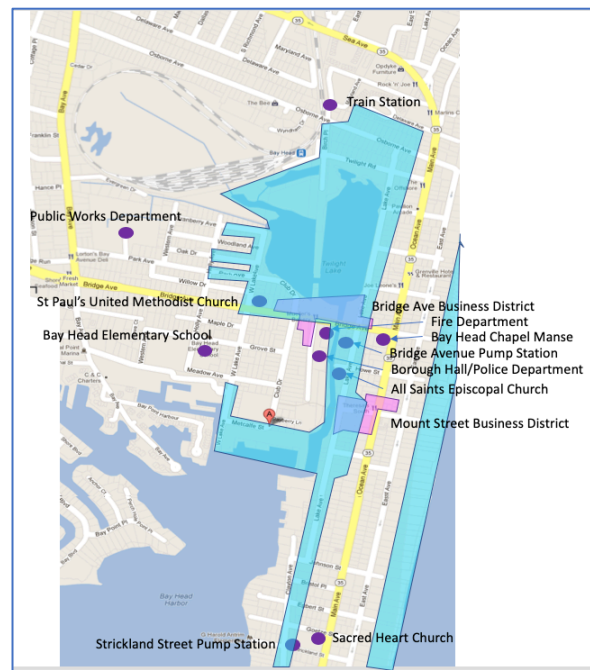


Not surprisingly the locations predicted to have increased water levels for 2050 tend to cluster around and extend the flooding in the previously identified areas of current flooding and then further spread along the low-lying terrain. Those areas that currently flood show potential depths in 2050 of 1 – 3 feet while the newly affected areas are normally less than 1 foot.

Taking the data from the 2-foot sea rise map and overlaying it onto the map with the Borough of Bay Head's critical infrastructure, three high-priority locations are identified as being impacted:

- St. Paul's United Methodist Church
- All Saint's Episcopal Church
- Pump Station on Bridge Avenue

At all three impacted critical locations the water is predicted to be between 1 and 2 feet.



Applying this information to the Vulnerability and Consequences keys located at Appendix 7, results in the following chart.

CRITICAL INFRASTRUCTURE ASSET	ASSET CATEGORIZATION/ FUNCTION	VULNERABILITY (APPENDIX 7)	CONSEQUENCES (APPENDIX 7)
1. BOROUGH HALL	Borough Hall	Insignificant	Insignificant
2. POLICE DEPARTMENT	Police Department	Insignificant	Insignificant
3. FIRE DEPARTMENT	Fire Department	Insignificant	Insignificant
4. PUBLIC WORKS DEPARTMENT	Public Works Department	Insignificant	Insignificant
5. BRIDGE AVE PUMP STATION	Utility	Low	Minor
6. STRICKLAND AVE PUMP STATION	Utility	Insignificant	Insignificant
7. BAY HEAD TRAIN STATION	Transportation	Insignificant	Insignificant
8. BAY HEAD ELEMENTARY SCHOOL	School/Place of Last Resort	Insignificant	Insignificant
9. SACRED HEART CHURCH	Place of Last Resort	Insignificant	Insignificant
10. ST. PAUL'S UNITED METHODIST CHURCH	Place of Last Resort	Low	Minor
11. BAY HEAD CHAPEL MANSE	Place of Last Resort	Insignificant	Insignificant
12. ALL SAINTS EPISCOPAL CHURCH	Place of Last Resort	Low	Minor

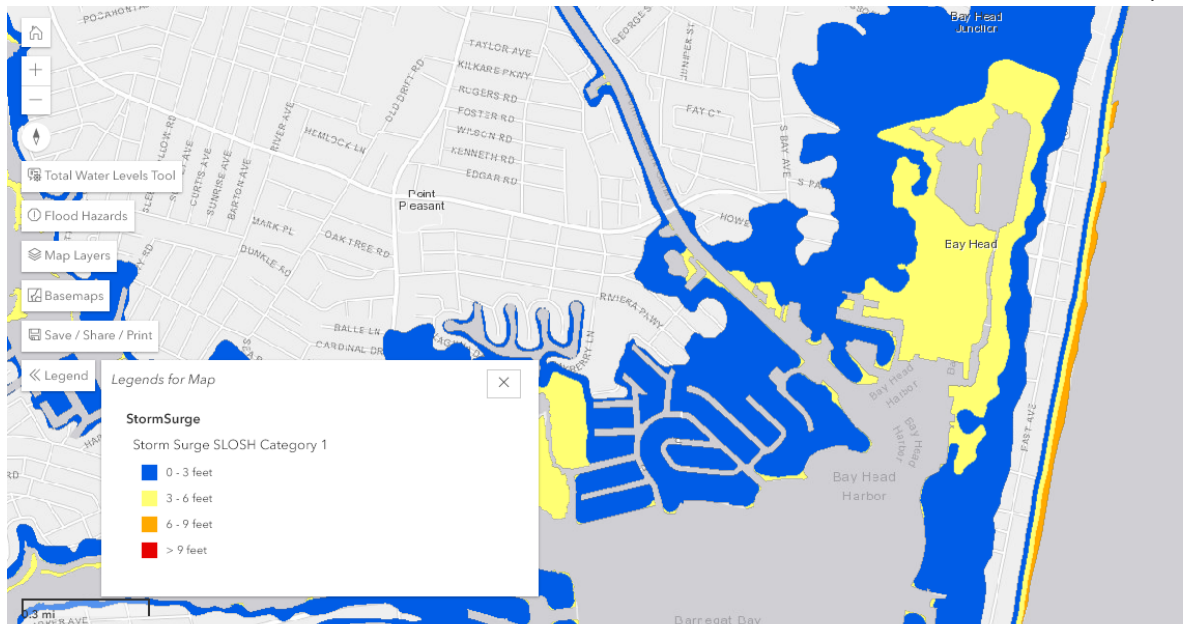
The take-aways from this analysis are that all three of the critical infrastructures impacted would continue to operate and fulfill their functions, but at times, access could be hindered by standing water. Besides cleaning the affected properties, there is no expectations of any structural damage or lasting environmental impacts.

Flooding Under Scenario 2 – Category 1 Hurricane in 2050 – Episodic Flooding

Further, the Coastal Vulnerability Action requires that the critical infrastructures be overlaid on a second scenario. The second scenario explores the flooding impact assuming that a Category 1 hurricane were to strike Bay Head in the year 2050.

As a result of Superstorm Sandy which hit the New Jersey coast in October of 2012, there has been a significant amount of data collected on storm surges, water levels, and inundation levels. Although technically the storm had been downgraded to a tropical storm, the force it retained and the impacts it created were close enough to a category 1 hurricane to allow us to use its impact for this scenario.

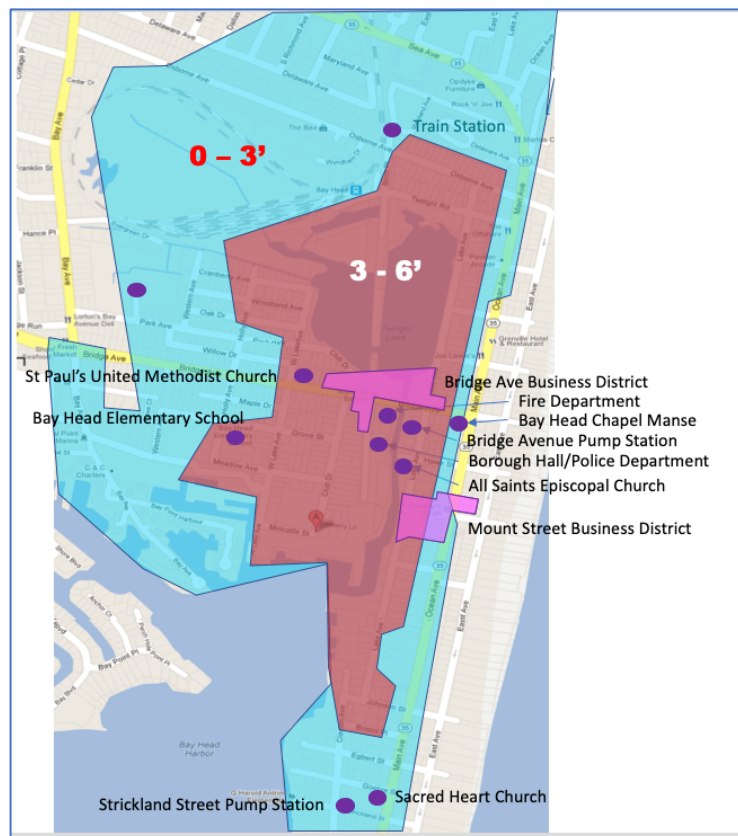
The map on the next page uses the predicted *SLOSH* (sea, lake, and overland surges from hurricanes) data for a category 1 hurricane in Bay Head. The peak height and duration of these predicted water levels will depend on the direction, strength and length of time of the winds, the amount of barometric pressure drop associated with the storm, the cycle of the tides, and the amount of accompanying rainfall. The faster the hurricane moves through the area, the sooner the water levels will fall. During Sandy, the peak water levels lasted less than two hours and much of the higher water drained after two tide cycles.



Taking the data from this map and overlaying it onto the map with the Borough of Bay Head's critical infrastructure, three locations are identified as being moderately impacted – the same three locations as identified in Scenario 1.

At all three locations, St. Paul's United Methodist Church, All Saint's Episcopal Church, and the pump station on Bridge Avenue, the water is predicted to be between 1 and 2 feet. Although all the critical infrastructures were repaired and retro fitted with flood limitation and prevention, there is likely to be minor damages,

Taking the data from the SLOSH map and overlaying it onto the map with the Borough of Bay Head shows that virtually all of the Borough is affected. There is an impact on all the critical infrastructures identified, although as a result of improvements and reconstruction that occurred post-Sandy, many are now able to either continue operations or at least resume operations in a short period of time.



Applying this information to the Vulnerability and Consequences keys located at Appendix 7, results in the following chart.

CRITICAL INFRASTRUCTURE ASSET	ASSET CATEGORIZATION/ FUNCTION	VULNERABILITY (APPENDIX 7)	CONSEQUENCES (APPENDIX 7)
1. BOROUGH HALL	Borough Hall	Low	Minor
2. POLICE DEPARTMENT	Police Department	Low	Minor
3. FIRE DEPARTMENT	Fire Department	Moderate	Moderate
4. PUBLIC WORKS DEPARTMENT	Public Works Department	Low	Minor
5. BRIDGE AVE PUMP STATION	Utility	Moderate	Moderate
6. STRICKLAND AVE PUMP STATION	Utility	Low	Minor
7. BAY HEAD TRAIN STATION	Transportation	Low	Minor
8. BAY HEAD ELEMENTARY SCHOOL	School/Place of Last Resort	Low	Minor
9. SACRED HEART CHURCH	Place of Last Resort	Low	Minor
10. ST. PAUL'S UNITED METHODIST CHURCH	Place of Last Resort	Low	Minor
11. BAY HEAD CHAPEL MANSE	Place of Last Resort	Low	Minor
12. ALL SAINTS EPISCOPAL CHURCH	Place of Last Resort	Moderate	Moderate

The three critical infrastructures listed as moderate above each have differing impacts.

- The **Fire Department** will move its trucks and equipment to a safe location prior to the event and the building has been retrofitted with flood prevention devices and a generator. Once the equipment returns to the Borough and the streets are cleared, normal operations will resume.
- **All Saints Church** was not able to be raised after Superstorm Sandy. Although many flood deterring retro fits were accomplished, it is expected that they will sustain damage during an event of this magnitude.
- The **Pump Station on Bridge Avenue** was refurbished after Superstorm Sandy but is expected to sustain damage during a storm like this.

Conclusions

Overall, the Borough of Bay Head's critical infrastructures will fare well in the various scenarios analyzed above. Even though some of the critical infrastructure locations may be impacted during the storm event and the immediate aftermath, they should remain viable and return to normal operations once clean-up operations are complete, fulfilling their functions to the community.

Given the overall experience the Borough gained during landfall of Superstorm Sandy, the majority of the critical infrastructures in Bay Head have either been elevated or retro fitted with flood limiting or preventing elements since the storm:

- The Borough Hall and Police Department were raised and outfitted with a generator.
- The Fire Department was retro fitted with a flood prevention system that should keep it dry and added a generator.
- Both the Bay Head School and St. Paul's took measures to move all utilities and at-risk elements above flooding level.
- New Jersey Transit raised all electrical signaling and switching equipment above flood level.

The more critical longer-term impact, however, may well be to the business and residential community.

Although new businesses are required to elevate to current standards, the majority of the two business districts were constructed between 75 – 100 years ago and will face significant damage as they did during Superstorm Sandy.

As a result of the damage wrought by Superstorm Sandy, many residences have been elevated. However, many of the historical residences do not lend themselves to being raised. As they are demolished and replaced, the new houses do meet current building requirements, but this is a slow process and will take many decades to complete.

NEXT STEPS

At the end of the second presentation, the Coastal Vulnerability Assessment Committee discussed the way ahead. It was felt that the CVA information should be shared among the Borough, possibly through a link on the Borough's Flood Information web page. Utilizing the Borough web site would allow access by both the year round and summer residents as well as the business owners. Also, the Coastal Vulnerability Assessment Committee should reconvene periodically to review up dated information on both climate change and critical infrastructure in the Borough.

APPENDICES

The Appendices for this report are provided in this Section. Due to the size of several of the appendices, the larger appendices have not been included in this document. Rather, the full set of all Appendices, including the larger appendices, can be downloaded in their entirety by clicking on this link: [DOWNLOAD FULL APPENDICES](#)

Appendix 1. Borough of Bay Head - Council Support for Sustainable Jersey

RESOLUTION

2019-60

RESOLUTION OF THE BOROUGH OF BAY HEAD AFFIRMING A SUSTAINABLE JERSEY GREEN TEAM COMMITTEE

WHEREAS, the Borough of Bay Head had previously adopted Resolution 2015-78 to create a Green Team to pursue Certification in the Sustainable Jersey Municipal Certification Program, this previous Green Team has achieved Bronze Level Certification in 2016, and the Borough of Bay Head wishes to retain or better this achievement; and

WHEREAS, the Borough of Bay Head strives to save tax dollars, assure clean air and water, improve working and living environments to build a community that is sustainable economically, environmentally and socially; a community which would thrive well into the new century; and

WHEREAS, the Borough of Bay Head wishes to build a model of government which benefits our residents now and far into the future with green community initiatives which are easy to replicate and affordable to implement; and

WHEREAS, in an attempt to focus attention on "Green" issues, the Borough wishes to establish a Sustainable Jersey Green Team Committee; and

WHEREAS, the Borough Committee of the Borough of Bay Head wants to begin the process of focusing on environmental and energy issues by starting with audits of municipality facilities and operations, reduce energy use, preserve the natural environment, promote good recycling practices, encourage conservation, present community and educational programs relating to environmental and preservation issues and follow the guidelines of Sustainable Jersey that are appropriate for the community of Bay Head; and

NOW, THEREFORE BE IT RESOLVED, by the Borough of Bay Head that we do hereby establish a Sustainable Jersey-Green Team Committee consisting of interested members of the community and residents of Bay Head, appointed bi-annually, but whose initial term of appointment shall be through December 31, 2019.

THEREFORE BE IT FURTHER RESOLVED, by the Borough of Bay Head that the Mission, Goals and Objectives of the Sustainable Jersey-Green Team through December 31, 2019 are established as follows:

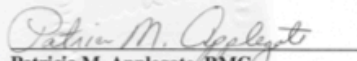
MISSION

The Borough of Bay Head Sustainable Jersey-Green Team will advise the Borough on ways to improve municipal operations with environmentally appropriate initiatives which are economically and environmentally sound through research and evaluation.

NOW, THEREFORE BE IT FINALLY RESOLVED, by the Borough of Bay Head, that the following persons are hereby appointed to the Bay Head Sustainable Jersey-Green Team herein attached as Schedule "A" for the remainder of the current year until December 31, 2019.

CERTIFICATION

I, Patricia M. Applegate, do hereby certify that the foregoing is a true copy of a resolution adopted by the Governing Body of the Borough of Bay Head at a meeting held on April 1, 2019.


Patricia M. Applegate, RMC
Borough Clerk, Borough of Bay Head

Schedule "A"

1. Mayor Bill Curtis
2. Councilwoman Diane Cornell
3. BHEC Chair Daniel Paulus
4. BHEC Member Heather Robertson
5. Planning Board Member / BHEC Member Tom Charlton
6. Citizen / Member Bay Head Fire Department Bob Hein

Appendix 2. Sustainable Jersey - Coastal Vulnerability Assessment Action

Due to the size of this document, Appendix 2 will be provided under separate cover.

Appendix 3. Coastal Vulnerability Assessment Committee Composition

This letter from the Mayor of Bay Head, William W. Curtis, formally creates and appoints the members of the Coastal Vulnerability Assessment Committee.



BOROUGH OF BAY HEAD

MAYOR WILLIAM W. CURTIS

October 9, 2019

To Whom It May Concern:

The following will be appointed to the Coastal Vulnerability Assessment Committee on November 4, 2019.

Committee Chair: Diane Cornell, Councilmember Parks, Grounds and Recreation

Mayor: William W. Curtis

Administrator: Chris Parlow

Office of Emergency Management: Doug Applegate, Coordinator

Office of Emergency Management: Kelley Mickle, Deputy Coordinator

Borough Safety Coordinator: Chris Parlow

Environmental Committee Representative: Tom Charlton

Police Department Representative: William Hoffman, Chief

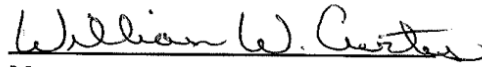
Fire Department Representative: Steve Fitzpatrick, Chief

Public Works Representative: Larry Gilman, Supervisor

Planning Board Representative: Jacqueline Keer

Construction Official: Todd Morgano

Borough Clerk: Patricia Applegate


Mayor

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Appendix 4. Coastal Vulnerability Committee - First Presentation - 08/28/2019

Due to the size of this document, Appendix 4 will be provided under separate cover.

Appendix 5. Getting to Resilience Questionnaire

Due to the size of this document, Appendix 5 will be provided under separate cover.

Appendix 6. Coastal Vulnerability Committee - Second Presentation-09/25/2019

Due to the size of this document, Appendix 6 will be provided under separate cover.

Appendix 7. Keys to Vulnerability and Consequences Ratings

Vulnerability Rating Key	
Level	Definition
Insignificant	Exposure to flooding: Located out of harm's way. Physical/Structure damage: No damage expected. Disruption/Impairment: No disruption to function. Accessibility: No interruption.
Low	Exposure to flooding: Mostly located out of harm's way. Physical/Structure damage: Minor damages expected. Disruption/Impairment: Limited disruption if any. Accessibility: Minimal interruption.
Moderate	Exposure to flooding: Significant portion in harm's way. Physical/Structure damage: Minor damage expected. Disruption/Impairment: Limited disruption. Accessibility: Secondary routes available.
High	Exposure to flooding: Majority is in harm's way. Physical/Structure damage: Significant damage and high degree of loss. Disruption/Impairment: Significant disruption or ceasing of operations. Accessibility: None.

Consequence Rating Key	
Level	Definition
Insignificant	Property damages: Minor damage. Typical operations: No impact. Environment: No impact. Emergency Response: No impact. Hazardous Materials: No impact. Municipal budget: No impact.
Minor	Property damages: Limited property damaged or destroyed. Typical operations: Limited disruption. Environment: Minor damage or loss to habitat. Emergency Response: Slight decrease in response times and effectiveness. Hazardous Materials: Limited spills and minor impacts. Municipal budget: Minor costs.
Moderate	Property damages: Substantial property damaged or destroyed. Population displacement: Long-term displacement. Typical operations: Disrupted and using back-up systems. Environment: Major damage or loss to habitat. Emergency Response: Significant degradation in response times and effectiveness. Hazardous Materials: Major spills with significant risk. Municipal budget: Significant costs.
High	Property damages: Majority of property destroyed. Population displacement: Permanent population displacement. Typical operations: Impacted for extended period. Environment: Permanent damage or loss to habitat. Emergency Response: Not functioning. Hazardous Materials: Spills require multi-year clean-up.