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BORDENTOWN TOWNSHIP, NJ

COASTAL VULNERABILITY

ASSESSMENT REPORT



NEW JERSEY
RESILIENT
COASTAL
COMMUNITIES
INITIATIVE

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



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Executive Summary

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

In this project, Bordentown Township elected officials, staff, and consultants worked with the Delaware Valley Regional Planning Commission (DVRPC) to conduct a coastal vulnerability assessment (CVA), in which participants reviewed and prioritized future risks to the township from the combined effects of storm surge and sea level rise. The CVA used 2100 sea level rise projections (3.3 feet) in combination with a model that shows the depth and extent of storm surge from a Category 2 storm if it were to strike at high tide and at an angle and direction that maximized the amount of surge.

The CVA project team reviewed the impact of this “CVA scenario” on 12 assets in Bordentown. Assets include properties, infrastructure, or natural resources that are of high value to the community and/or facilities and populations that might be particularly vulnerable to extreme events (see Table 1). The project team determined whether each asset would get flooded using the previously described flooding scenario, what would happen to the asset if it were to be flooded, and the consequences to the township if the asset were damaged or unable to function during a flood.

Table 1: Breakdown by Type for All Analyzed Assets

Asset Category	Count
Utility	4
Evacuation Route/Transportation	3
Vulnerable Population	1
Hazardous Site	1
Priority Growth Area	1
Open Space	1
Cultural Site/Open Space	1
Total Number of Assets	12

Bordentown has a low overall vulnerability to the flooding scenario described, although the analysis revealed four assets that Bordentown should consider as being of high concern (Table 2).

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

Asset Category	Count
Evacuation Route/Transportation	2
Hazardous Site	1
Utility	1

The four assets of high concern include the River LINE railway (transportation asset), the Interstate Route 295 (I-295) crossing at Crosswicks Creek (evacuation route and transportation asset), the former North American Salvage Company site (hazardous site), and the township's bulkhead along the Delaware River (utility, specifically a flood control structure).

Bordentown CVA

Introduction

The CVA is a tool to help communities plan for flooding along their coastlines and tidal waterways and prioritize flood mitigation strategies, enabling them to better manage and recover from these floods. Every level of government—federal, state, and local—has a role in planning for stressors and threats likely to afflict its citizens. However, municipalities that have the tools to understand, predict, and prepare for the natural disasters that occur within their borders are arguably best poised to assist their constituents in reducing potential harms associated with climate hazards and extreme weather events.

The CVA assesses the degree to which a community's "assets" (its properties, infrastructure, natural resources, and populations) will be affected by flooding from projected sea level rise and storm events. For those assets that are affected, the CVA analyzes the consequences that their temporary or long-term loss poses to the community. With this assessment, communities will be better informed to make decisions about land use planning, flood mitigation, sea level rise adaptation, infrastructure maintenance, capital improvements, and post-disaster recovery.

On August 27, 2015, Bordentown Township met with DVRPC, the region's Metropolitan Planning Organization, to begin the CVA process. The project team used a CVA methodology created by Sustainable Jersey within the New Jersey Resilient Coastal Communities Initiative, a program run by the Office of Coastal and Land Use Planning in the New Jersey Department of Environmental Protection (NJDEP). NJDEP and Sustainable Jersey developed the methodology to help municipalities prepare for sea level rise and likely increases in the frequency of extreme storm events.

Bordentown's Location

Bordentown Township is a suburban municipality that encompasses 9.3 square miles in Burlington County, New Jersey. Located along the tidal Delaware River and bisected by tidal sections of Crystal Creek, Blacks Creek, and Crosswicks Creek, Bordentown will feel the effects of sea level rise. At the same time, it will be affected by the stronger storms anticipated in the northeastern United States. The combination of rising tidal waters, increasingly severe coastal storms, and more extreme precipitation events will increase the risk of flooding in the township over time.

Historical Flooding in Bordentown Township

Like other communities in New Jersey, Bordentown Township is susceptible to extreme precipitation events and potential flooding, but to the knowledge of the participants in the CVA, the township has not had a highly damaging coastal flood event in recorded history. Communities north of the head-of-tide at Trenton along the Delaware River have experienced numerous devastating coastal floods since the beginning of the 20th century, with eight major floods having occurred since 1996. However, the impacts of these floods were experienced from Trenton northward, where the river is not tidal and the water is confined to a narrower channel.

In Bordentown, CVA participants mentioned "coastal" flooding in recalling that NJ Route 206 (NJ-206), an emergency evacuation route that passes over a tidal portion of Crosswicks Creek, overtops by 1.5 feet in major storms. Instead of coastal flooding, historical storm events in the township have caused localized

stormwater flooding, particularly along Jumble Gut Run in the northern part of the township. Jumble Gut Run has become hazardous, as one CVA participant noted, to residents living along Groveville Road and the “Tree Streets” (Oak Street, Spruce Street, Pine Street, and Elm Street), as well as in the Sylvan Glen neighborhood, because of the potential of street flooding to block ingress to and egress from those neighborhoods.

Bordentown Township’s Coastal Vulnerability

Why a CVA is Relevant to Bordentown Township

Despite the lack of catastrophic coastal floods in Bordentown’s past, the combination of sea level rise and increases in the intensity and frequency of coastal storms caused by climate change will introduce new vulnerabilities in Bordentown that the township will need to address.

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

Sea Level Rise

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

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

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

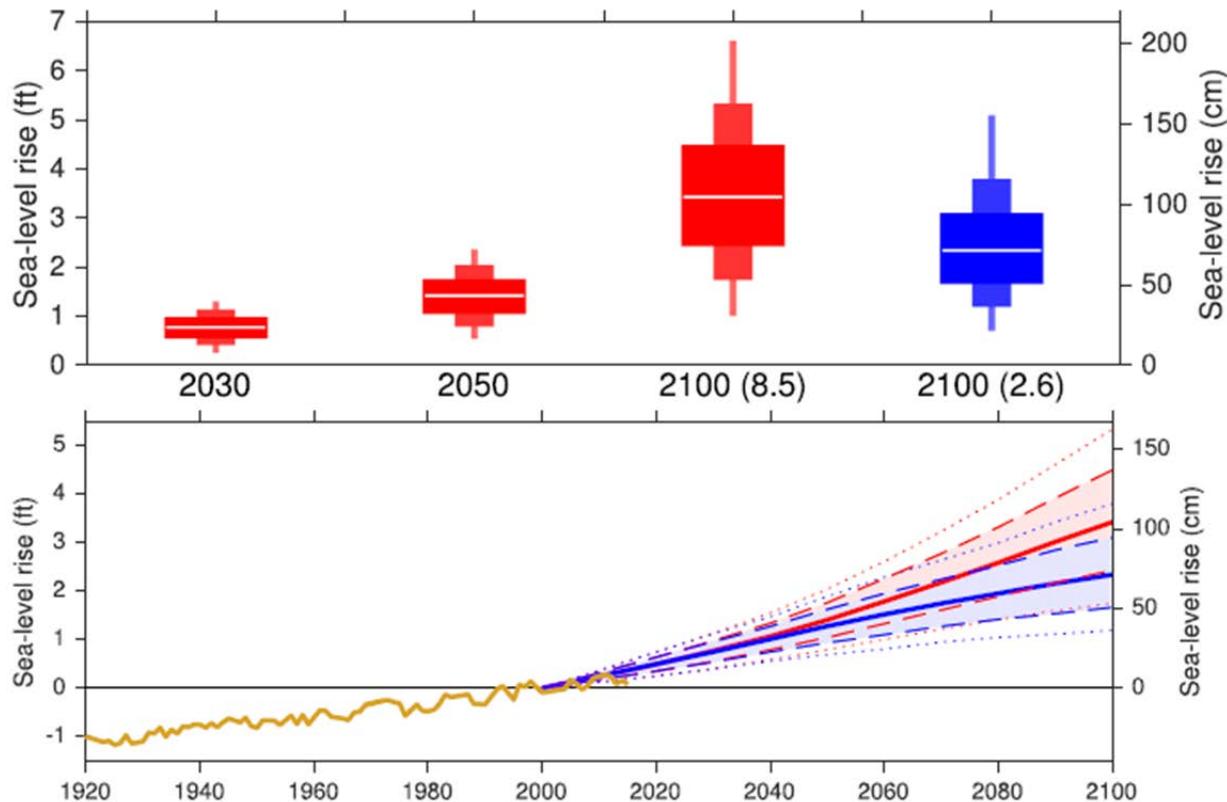
In the bottom chart, the gold-colored line indicates observed tide-gauge heights. Solid red and blue lines are the 50th percentile projection for the high-emissions (RCP 8.5) and low-emissions (RCP 2.6) scenarios, respectively. Dashed lines are 17th–83rd percentile projections, and dotted lines are 5th–95th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

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

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

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

Figure 1: Sea Level Rise Projections for New Jersey in 2030, 2050, and 2100



Source: Kopp et al., 2016

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

Coastal Storms and Storm Surge

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

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

³ Ibid.

⁴ Horton et al., 374.

greater than the projected amount of sea level rise. For example, storm surge heights during Superstorm Sandy exceeded 10 feet in some parts of Northern New Jersey and New York, three times the median amount of projected sea level rise by 2100.

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

Riverine Flooding

While this report focuses primarily on coastal flooding, riverine and stormwater flooding cannot be ignored and likely poses an even greater threat for an inland township like Bordentown, particularly around Jumble Gut Run and near the Old Amboy Railroad. The Sylvan Glen neighborhood and the Old Amboy Railroad neighborhood are out of harm's way as far as coastal flooding is concerned, but high volumes and velocities of stormwater runoff pose a problem for these areas.

In the Sylvan Glen neighborhood, stormwater volume in Jumble Gut Run causes bank erosion and slope destabilization, undermines utilities and stormwater infrastructure, and can cut off ingress and egress from the overtopping of NJ-206 and Orchard Road. Adding to the vulnerability of this neighborhood, many of the residents are elderly.

In the Old Amboy neighborhood, poor drainage at a culvert leads to flooding of properties along the adjacent rail corridor during heavy rainfall events.

Bordentown currently uses Federal Emergency Management Agency's (FEMA's) 100-year floodplain map (or "Flood Insurance Rate Map" [FIRM]) to evaluate the threat of riverine flooding. The township should continue to use this map for that purpose but at the same time should recognize that the frequency of storms with heavy downpours is projected to increase as a result of climate change.⁶ As products and models become available to project the spatial extent of this evolving threat, they should be evaluated by township officials.

Current Preparedness for Flooding

Emergency Operations Procedures

Bordentown officials and staff feel prepared for flood emergencies. Officials and emergency response managers have multiple means of township-wide communication. The township uses Swift911, which conducts reverse 911 calls using traditional phone lines or voice over internet protocol, and NJ Register Ready, a county-wide registration program for residents with limited mobility or other impairments that would make emergency evacuation more challenging. Residents need to register for both of these services, but weblinks and some instruction are available on the township's website.

The website also contains guidance for township residents on creating a household emergency plan, emergency contacts and services in the township and region, and a list of brochures on New Jersey Office of Emergency Management (OEM) topics that are available at the OEM or can be ordered by phone.

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

⁶ Horton et al., 374.

Vulnerable Populations

Bordentown Township has a population of approximately 11,566 residents (2015 5-Year American Community Survey [ACS]), and a density of 1,244 residents per square mile. There are several populations that may need additional assistance in the event of a storm, but as indicated in the “Current Preparedness” section above, the township continues to demonstrate its desire to ensure that all citizens are given the assistance they need before, during, and after storms.

Carless Households

Approximately 2.2 percent of households in Bordentown Township did not own cars in 2015, which is higher than the county’s reported value (1.5 percent), although consistent with the state’s value (2.4 percent).⁷ Carless households face additional challenges in evacuating before a storm by relying on alternative modes of transportation to leave the township. However, the majority of residents (97.8 percent) have cars and thus more options to evacuate before an emergency.

Residents with a Disability

In 2015, 10.3 percent of residents reported having a disability, which is roughly equivalent to the state and county percentages of 10.3 percent and 11.0 percent.⁸ These residents may have particular mobility and medical care needs in an evacuation.

Seniors

In 2015, 18.4 percent of Bordentown Township residents were elderly, which is relatively lower than the state and county percentages of 20.2 and 21.0 percent.⁹ As with residents with a disability, seniors may also have particular mobility and medical care needs in an evacuation.

Homeowners and Renters

In 2015, 78.7 percent of residents reported owning their homes, which is higher than the 76.5 percent reported by Burlington County residents and also higher than that reported in New Jersey (64.5 percent).¹⁰ Renters have less ability to repair their homes following a disaster, so while the majority of the township’s residents, as homeowners, are more secure in this regard, there is still a substantial portion of households that, as renters, are more at risk of displacement following a severe storm.

Limited English Speakers

In 2015, 1.8 percent of Bordentown residents reported that they spoke English “not well” or “not at all,” which is equivalent to that reported for Burlington County (1.7 percent), and lower than that for New Jersey (6.3 percent).¹¹ This population may need additional outreach to enable them to understand threats associated with incoming flooding, what is required for them to prepare, what resources are available to avoid harm, and what assistance can help with recovery from these events.

⁷ U.S. Census Bureau, “B25044: Tenure by Vehicles Available,” 2011–2015 ACS 5-Year Estimates.

⁸ U.S. Census Bureau, “B18101: Sex by Age by Disability Status,” 2011–2015 ACS 5-Year Estimates.

⁹ U.S. Census Bureau, “B01001: Sex by Age,” 2011–2015 ACS 5-Year Estimates.

¹⁰ U.S. Census Bureau, “B25044: Tenure by Vehicles Available,” 2011–2015 ACS 5-Year Estimates.

¹¹ U.S. Census Bureau, “B16004: Age by Language Spoken at Home by Ability to Speak English for the Population 5 Years and Over,” 2011–2015 ACS 5-Year Estimates.

Households in Poverty

In 2015, 3.3 percent of households in Bordentown reported an income below the poverty level, which was below the state average of 10.5 percent and the county average of 6.25 percent within the same time period.¹²

Scenarios

The flood scenario used in this CVA shows the result of storm surge generated by a Category 2 storm plus sea level rise projection of 3.3 feet by 2100.¹³ Storm surge was modeled using the National Oceanic and Atmospheric Administration's (NOAA's) SLOSH (Sea, Lake, and Overland Surge from Hurricanes) model and shows what would happen if a Category 2 storm were to strike the Delaware Bay at an angle that would maximize storm surge at high tide. In other words, this is a "worst case scenario" for a Category 2 storm in the tidal Delaware River. **This flooding scenario will be described in this report as the "CVA scenario."**

Notably, the inundation resulting from the combined sea level rise and storm surge depicted in the CVA scenario closely resembles the 1 percent/100-year flooding extent. Figure 2 demonstrates this similarity along the Delaware River near the south corner of the township. FEMA uses the 1 percent scenario in its FIRMs, and Bordentown Township uses these maps for planning purposes. Because the extent of flooding from sea level rise in 2100 during a Category 2 storm is similar to the extent of the township's FEMA floodplain, the authors determined that the CVA scenario was not overly pessimistic or of such a low probability as to not warrant modeling. Furthermore, the storm surge heights expected in a modeled Category 2 storm are certainly possible, as was experienced in northern New Jersey during Superstorm Sandy.¹⁴ Since storm surge heights associated with a Category 3 or Category 4 storm are less likely, the authors of this report determined that these are not scenarios for which municipalities should focus their planning efforts.

Flood depths were determined using a baseline elevation derived from Light Detection and Ranging (LiDAR) data.¹⁵ The storm surge modeling and the baseline elevation layers were developed state-wide by NJDEP and layered on maps developed by DVRPC. The maps for this study are located in Figure 2 and Appendix C.

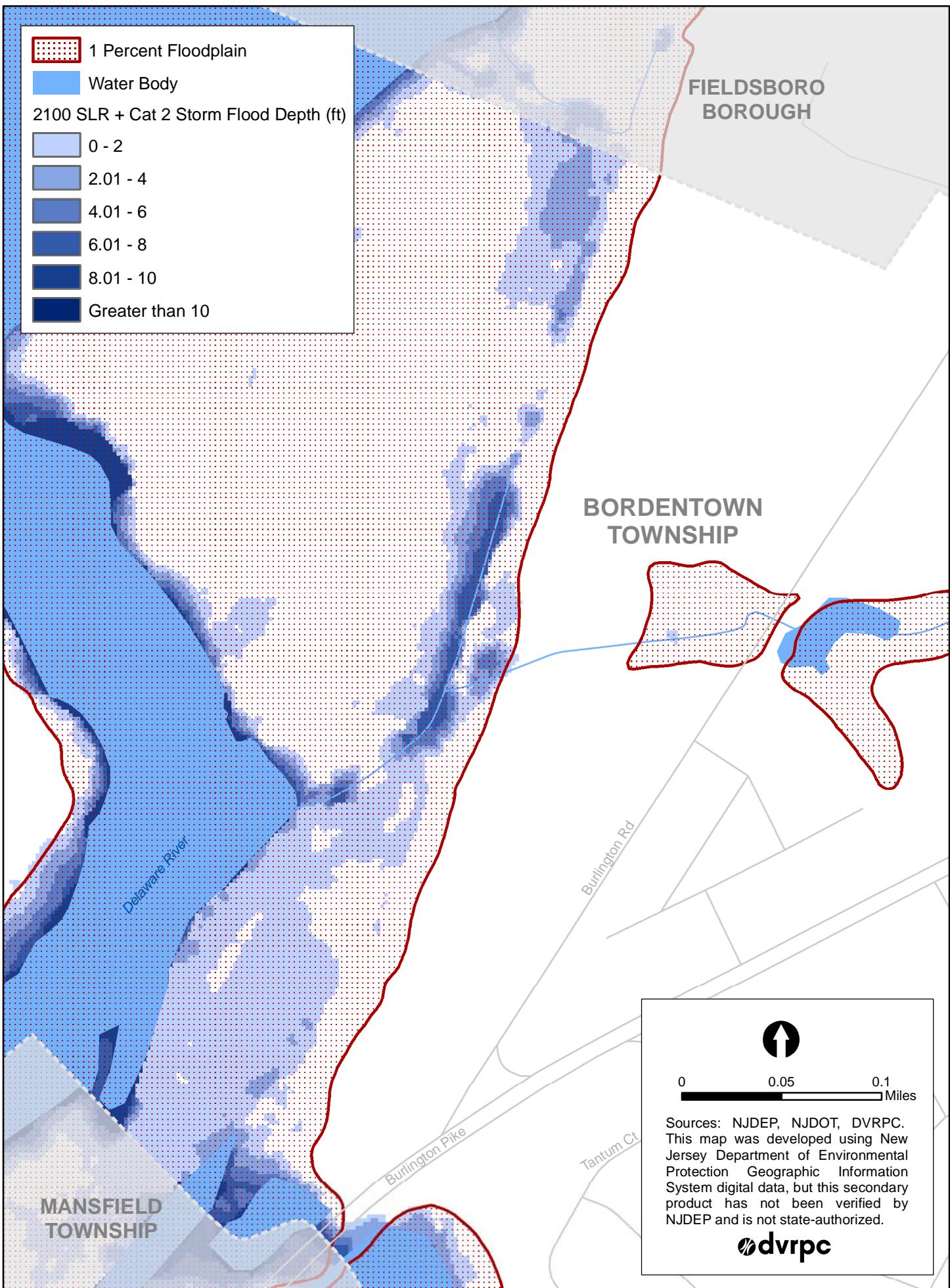
¹² U.S. Census Bureau, "DP03: Selected Economic Characteristics," 2011–2015 ACS 5-Year Estimates.

¹³ The 3.3-foot figure was from a report produced by the New Jersey Climate Adaptation Alliance Science and Technical Advisory Panel that predates the current report. The 3.3-foot figure was already built into the maps and models by the time the report with the 3.4-foot median estimate was produced.

¹⁴ The storm surge experienced in Sandy Hook in northern New Jersey during Superstorm Sandy was approximately 8.5 feet above mean higher high water. This height is commensurate with what the SLOSH model would predict for a Category 2 hurricane striking the area. Sandy was not technically a hurricane when it made landfall on the New Jersey shore, but the storm's large wind field and low pressure generated a storm surge that would normally be associated with a Category 2 hurricane according to predictive modeling.

¹⁵ Note that the projected flood events used in this assessment were generated by several models prepared by state and national agencies and professionals, and are suitable for planning purposes. However, due to the uncertainty of projections and accuracy of certain types of data, the maps should not be the sole resource for conducting site-specific analyses.

Figure 2: South Corner of Bordentown Township and 1 Percent Floodplain



Assessing Vulnerabilities

Methodology

On August 27, 2015, DVRPC staff met with Bordentown Township staff (listed in the Acknowledgments section) to discuss the township's past vulnerabilities to flooding and participate in a site tour of some of the township's most vulnerable areas around Jumble Gut Run. On February 19, 2016, the group convened a second time to discuss the township's critical assets and conduct the CVA. This group examined the vulnerability of 12 "assets," which are properties, infrastructure, or natural resources that are owned by the township or have high value to the community, as well as vulnerable populations located within the township. The assets are evaluated using a three-step process:

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

Identifying and Mapping Community Assets

The CVA relies on Geographical Information Systems (GIS) maps to locate and analyze community assets and flood hazards. Community assets are identified among three categories—Built Environment, Natural Environment, and Vulnerable Populations—and are plotted using GIS. DVRPC mapped assets and plotted them against the CVA scenario to determine whether they would be exposed to flooding.

Evaluating Asset Sensitivity and Vulnerability

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

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

Evaluating the Consequences of Asset Damage

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

Analysis and Findings

Bordentown's CVA assessment examined 12 assets, which were listed by type in Table 1.

The CVA indicates that most assets in Bordentown will not likely sustain many significant impacts from the combined effects of a Category 2 storm surge and sea level rise in 2100. Many of the assets are located inland of tidal waterways and at higher elevations, and are thus not exposed to flooding. Nevertheless, there are some assets in Bordentown that are vulnerable to potential flooding.

Assets of High Concern

Four of the assets examined by this CVA were determined to be assets of high concern (Table 3). These assets are the most vulnerable to flooding of the total examined and have the greatest consequences to the township should they become damaged. For the full asset matrix, see Appendix A.

Table 3: Overview of Assets Identified as High-Concern

Assets of High Concern				
Asset Name	Asset Category	Exposure (Flood Depth)	Vulnerability	Consequences
Bulkhead	Utility	0–3.5 ft	Low to High	Minor to Moderate
I-295 Crossing at Crosswicks Creek	Transportation	0–7.1 ft	Insignificant to High	Minor to Moderate
North American Salvage Company (Former)	Hazardous Site	0–2.0 ft	Moderate to High	Insignificant to Minor
River LINE Railway	Transportation	0–7.0 ft	Insignificant to High	Minor to Moderate

Bulkhead

Bordentown constructed a bulkhead to prevent erosion along the Delaware River, adjacent to the former North American Salvage Company (Figure 3). While the bulkhead is predicted to be faced with flooding of up to 3.5 feet in the CVA scenario, most of the flood depths along it will be less than 2 feet.

The bulkhead was assigned a vulnerability rating of low to high. This wide range is due to the fact that damage to the bulkhead will depend on whether it is eroded or undermined during a storm, which cannot be known at this time.

The bulkhead was assigned a minor to moderate consequences rating because of its proximity to the site of the former North American Salvage Company, which contains hazardous materials and is under remediation. See below for more information on that asset. Damages to the bulkhead would leave the North American Salvage Company lot susceptible to erosion, which increases the likelihood that hazardous materials would spread into the township or Delaware River. More information is needed regarding the contaminants located on that site and the protective measures in place to better understand the nature of this threat.

Figure 3: Bulkhead, Facing East



Source: Bing Maps, 2017

I-295 Crossing at Crosswicks Creek

I-295 is a highway passing through Bordentown Township from north to south (Figure 4). The portion of the highway passing over Crosswicks Creek may face flooding of up to 7.1 feet in the CVA scenario. This height represents flooding above the water surface, not the bridge deck. The distance from the water to the bridge deck would need to be accurately calculated to determine whether the bridge would be overtopped.

The vulnerability of this crossing ranges from insignificant to high, depending on whether overtopping occurs. In addition, the higher velocities of water associated with the flooding of Crosswicks Creek may cause scouring of the bed of the waterway on which the bridge is anchored, potentially destabilizing it. If the deck is overtopped, flood waters may also cause substantial pressure on the bridge, potentially leading to its destruction.

The crossing was assigned a consequences rating of minor to moderate. Overtopping or damages to I-295 would require drivers to reroute to NJ Route 130 (NJ-130) and Interstate 195, which would cause adverse impacts to traffic and connectivity in the area. If the bridge were damaged, it might take more than a year for it to be replaced.

Figure 4: I-295 Crossing at Crosswicks Creek



Source: Google Maps, October 2015

North American Salvage Company (Former)

The North American Salvage Company site, located between the Delaware River and the River LINE railway, formerly held a shipyard that salvaged metal from ships (Figure 5). It is now on New Jersey's Known Contaminated Sites list. The site will be remediated, likely within the next year, and it will be reconstructed as mixed-use development. In the CVA scenario, much of this parcel will be flooded, with depths of typically less than two feet.

The site has a moderate to high degree of vulnerability. It is protected to some degree by the bulkhead mentioned previously, but this bulkhead is predicted to be flooded during the CVA scenario and could be structurally undermined after the waters recede, leading to erosion of the site.

Flooding of this site would have insignificant to minor consequences. Since it is on schedule to be remediated soon, a flood may have a minimal effect on the township. However, more information is needed about the location and nature of the contamination, as well as how the site will be used in the future, since predicted flood depths could damage structures or make egress more difficult during a storm.

Figure 5: Former North American Salvage Company Site



Source: Google Maps, October 2017

River LINE Railway

The River LINE railway is a passenger rail line, operated by NJ Transit, that travels along the Delaware River to connect Camden and Trenton. It averaged over 18,300 passenger trips per week in the 2016 fiscal year.¹⁶ The railway is located near the shore on a berm at an elevation just above the level of water for the CVA scenario (Figure 6).

The vulnerability of the rail line ranges from insignificant to high. It will remain above the floodwaters during the CVA scenario, but the berm on which it sits may be undermined or eroded by immediately adjacent floodwaters from the Delaware River. More information is needed regarding the structure and durability of the berm to determine how it would respond to exposure from the floodwaters associated with the CVA scenario.

The consequences of damage to the rail line are moderate to high. Damage to the rail line would interrupt the commuting schedules of thousands of workers traveling between Trenton, Camden, and Philadelphia, requiring them to seek alternative means of transportation. This inconvenience to commuters and increased pressure on roadways and bus routes could last for weeks or months, depending on the severity of the damage.

Figure 6: River LINE Light Rail Bridge over Crosswicks Creek, Bordentown, New Jersey



Source: Mario Burger, www.flickr.com.

A full table showing the exposure, sensitivity, and consequences of all assets can be found in Appendix A of this report. Appendix C shows a map of all listed assets superimposed with the CVA scenario, as well as inset maps showing vulnerable assets along the Delaware River and Crosswicks Creek at a larger scale.

¹⁶ NJ Transit, *NJ Transit Facts at a Glance: Fiscal Year 2016*, accessed August 28, 2017, www.njtransit.com/pdf/FactsAtAGlance.pdf.

Municipal Assets of Lower Risk

The highest number of remaining (lower-risk) assets are utilities. This category includes the township's sewage treatment plant, water treatment plant, and a pump station. Other assets with some degree of risk include a pending mixed-use waterfront development in one of the township's priority growth areas; the NJ-206 crossing at Crosswicks Creek; the township's open space and habitat along its tidal waterways; and the Abbott Farm National Historic Landmark, a 2,000-acre municipal site with archaeological and natural significance.

Table 4 combines the vulnerability and consequences rating to show the overall risk rating for all assets not considered to be of high concern. Four assets are considered to be "out of harm's way" because they are not predicted to be exposed to flooding in the CVA scenario. The remaining three assets were assigned to the minor or moderate risk categories.

Table 4: Breakdown of Remaining Assets by Degree of Risk

Rating	Number of Assets
Out of Harm's Way	4
Minor Risk	1
Moderate Risk	3
Total	8

Recommendations for Bordentown's Assets

Because not many of its assets are vulnerable in the CVA scenario, Bordentown does not need to implement many adaptation measures immediately. However, action is particularly important for the assets considered to be of high concern. The asset-specific recommendations below are derived from DVRPC's introductory meeting and CVA session with Bordentown Township. Recommendations are organized by degree of importance.

Riverine Flooding

As mentioned previously, Bordentown Township's major current and projected future flooding concerns are related to riverine flooding and stormwater runoff, not coastal flooding. There are no easy solutions to these problems, because the stormwater runoff originates throughout the watershed. In the case of the Old Amboy Railroad, the correction of drainage issues caused by the rail grade should be investigated and could possibly be addressed with relatively modest infrastructure upgrades. The township has already conducted a hydrological study for the Jumble Gut Run basin as a whole and should continue to conduct studies of the basin to pinpoint techniques for mitigating the acute effects of stormwater runoff, erosion, and drainage in this problematic channel.

The township should comprehensively manage its stormwater to mitigate its stormwater problems within its borders, including installing green stormwater infrastructure to decrease the volume and velocity of stormwater runoff and address acute problems on a case-by-case basis. However, because Bordentown Township is at the bottom end of several subwatersheds—at the HUC-12 level, they include the Van Sciver

Lake-Delaware River watershed, the Blacks Creek watershed, and the Lower Crosswicks Creek watershed—it is limited in what it can do alone, as it receives stormwater runoff from upstream municipalities. Bordentown should reach out to these upstream municipalities (particularly Hamilton Township, Chesterfield Township, Upper Freehold Township, North Hanover Township, Mansfield Township, and Florence Township) and to NJDEP's Office of Stormwater Management to address the watershed-wide issue of stormwater runoff.

Coordination with NJDEP Regarding Onsite Contaminants

The former North American Salvage Company site is on New Jersey's Known Contaminated Sites list. The site is on schedule to be remediated in one to two years and then developed along with several other waterfront parcels. Since much of the parcel will likely be flooded in the CVA scenario, the township should confirm with NJDEP that the site's mitigation plan for the site accounts for possible flood depths of up to two feet predicted by the CVA scenario.

Ascertain the Structural Vulnerability of the Bulkhead

While several of Bordentown's assets are at risk due to coastal sea level rise, the degree of risk for one of them, the bulkhead, is not fully understood. Severe flooding could have a large impact on the structural integrity of the bulkhead, precipitating its failure and thereby opening the door to severe coastal erosion. The degree to which the bulkhead would be affected is partly a function of its current structural properties. The township should periodically evaluate the condition of the bulkhead and conduct appropriate maintenance to ensure that it will not collapse during a flood.

Research and Communication Regarding Transportation Corridors

The CVA analysis predicts flooding along I-295, NJ-206, and the River LINE railway as they run through Bordentown Township. The township should examine its evacuation routes to ensure that none would be affected by the flooding of these corridors in the CVA scenario. Using the CVA data, the township may need to plan alternative routes to these corridors and provide residents and businesses with that information.

Site Planning

The Mixed-Use Waterfront Development Property will contain single-family residential units, commercial units, and a waterfront promenade. The design has been approved by the township, but construction has not yet commenced. Aerial imagery indicates construction is out of harm's way, with the exception of the entrance and egress in the south corner, which may receive over five feet of flooding. Bordentown should work with the developer to ensure either that the site design avoids the south corner or that all roadways are designed to be elevated above the predicted flood elevation or FEMA's base flood elevation, whichever is higher.

Open Space and Habitat

Rather than opening it to development, the township should continue to preserve the remaining unprotected open space along the Delaware River, Crosswicks Creek, Blacks Creek, and Crystal Creek that is predicted to flood in the CVA scenario. Green Acres, Blue Acres, the Nature Conservancy, the Trust for Public Land, and the New Jersey Conservation Foundation are potential sources of funding for acquisition or easements.

General Recommendations

The general recommendations below are organized by degree of importance within each subcategory. They are derived from the Getting to Resilience reports written by the Jacques Cousteau National Estuarine Research Reserve (JCNERR).¹⁷ JCNERR wrote these reports for municipalities that completed the Getting to Resilience questionnaire, which is a set of questions posed to municipalities about their past and ongoing work to plan for and respond to coastal flood hazards. The reports offer recommendations based on the municipality's responses to the questionnaire.

Planning

Incorporating Coastal Hazards in Plans and Regulations

Bordentown should include information discussed in the CVA, particularly the flood projections and depths caused by sea level rise and storm surge, in municipal plans and ordinances. These documents may include (but are not limited to) the municipal master plan, all hazards mitigation plan, emergency response plan, zoning ordinance, subdivision and land development ordinance, and stormwater management ordinance. For example, Worcester County, Maryland, created a comprehensive plan that incorporates coastal hazards throughout the entire document.¹⁸

Long-Range Planning for Coastal Flooding

Bordentown should begin a community-wide planning process to prepare for the long-term effects of storm surge and sea level rise at time scales that extend beyond the standard 20- or 25-year planning horizon. This process will help the community prepare for the gradual, but steadily increasing, rates of sea level rise expected in the ensuing decades. Actions may include decisions to avoid long-term capital investments in areas that may be affected by sea level rise in 30 or 50 years.

Capital Improvements Plan or Hazard Mitigation Plan

Bordentown should incorporate flood mitigation projects into a municipal capital improvements plan or hazard mitigation plan. In doing so, the township can add these projects to an existing “funding pipeline” and make it easier for these projects to be funded and implemented.

Cost-Benefit Analysis for Specific Projects

Bordentown should consider using a cost-benefit analysis to guide long-term decision making with regard to the placement of critical municipal assets, especially shoreline protection structures, along or immediately inland of the waterfront. A cost-benefit analysis will ensure that the cost of each project over its lifespan (including internal and external costs) has been properly weighed against benefits such as avoided flood damages and improvement in a community’s quality of life (e.g., by the creation of parks and greenspaces in flood-prone areas).

¹⁷ New Jersey Resilient Coastal Communities Initiative, *Case Studies*, accessed November 1, 2017, www.prepareyourcommunitynj.org/case-studies/.

¹⁸ Worcester County, Maryland, The Comprehensive Development Plan, March 14, 2006, planning.maryland.gov/PDF/OurWork/CompPlans/Worcester/06_CMP_Worcester.pdf.

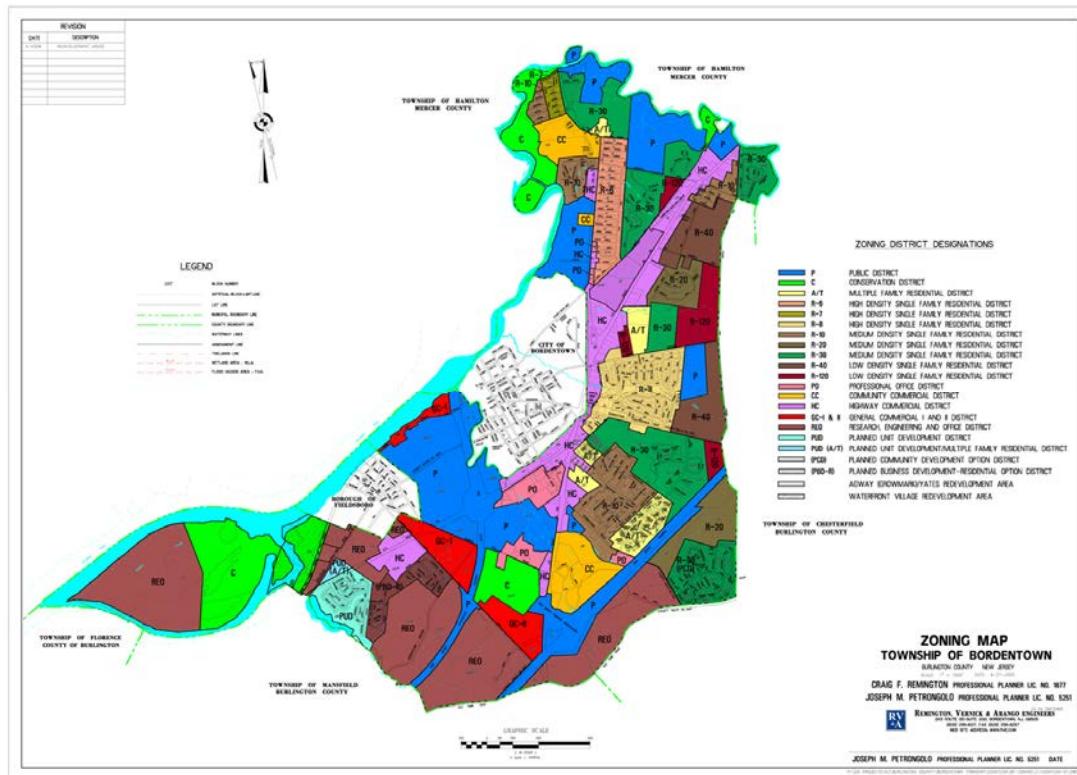
Regulations

Zoning Strategies

Zoning ordinances can be used in a variety of ways to protect community assets against flooding. For example, zoning ordinances can be used to regulate setbacks from rivers and streams, increase base flood elevations for buildings, and set requirements for stormwater management.

Bordentown has zoned several areas along the Delaware River, Blacks Creek, and Crosswicks Creek within the Public district (P, in dark blue; see Figure 7)¹⁹ or Conservation district (C, in light green) with some flood protection goals in mind. Both districts permit public playgrounds, public conservation areas, public parks, and public open space. However, these zones also permit uses that might be vulnerable during a flood, including detached single-family dwelling units and commercial uses in the Conservation district and public buildings, such as township, state, or federal offices; police departments; or public works buildings, in the Public district.²⁰

Figure 7: Bordentown Township's Zoning Map



Source: Bordentown Township Zoning Map, 2008

Bordentown should revisit these permitted uses and determine if they might yield development that could be at risk to flooding if constructed in the Public and Conservation districts by right. The township should also consider creating a zoning overlay in floodplain areas or updating the existing zoning code in general, to

¹⁹ Bordentown Township, Zoning Map, 2008, www.ecode360.com/documents/BO3500/BO3500%20Zoning%20Map.pdf.

²⁰ Bordentown Township, Land Development Ordinance, Bordentown Municipal Zoning Code, 1999, www.ecode360.com/28151068; Chapter 25.402, www.ecode360.com/28151079#28151079.

require new construction, renovations, and/or flood-sensitive building systems to be elevated above the flood heights predicted in the CVA scenario.

[Building Codes](#)

By updating the building codes that regulate building design, construction, and landscaping, Bordentown can improve the ability of structures in flood-prone areas to withstand future floods.

[Programs and Projects](#)

[Buying Out Floodplain Properties](#)

The most effective way to reduce losses from flooding is to acquire improved flood-prone properties, both land and structures, demolish or relocate the structures, and restrict future development on the land with a conservation easement. Repetitive loss properties that are also threatened by future sea level rise should be a priority for potential buy-outs. In cases of properties where unimproved portions of the parcel are expected to be flooded, an easement rather than a fee simple acquisition may be more appropriate.

[Restoring Floodplain Parcels to Natural Conditions](#)

Bordentown Township should return any properties within flood-prone areas that were acquired through Blue Acres or other land conservation programs to natural floodplain conditions. As a municipality nears buildout, there are increasingly limited areas of land left that still perform natural floodplain functions. Returning lands to natural floodplain functions can be accomplished by restoring wetlands, planting natural vegetation, reducing sediment compaction, and creating a more natural elevation profile. Funding for this type of project is often available through FEMA grant programs.

[Living Shorelines](#)

The township should consider living shorelines as an alternative to hard shore protection structures in efforts to restore, protect, and enhance the shoreline and its environment. Living shorelines use natural stabilization techniques that rely on vegetative plantings, organic materials, and sand fill, or a hybrid approach combining vegetative plantings with low rock sills or living breakwaters to keep sediment in place and reduce the erosive impact of wave energy.

[Disaster Preparedness](#)

[Action Plan for Riverine Floods](#)

As mentioned previously, several neighborhoods in Bordentown receive severe noncoastal flooding during storms. By drawing upon its knowledge of past storms and topographical information, Bordentown should create an action plan that identifies (1) the type of storms that create flooding at vulnerable locations, (2) steps for staff and community members to take to prepare for and respond to similar storms in the future, and (3) resources available for addressing the anticipated problems.

[Regional Emergency Management Coordination](#)

Bordentown should develop formalized emergency management practices with Burlington County and neighboring municipalities. Some examples could include coordinating evacuation and re-entry routes, creating large-scale outreach initiatives, or expanding available sheltering options and amenities.

[Continuity of Operations Plan](#)

A continuity of operations plan is separate from an emergency operations plan and ensures that essential municipal functions continue to be performed before, during, and after a wide range of emergencies. The continuity of operations plan can help Bordentown prioritize essential facilities, equipment, vital records, and other assets for protection. It can also help reduce or mitigate disruptions to operations, and facilitate decision making during an emergency. The Borough of Avalon has a sample plan.²¹

[Evacuation Plan](#)

Bordentown should create an evacuation plan that documents its evacuation protocol before and during disasters. Information that could be added includes evacuation routes that could be flooded, the necessary time frame to evacuate residential neighborhoods, and conditions (if any) that would spur a lane reversal in order to evacuate a greater volume of residents from the municipality.

[Community Emergency Response Team \(CERT\)](#)

Bordentown should consider creating a local CERT program. CERT programs can provide volunteer support to first responders, provide assistance to victims, help to organize volunteers at disaster sites, and collect disaster information to support first responder efforts. For small municipalities with limited staff, CERT teams are particularly useful and can help cut costs. See www.ready.gov/community-emergency-response-team for more information.

[Municipal Organization](#)

[Historic Recordkeeping](#)

Bordentown should collect and maintain an easily accessible record of historic storms. Residents' and municipal staff members' photographs and accounts of these events, especially ones that were not documented by state and federal agencies, are useful tools that can be used to plan for future storms. These records may identify past surge extents, conditions that caused amplification of storm damages, and vulnerable areas not shown by mapping.

²¹ The Borough of Avalon, *Continuity of Operations/Continuity of Government (COOP/COG) Plan*, April 15, 2009, www.prepareyourcommunitynj.org/media/27952/Avalon_COOP_COG.pdf.

Outreach

Program for Public Information (PPI)

A PPI can help organize Bordentown's outreach practices on flood hazards. A PPI is a researched, organized, and implemented program for public outreach that includes assessing the community's information needs; formulating messages; identifying means of conveying the messages; and implementing, monitoring, and evaluating the program. The National Flood Insurance Program's Community Rating System provides guidance on establishing a PPI, as well as information on outreach projects.²²

This is a significant project, and the township may want to partner with other organizations or entities that have experience in educating residents on flood hazards, particularly those that can offer translation services from English to other major languages spoken in the township.

Public Presentations

Bordentown should hold annual presentations for residents, business owners, and other groups to discuss flood hazards. By continuing to emphasize the importance of planning for flooding, the township can set an example that disaster readiness should be maintained, even in relatively "quiet" times. A PPI can ensure that these presentations are effective. Publicized and recorded presentations can reduce the need for numerous one-on-one meetings with constituents.

Topics can include but are not limited to discussing the science behind different types of flooding; defining base flood elevations, flood zones, and flooding risk; providing updates on changes to FEMA's flood maps; sharing information on evacuation routes; providing recommendations for renovating a structure in the floodplain to better withstand floods; and discussing actions that can be taken to reduce flood insurance rates. Presentations could be accompanied by information on the municipality's special needs database and/or flood warning systems to get more residents registered.

Information on Floodplains

Bordentown Township should conduct regular outreach to residents about the natural and beneficial functions of floodplains. Preserving floodplain areas as open space or for recreational uses only is an effective strategy for reducing—if not eliminating—risks of damage or injury from floods. A continued outreach effort focused on the positive aspects of floodplains is part of a long-term strategy for getting residents to understand and support converting more of the township's floodplain areas into open space. A white paper written by the National Association of Floodplain Managers has more information on the topic.²³

Coastal Hazard Disclosure Policy

Bordentown should create a consistent coastal hazard disclosure policy that is used by all lenders and real estate agents when speaking with potential buyers about buildings located in flood-prone areas. Disclosure

²² National Flood Insurance Program, *Developing a Program for Public Information for Credit under the Community Rating System of the National Flood Insurance Program*, 2014, crsresources.org/files/300/developing_a_ppi_for_credit_under_the_crs_2014.pdf.

²³ Association of State Floodplain Managers, *Natural and Beneficial Floodplain Functions: Floodplain Management—More than Flood Loss Reduction*, September 16, 2008, www.floods.org/PDF/WhitePaper/ASFPM_NBF%20White_Paper_%200908.pdf.

of known flood, erosion, or other related hazard risks at the time of property transfer is an important educational effort consistent with the “No Adverse Impact”²⁴ concept. Some states, such as Florida and California, have disclosure requirements. If a disclosure is required for property in a flood or coastal hazard area, the seller is required to notify potential buyers of the risks, and the risks can be factored into the purchase decision. If there is a berm, sea wall, or other protective structure on coastal property for sale, a disclosure policy could also require that prospective buyers be made aware of the issues surrounding such structures, particularly the need for monitoring and maintaining them. This type of policy can help sellers avoid transferring known adverse impacts that become unpleasant surprises to buyers.

[Web Page with Municipal Flooding Resources](#)

Bordentown should create a dedicated and easily accessible (from the home page) “Flood Information” page on its website, which could be an expansion of its existing Office of Emergency Management page. The process for creating and maintaining this web page can be included in the PPI discussed previously. The web page can contain a link to the FEMA Region II website,²⁵ FIRMs; the CVA maps; evacuation routes; the municipality’s base flood elevation; basic outreach brochures; and other information that further educates the community on coastal hazard preparation, response, and recovery. The Monmouth County Planning Department has some sample resources on its website.²⁶

[Packaged Flood Preparedness Outreach Materials](#)

By packaging flood-preparedness materials to residents in anticipation of future floods, Bordentown could save time and energy leading up to, during, and after a flooding event as outreach will already have been prepared for dispersal. The outreach should cover evacuation routes, safety procedures, shelter locations, recovery operations, procedures for entering a flooded building, steps for getting a permit for repairs, substantial damage rules, flood protection opportunities during repairs, and information on grants.

[Resources and Funding Opportunities](#)

[Federal Programs: Flood Hazards](#)

[FEMA: Flood Mitigation Assistance Grants](#)

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

²⁴ Association of State Floodplain Managers, *No Inverse Impact (NAI)*, accessed November 1, 2017, www.floods.org/index.asp?menuID=460.

²⁵ U.S. Federal Emergency Management Agency, *Region II Coastal Analysis and Mapping*, May 4, 2015, www.region2coastal.com.

²⁶ Monmouth County Division of Planning, *Supporting Documents for CRS Activities*, February 7, 2017, co.monmouth.nj.us/page.aspx?Id=4382.

FEMA: Hazard Mitigation Grants

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

FEMA: Pre-Disaster Mitigation Grants

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

Federal Programs: Community Support

Partnership for Sustainable Communities

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

HUD: Community Development Block Grant Program

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

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

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

Federal Programs: Infrastructure

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

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

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

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

Federal Programs: Open Space and Natural Resources

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

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

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

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

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

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

State Programs: General Assistance

NJDEP Bureau of Flood Control

The Community Assistance Program Unit in NJDEP's Bureau of Flood Control offers a range of floodplain assistance to municipalities. This unit offers assistance with floodplain issues (in person or on the phone), floodplain ordinance and floodplain map creation and adoption, solving problems on development within

Special Flood Hazard Areas, Community Rating System applications and compliance, flood mapping, and disaster response. The unit also offers regular workshops on floodplain-related topics. More information on this program is available at www.nj.gov/dep/floodcontrol/about.htm#management.

NJDEP Coastal Management Program

The New Jersey Coastal Management Program is part of the National Coastal Zone Management Program and provides resources for sustainable and resilient coastal community planning, and climate change planning. Their technical assistance offerings include contractor assistance, direct municipal grant programs, and funding for the implementation of living shorelines or other nature-based mitigation projects. The available resources are updated regularly. For more information, contact the Coastal Management Office (www.state.nj.us/dep/cmp/czm_contact.html).

State Programs: Flood Relief and Control

NJDEP Shore Protection Program

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

NJ Office of Emergency Management Public Assistance Program

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

State Programs: Open Space Preservation and Management

NJDEP Blue Acres Program

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

NJDEP Community Stewardship Incentive Program Grant

This program provides grants to local governments and shade tree commissions to help implement a comprehensive community forestry management plan. Grant categories include resiliency planning, hazard

mitigation, and reforestation and tree planting. More information on the program is available at www.state.nj.us/dep/parksandforests/forest/community/grants-csip.html.

NJDEP Green Acres Program

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

NJDEP Green Communities Grant (Community Forest Program)

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

State Programs: Contaminant Mitigation

NJDEP Hazardous Discharge Site Remediation Fund

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

NJDEP Technical Assistance Grants

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

State Programs: Water Quality Protection

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

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

NJDEP Nonpoint Source Pollution Control Grants (319 Grant Program)

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

Rutgers University Cooperative Extension Water Resources Program

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

Water Quality Restoration Grants Program

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



Appendix A

Coastal Vulnerability Assessment Matrix
Vulnerability of Structures, Properties, and Populations in a Category 2 Storm in 2100

Sea Level Rise (SLR) Projections

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

TOP AREAS OF CONCERN

Asset Name	Asset Type	Asset Description	Exposure	Sensitivity	Vulnerability Rating	Consequences	Consequences Rating
Bulkhead	Utility (Flood Control Structure)	A flood management and erosion control structure along the Delaware River and adjacent to the former North American Salvage Company. It will be incorporated into the proposed asset "Mixed-Use Waterfront Development Property."	Flooding of up to 3.5 ft, but generally less than 2 ft, may occur on the landward side of the bulkhead.	Damage to the bulkhead will depend on whether or not it is eroded or undermined during a storm, which cannot be known at this time. Newer construction or more durable materials may also increase its resilience to flood effects.	Low to High	Damages to the bulkhead would leave the North American Salvage Company lot susceptible to erosion, which increases the likelihood that hazardous materials would spread into the township or river. More information is needed on the contaminants present on that site.	Minor to Moderate
I-295 Crossing at Crosswicks Creek	Transportation (Bridge and Designated Evacuation Route)	State highway passing through Bordentown Township between the north and south.	There may be flooding of up to 7.1 ft at the bridge over Crosswicks Creek. Flooding of the bridge may or may not occur, depending on its elevation over the creek.	Higher velocities of flood waters may cause scouring of the bed of the waterway on which the bridge is anchored, potentially destabilizing it. If the deck is overtopped, flood waters may also cause substantial pressure on the bridge, potentially leading to its destruction.	Insignificant to High	Overtopping or damages to I-295 would require drivers to reroute to NJ-130 and Interstate 195, which would cause adverse impacts to traffic and connectivity in the area. If the bridge were destroyed, it would likely require more than a year to be replaced.	Minor to Moderate
North American Salvage Company (Former)	Hazardous Site	Currently holds scrapped ships and is on New Jersey's Known Contaminated Sites list. It will be remediated, likely within the next one to two years, as part of the Mixed-Use Waterfront Development project, and the site will be incorporated into that project. Located between the Delaware River and the River LINE railway line.	Much of the parcel will likely be flooded, with depths of typically less than 2 ft.	The site is protected to some degree by the Delaware River bulkhead, but this bulkhead is predicted to be overtopped during the CVA scenario and could be structurally undermined after the waters recede, leading to erosion.	Moderate to High	Since the site is on schedule to be remediated soon, a future flood may have a minimal effect on the township. However, more information is needed about the location and nature of the contamination, as well as how the site will be used in the future, since predicted flood depths could damage future structures or make egress more difficult during a storm.	Insignificant to Minor

TOP AREAS OF CONCERN (CONTINUED)

Asset Name	Asset Type	Asset Description	Exposure	Sensitivity	Vulnerability Rating	Consequences	Consequences Rating
River LINE Railway	Transportation	Passenger rail that is located along the Delaware River and travels between Camden and Trenton.	The railway is located near the shore on a berm at an elevation just above the level of water for the CVA scenario.	The rail line will remain above the floodwaters, but the berm on which it sits may be undermined or eroded by immediately adjacent floodwaters from the Delaware River. More information is needed regarding the structure and durability of the berm to determine how it would respond to exposure from the floodwaters associated with the CVA scenario.	Insignificant to High	Damage to the rail line would interrupt the commuting schedules of thousands of workers traveling between Trenton, Camden, and Philadelphia, requiring them to seek alternative means of transportation. This inconvenience to commuters and increased pressure on roadways and bus routes could last for weeks or months, depending on the severity of the damage.	Moderate to High

BUILT ENVIRONMENT

Abbott Farm National Historic Landmark	Institutional/ Cultural/ Government and Open Space	An approximately 2,000-acre tract of freshwater tidal marshland, spanning Burlington and Mercer Counties, with important historic and prehistoric sites.	Within Bordentown, the site may face flooding of up to 8.3 ft in the CVA scenario. This flood depth is only predicted along the Crosswicks Creek waterfront, however; inland sites are likely to be flooded with up to 4 ft of water.	More information is needed about the location of archaeological sites and their degree of vulnerability to floodwaters to determine the true sensitivity of this asset. The sensitivity of the township's wetlands is evaluated through the Open Space and Habitat asset.	Insignificant to High	If sensitive historic or prehistoric sites are damaged or destroyed in a flood, their loss would be a notable cultural loss to the township and region. The consequences of the loss of the township's wetlands are evaluated through the Open Space and Habitat asset.	Minor to Moderate
Mixed-Use Waterfront Development Property	Priority Growth Area for Bordentown	The property, located along the Delaware River, will contain townhomes, apartments, commercial units, and a waterfront promenade. The design has a conditional approval, but it has not yet been constructed. The development as a whole will also incorporate two other assets, the bulkhead and the North American Salvage Company (Former).	The parcel will likely have flooding of up to 1.2 ft in its southeast corner, up to 5.4 ft in its south corner, up to 6.7 ft in its north extent, and up to 1 ft in its northeast corner. Aerial imagery indicates that construction is out of harm's way, with the exception of the entrance and egress in the south corner.	The developer has a Waterfront Development Permit from NJDEP to construct in this area, indicating that the site already has been planned to reduce vulnerabilities to flooding. For example, the site's dwelling units are planned to be elevated above base flood elevation. However, more information is needed regarding the site plan and the durability of the structures.	Low to High	Residents in market-rate homes can typically evacuate and recover faster after a flood than residents in rentals, affordable housing, elderly housing, or housing for people with limited mobility. Regarding commercial facilities, the township will recover more easily from the loss of smaller neighborhood-serving retail or small offices than larger region-serving facilities with many employees.	Insignificant to Minor
NJ-206 Crossing at Crosswicks Creek	Transportation (Bridge and Designated Evacuation Route)	State highway passing through Bordentown Township between the north and south.	Flooding of up to 6.9 ft is predicted at the bridge over Crosswicks Creek. Flooding of the bridge may or may not occur, depending on its height.	Extended periods of flooding or high-velocity floods may cause scouring of the bed of the waterway on which the bridge is constructed, potentially destabilizing the bridge. If the deck is overtapped, flood waters may cause substantial pressure on the bridge. However, the elevation of the bridges may prevent flooding from occurring.	Insignificant to High	Damages to NJ-206 would likely require drivers to reroute to NJ-130 to avoid flooding, which would increase volume on that road. If the bridge were destroyed, it would likely require more than a year to be replaced.	Minor to Moderate

BUILT ENVIRONMENT (CONTINUED)

Asset Name	Asset Type	Asset Description	Exposure	Sensitivity	Vulnerability Rating	Consequences	Consequences Rating
Pump Station	Utility (Pump Station)	Pump station located between the River LINE railway and the QuickChek gas station.	No flooding is expected from coastal flooding or sea level rise.	More information would be needed concerning the elevation of key infrastructure at the pump station and its resistance to floodwaters.	Insignificant	If the pumping station equipment were flooded, then only neighborhoods serviced by the pump station would be affected. Homes and businesses affected would not have access to their typical water source for days or weeks.	Minor to Moderate
Water Treatment Plant	Utility (Water Treatment Plant)	The plant treats water for the township. It is located on Hobson Ave. and along Crosswicks Creek.	The southern edge of the site may receive flooding of up to 4 ft, but the plant will not be affected.	Many of the structures onsite are elevated, but more information would be needed regarding the degree of elevation above potential flooding, the durability of structures that could be in harm's way, and any vulnerable equipment stored onsite.	Insignificant	As a result of flooding, the residents and businesses who rely on municipal water would not have access to this particular water source for several days or weeks until flooding abated and the township was able to adequately treat the water and repair damages. The township would be required to seek an alternative water treatment source for residents and businesses during the period of reconstruction.	Moderate

NATURAL ENVIRONMENT

Asset Name	Asset Type	Asset Description	Exposure	Sensitivity	Vulnerability Rating	Consequences	Consequences Rating
Riparian Open Space and Habitat	Open Space and Habitat	Wetlands, shrubland, and forested areas located along the Delaware River, Crystal Creek, Blacks Creek, Crosswicks Creek, and tributaries.	Portions of open space along the Delaware River, Blacks Creek, and Crosswicks Creek will likely become flooded. Although the flood depth may reach above 8.3 ft in some places, most depths will be 2 to 6 ft.	Most of the open space that may be affected by sea level rise and storm surge is already in the 1 percent/100-year floodplain, and wetland plant and animal species already in that floodplain should be somewhat adapted to flooding conditions, although not as much as species immediately on the waterfront.	Low to Moderate	The loss of wetland area from flooding could reduce biological diversity, make the township more vulnerable to impacts from stormwater runoff, and reduce available recreational options in the township. Erosion of habitat, often wetlands, reduces the amount of open space that serves as a buffer between water bodies and neighborhoods, making the flooding of inland structures more probable.	Insignificant to Moderate

VULNERABLE POPULATIONS

Senior Rental Units	Retirement Home	Future site of senior housing, located along NJ-130 at Block 140/Lot 3. The site has a conditional approval but is not yet built.	This asset is out of harm's way in this scenario.	-	Insignificant	N/A	N/A
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Appendix B

Appendix B: Vulnerability and Consequences Rating Keys

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

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



Appendix C

Figure C1: Bordentown Township with Flooding from Sea Level Rise in 2100 and a Category 2 Storm

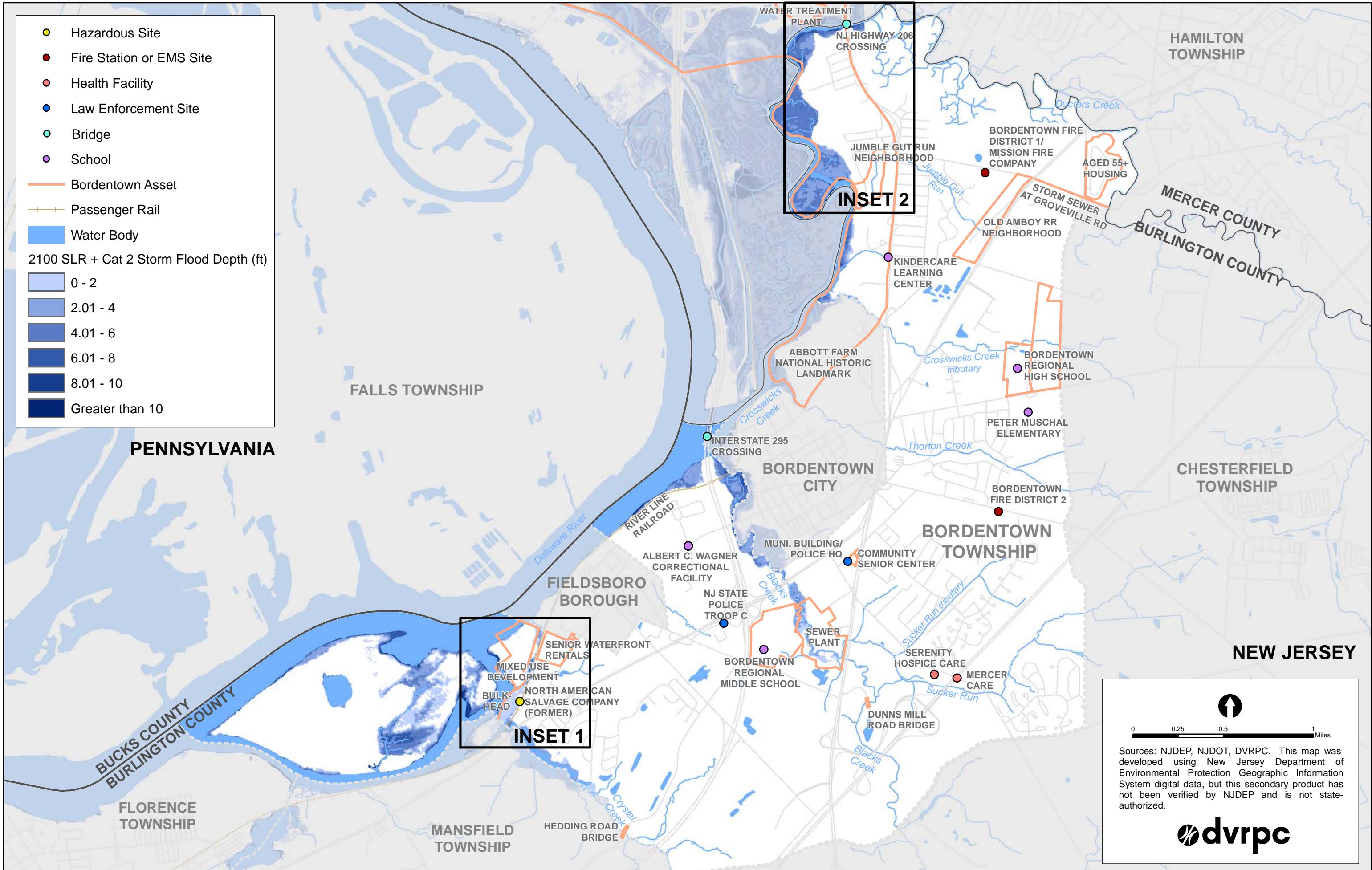


Figure C2: Inset 1 with Flooding from Sea Level Rise in 2100 and a Category 2 Storm

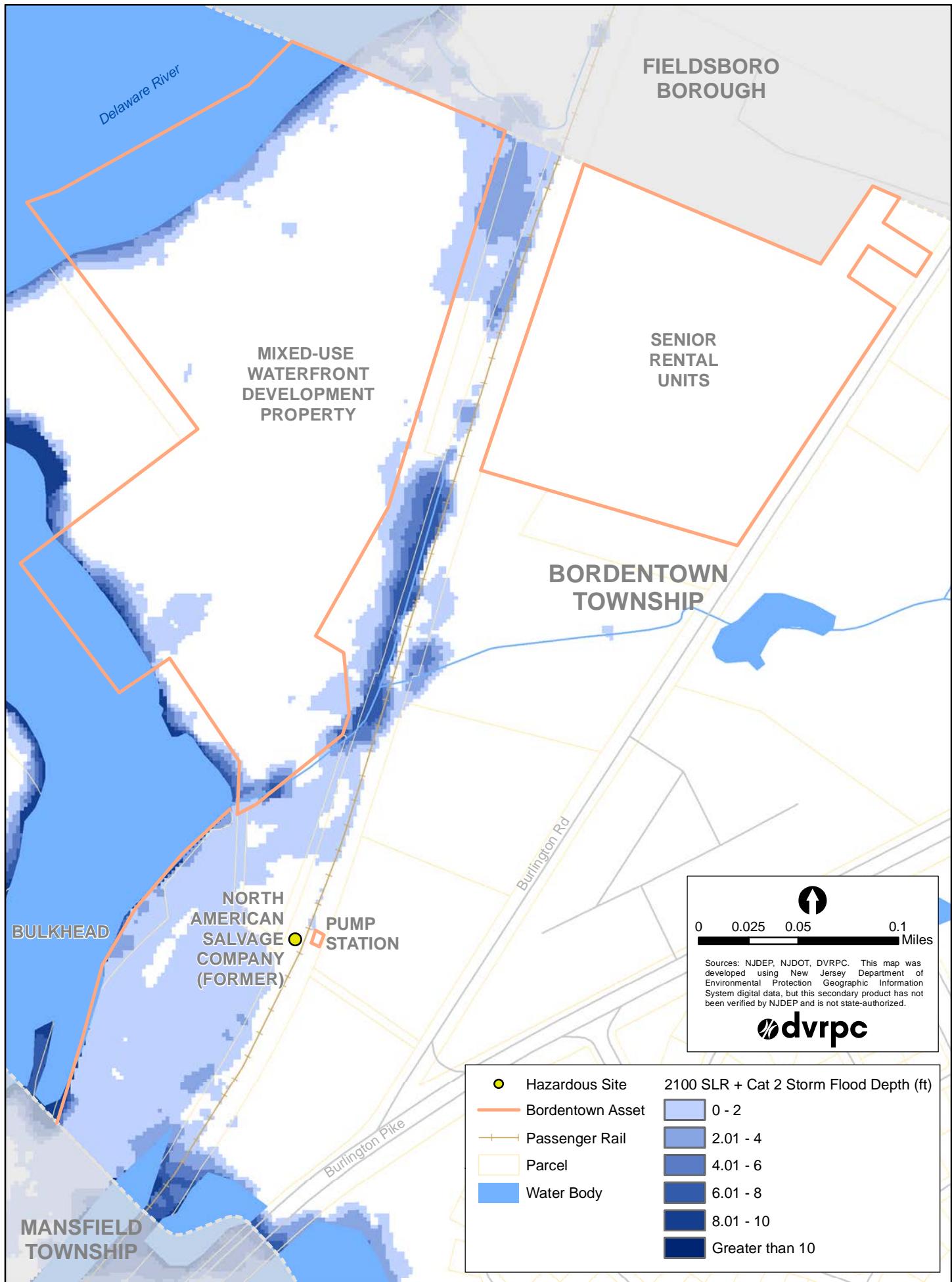


Figure C3: Inset 1 with Aerials

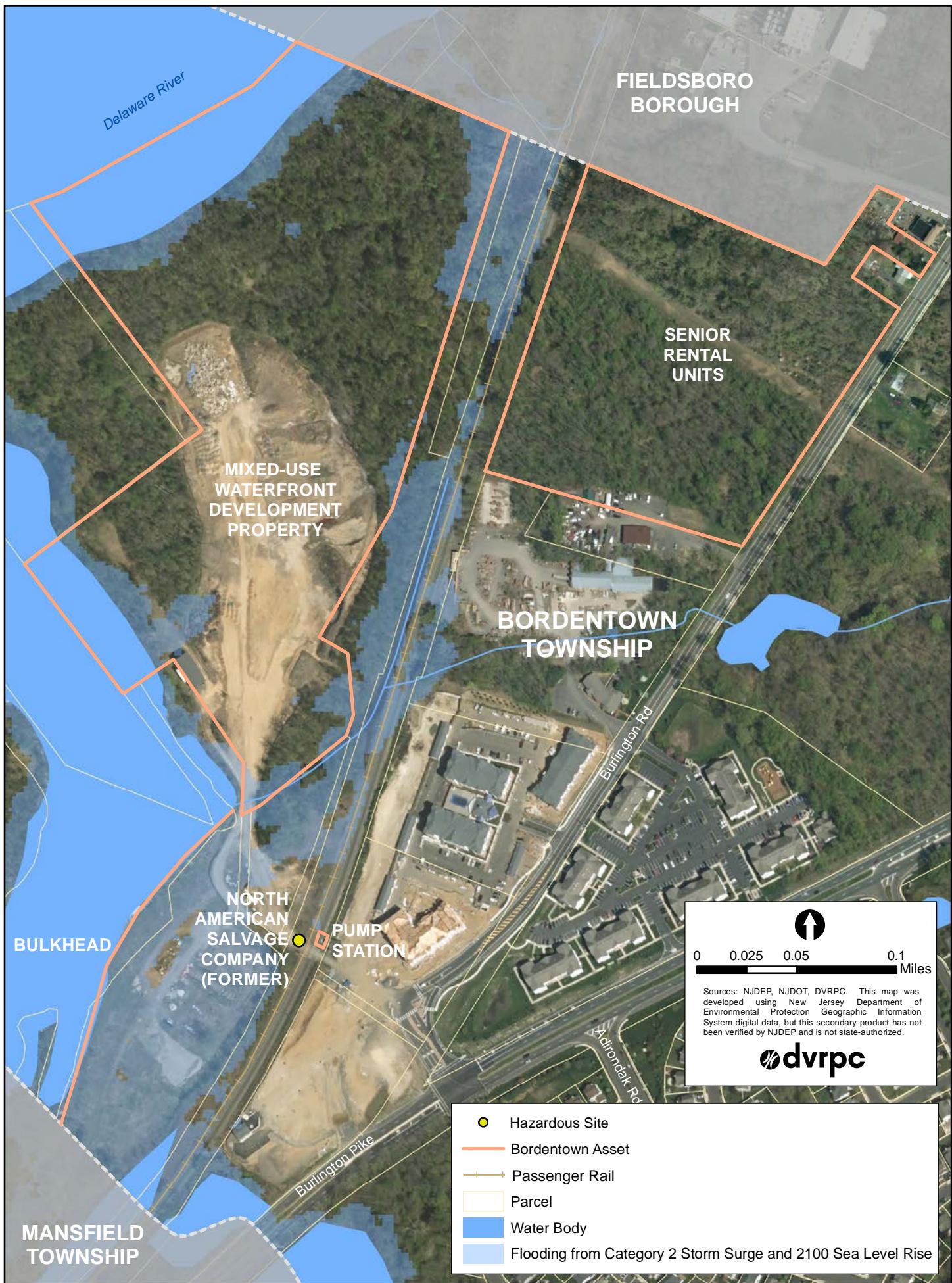


Figure C4: Inset 1 with Open Space



Figure C5: Inset 2 with Flooding from Sea Level Rise in 2100 and a Category 2 Storm

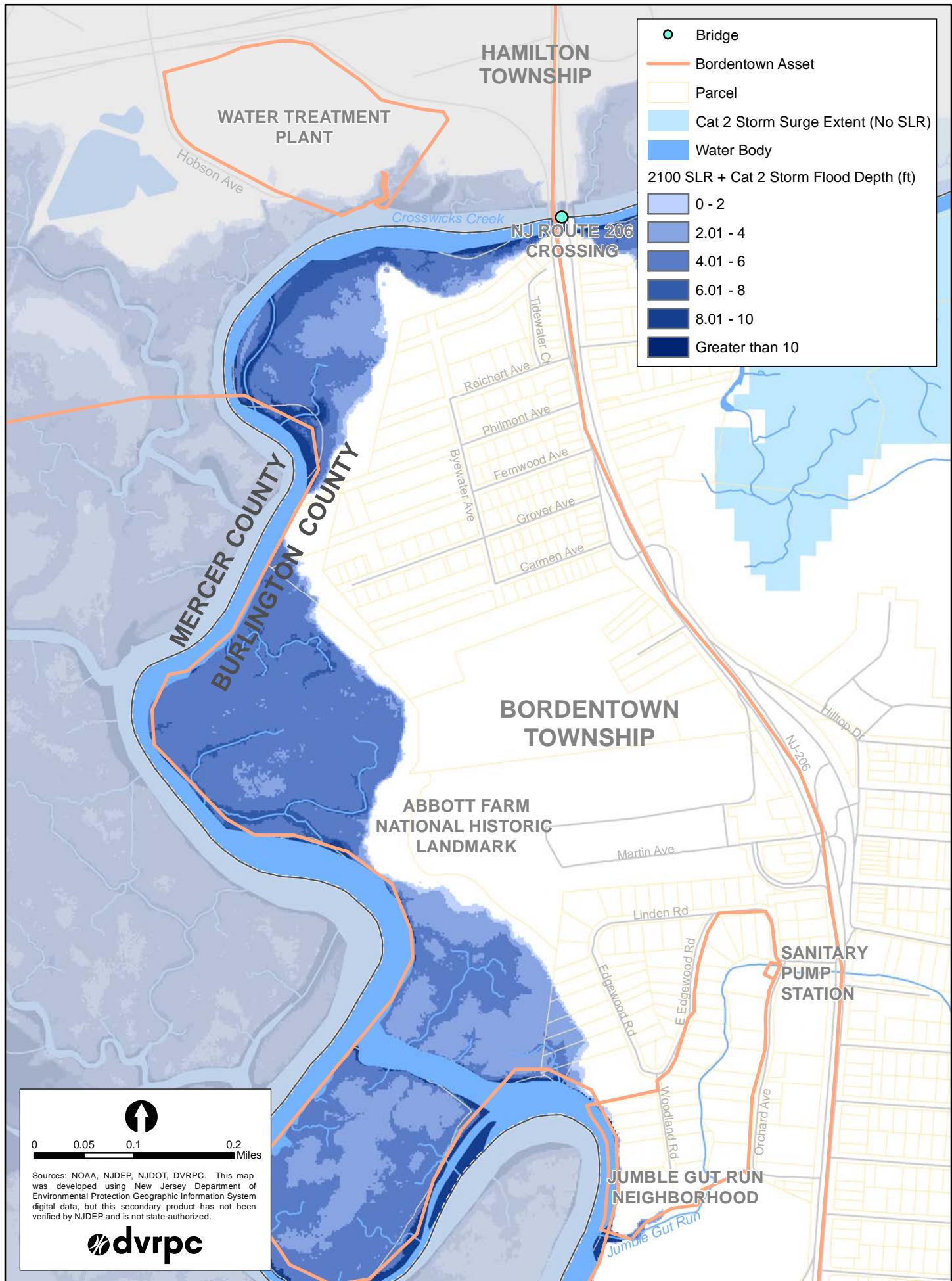


Figure C6: Inset 2 with Aerials

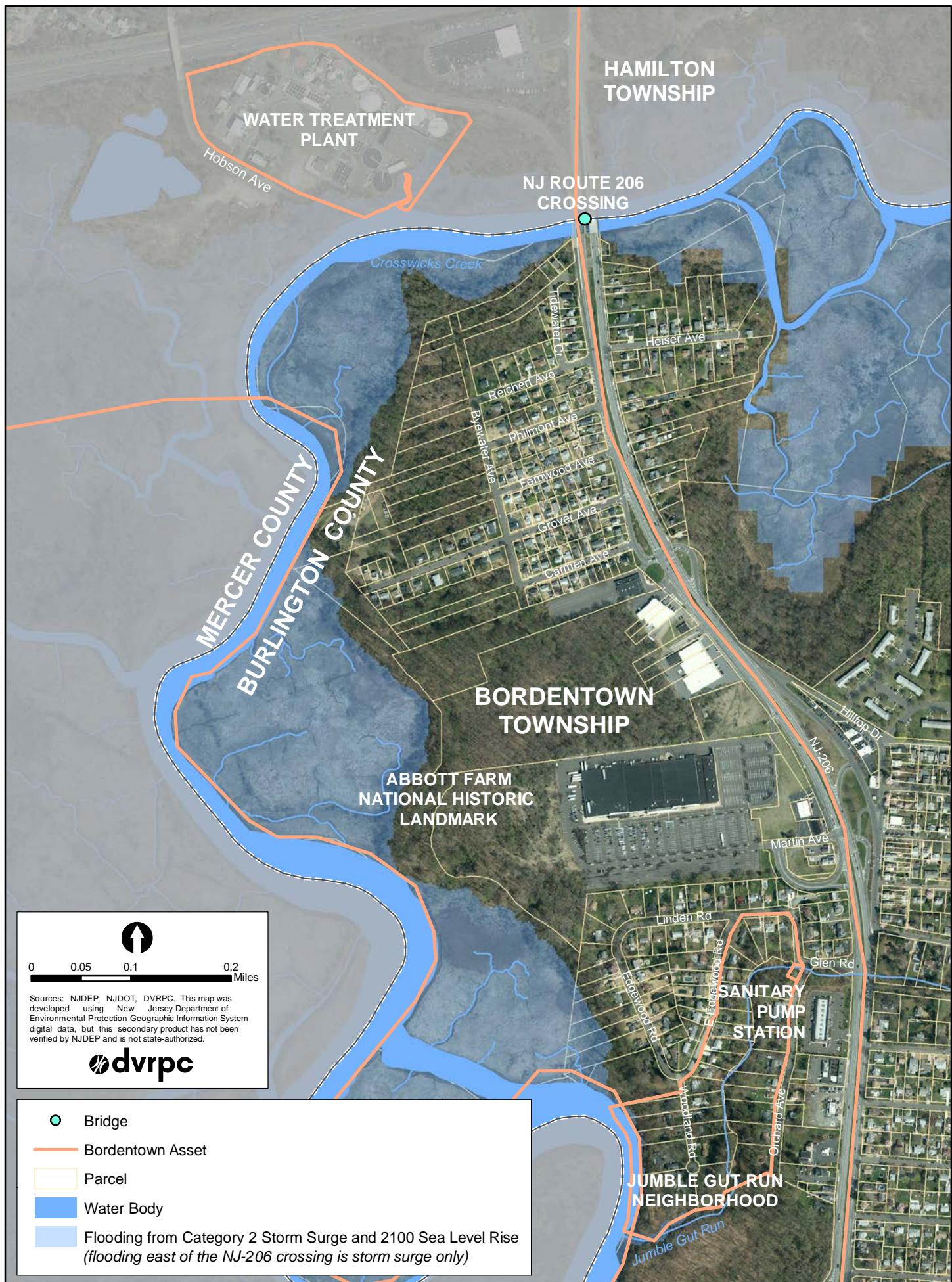
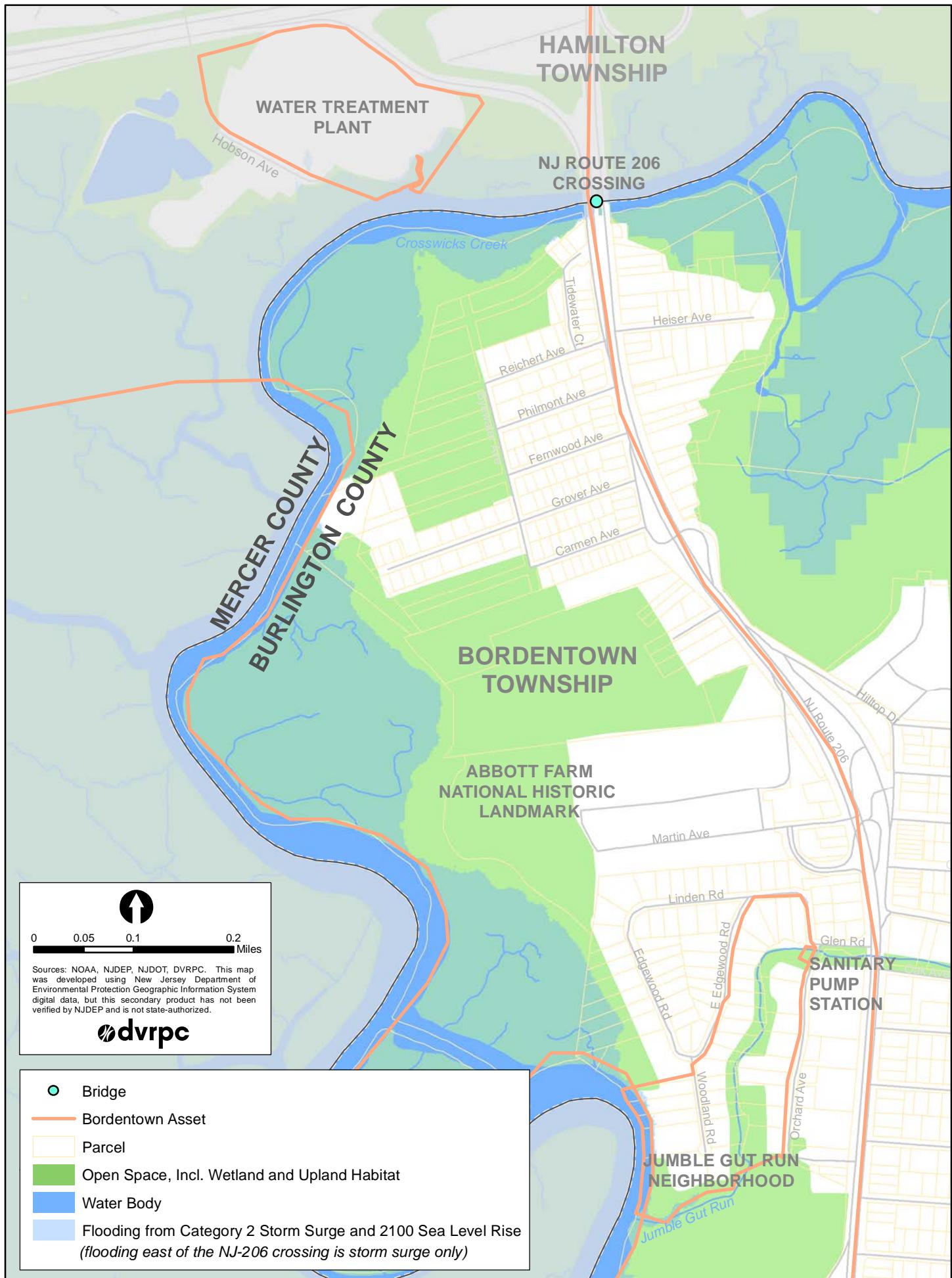


Figure C7: Inset 2 with Open Space



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Geographic Area Covered:

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Bordentown Township, Burlington County, Climate Change, Coastal Vulnerability Assessment, Crosswicks Creek, Delaware River, Environment, Flooding, Hazard Mitigation, Jumble Gut Run, Municipal Planning, Natural Resources, New Jersey, Sea Level Rise, Waterfront

Abstract:

This report documents the coastal vulnerability assessment that the Delaware Valley Regional Planning Commission conducted with municipal staff and residents from Bordentown Township in 2015 and 2016. The narrative outlines projected effects of climate change in New Jersey, records Bordentown's historic flooding issues and the actions taken to increase its resilience to floods, and discusses the coastal vulnerability assessment's methods, findings, and recommendations.

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