

# City of Perth Amboy “Getting to Resilience” Recommendations Report

Prepared by the Jacques Cousteau National Estuarine Research Reserve

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*Recommendations based on the “Getting to Resilience” community evaluation process.*



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## **Introduction**

The Getting to Resilience (GTR) questionnaire was originally developed and piloted by the New Jersey Department of Environmental Protection's Office of Coastal Management in an effort to foster municipal resiliency in the face of flooding, coastal storms, and sea level rise. The questionnaire was designed to be used by municipalities to assist in reducing vulnerability and increase preparedness by linking planning, mitigation, and adaptation. Originally developed by the State of New Jersey's Coastal Management Program, the Getting to Resilience process was later adapted by the Coastal Training Program of the Jacques Cousteau National Estuarine Research Reserve (JC NERR), converted into a digital format, and placed on an interactive website. Further improving the questionnaire, the JC NERR added linkages to evaluation questions including the National Flood Insurance Program's (NFIP) Community Rating System (CRS), Hazard Mitigation Planning, and Sustainable Jersey. While this website is publicly available, through the facilitated Getting to Resilience process, JC NERR Coastal Community Resilience Specialists can enhance the outcomes of the evaluation by providing community-specific recommendations, guided discussions with municipal representatives, a vulnerability analysis, and municipal plan reviews.

The Getting to Resilience process started as a facilitated discussion regarding the City's resilience strengths and challenges. Perth Amboy rests at the convergence of the Arthur Kill and the Raritan River. Staten Island sits across the Arthur Kill to the east and South Amboy sits across the Raritan to the South. The Outerbridge Crossing and the Route 35 Bridge connect those respective communities to Perth Amboy. The City is bordered to the north and west by Woodbridge Township. The City has limited low lying areas near the waterfront. Most of these areas are used for open space, marinas, and industrial uses such as factories and refineries. Commercial and industrial uses located in the floodplain may present a resilience challenge. The City has a rich history and is fully developed and built out. Several redevelopment and neighborhood planning projects are underway.

After Superstorm Sandy, a committee was appointed by the Mayor to create recommendations for the waterfront area, the most impacted section of the City. There were numerous meetings that involved public input. The committee created a report with their recommendations, many of which have been implemented. These included building a retention wall along the parkway, creating sand dunes, rebuilding the marina to higher standards. Numerous plans and strategies for the City currently exist or are being developed to address neighborhood revitalization, economic development, and resident and business needs.

Though the committee tasked with recommendations for the waterfront post-Sandy did an excellent job focusing on resiliency efforts in the waterfront area, City staff noted that other areas of the City are still facing resilience challenges. The sewer pumping station at the foot of 2nd Street has been impacted by flooding during numerous events and lost its pumps due to 5 feet of flooding during Sandy. The City is looking to secure funding to either elevate or move it to another property. The stormwater and sewage systems for the City are combined and are often overwhelmed during heavy precipitation events. Heavy precipitation also leads to flooding on several low lying streets in the City.

The City would like to have topographic information and GIS capacity to analyze this and other threats.

The Raritan Bay Drawbridge also is seen as vulnerable, only resting 5 feet above the high tide line. The bridge is outdated and prevents larger barges from moving upriver and also does not allow important emergency response vessels to move upriver when it is not operational. The beach area on the south shore sees regular erosion, requiring sand to be trucked in. Currently, the City has several groins installed to prevent erosion. However, due to limited success in erosion reduction, the City is interested in possibly changing the design to form T-groins to reduce the erosion rate.

## **Methodology**

The GTR questionnaire is broken into five sections: Risk and Vulnerability Assessments, Public Engagement, Planning Integration, Disaster Preparedness and Recovery, and Hazard Mitigation Implementation. In order to efficiently answer all of the questions within the questionnaire, participation from a wide array of municipal officials and staff is encouraged. These can include administrators, floodplain managers, emergency managers, stormwater managers, public works officials, town engineers, and appointed and elected officials. For Perth Amboy this team included Andrew Toth (Perth Amboy Office of Economic and Community Development), William Kurzenberger (Jewish Renaissance Foundation), Bill Schultz (Raritan River Keeper), Michael Keller (concerned citizen), Larry Cattano (Perth Amboy OEM), Frank Dann (Perth Amboy DPW), and Aneil Mohammed (The Citizens Campaign). The questions in the GTR questionnaire were answered collectively by this group with JC NERR staff recording answers and taking notes on the discussions connected to each question.

The GTR process was started with the town on July 16th, 2014. JC NERR staff met with seven representatives of Perth Amboy and two observers from the NJ Resiliency Network. A discussion of the towns' resilience strengths and challenges began the meeting and sections one and two of the questionnaire were completed. On September 23rd, the questionnaire was completed with five representatives of Perth Amboy and one observer from the NJ Resiliency Network meeting with JC NERR staff.

Upon completion of the GTR questionnaire, JC NERR staff analyzed the answers provided by the City of Perth Amboy, linkages provided by the GTR website, notes taken during the discussion of questions, various municipal plans and ordinances, and mapping of risks, hazards, and vulnerabilities provided by Rutgers University and the NJ Floodmapper website. After reviewing all of this information, this recommendations report was drafted by JC NERR staff to help assist the City of Perth Amboy's decision makers as the City works to recover from Superstorm Sandy and become more resilient.

## **Recommendations**

### **OUTREACH**

#### ***1. Make sure all outreach programs are quantified and catalogued according to CRS standards.***

Although Perth Amboy may not participate in the CRS program, it would be beneficial to plan outreach and other actions according to CRS guidelines as the program is based upon increasing flood preparedness and reduction of risk. Outreach should include information about the natural and beneficial functions of floodplains. Particularly after Sandy, residents throughout the impacted area have been looking for as much information as possible. A well organized and efficient outreach program can provide validated information from a trusted source and better prepare residents and businesses for natural risks. Past outreach efforts should be examined and revisited if they were successful. It is particularly important to revive past programs to educate the public on the importance of disaster plans and emergency kits.

It would be beneficial to develop a Program for Public Information (PPI) which would help to organize outreach and continue to include the current methods and avenues for outreach. A PPI is a researched, organized, and implemented program for public outreach that is seen as having a seven step process. These steps are Establish a PPI Committee, Assess the Community's Public Information Needs, Formulate Messages, Identify Outreach Projects to Convey the Messages, Examine Other Public Information Initiatives, Prepare a PPI Document, and Implement, Monitor and Evaluate the Program. If done correctly, a PPI will make outreach initiatives more effective and can gain CRS credits in numerous categories besides outreach. For guidance on establishing a PPI, visit [http://crsresources.org/files/300/developing\\_a\\_ppi\\_march\\_13.pdf](http://crsresources.org/files/300/developing_a_ppi_march_13.pdf). For more information on Outreach Projects credit requirements, visit page 330-2 of the CRS Coordinator's Manual. [http://crsresources.org/files/2013-manual/crs\\_manual\\_508\\_ok\\_5\\_10\\_13\\_bookmarked.pdf](http://crsresources.org/files/2013-manual/crs_manual_508_ok_5_10_13_bookmarked.pdf)

#### ***2. Develop a pre-flood plan for public information projects that will be implemented during and after a flood.***

Perth Amboy should consider developing a collection of outreach projects in anticipation of future storm events. The outreach should cover all necessary information such as evacuation routes, safety procedures, and recovery operations. This action could be undertaken through a PPI and would help Perth Amboy save time and energy leading up to, during, and after a flooding event as outreach will already have been prepackaged and prepared for dispersal. Pre-flood planning should take place with careful coordination with the community's emergency manager. Examples of messages include evacuation routes, shelter locations, "Turn Around Don't Drown," when it is safe to go back, don't enter a flooded building until it has been cleared by an inspector, get a permit for repairs, substantial damage rules, mitigation opportunities during repairs, and information on mitigation grants.

**3. Make the public talks that took place post-Sandy about flood zones, flooding risk, building recommendations, etc into annual meetings.**

After Sandy, City staff have held talks and discussions on various flood related topics. By continuing to discuss the importance of planning for flooding, the City can set an example to its residents and businesses that readiness for disaster events should be maintained, even in relatively “quiet” times. A PPI can ensure these talks are well placed and effective. Well publicized and attended talks can reduce the workload on City staff that would otherwise need to give numerous one on one meetings. However, continuing to have staff available for one on one meetings is highly recommended as it is highly beneficial.

**4. Create a section of the City website to increase outreach and awareness of storm preparedness.**

A new section entitled “Storm Information” could be created to hold information on flooding threats, evacuation routes, family emergency kits, etc. Once again, by establishing a PPI, the process for establishing this section of the website and subsequently updating it will be defined and documented. To make this information easier to find, it might be beneficial to have the new website section under its own tab.

**5. Create a coastal hazard disclosure policy.**

Disclosure of known flood, erosion, or other coastal hazard risks at the time of property transfer is an important educational effort consistent with an NAI or No Adverse Impact (<http://www.floods.org/index.asp?menuID=460>) attitude. 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 these risks can be factored into the purchase decision. If there is a shore protection structure on coastal property for sale, a disclosure policy could also require that prospective buyers be made aware of the issues surrounding such structures—their drawbacks, negative impacts, and the need for monitoring and maintenance. This type of policy can help sellers avoid transferring known adverse impacts that become unpleasant surprises to buyers.

During Getting to Resilience meetings, City staff noted that some lenders and real estate agents disclose information about hazards associated with properties being considered for purchase. To ensure that this process continues and to establish congruence of methodology regarding these disclosures, a hazard disclosure policy could be established. The City would then be able to dictate what information must be shared with potential buyers and set guidelines for the education of new residents concerning their flooding risk. Disclosing these risks to the public using various techniques also may result in CRS credits in the Outreach Projects and Hazard Disclosure sections. For more information on Outreach Projects credit requirements, visit page 330-2 of the CRS Coordinator’s Manual. For more information on Hazard Disclosure credit requirements, visit page 340-2 of the CRS Coordinator’s Manual.

[http://crsresources.org/files/2013-manual/crs\\_manual\\_508\\_ok\\_5\\_10\\_13\\_bookmarked.pdf](http://crsresources.org/files/2013-manual/crs_manual_508_ok_5_10_13_bookmarked.pdf)

## **MITIGATION**

### **6. Consider being designated as a StormReady Community by the National Weather Service.**

The National Weather Service has created a community preparedness program to assist towns as they develop plans for a wide variety of severe weather events. This program provides guidance on hazardous weather identification, warning systems, and creating public readiness. For more information, visit <http://www.stormready.noaa.gov/howto.htm>. Perth Amboy officials conveyed that they have strong storm preparedness operations that may already qualify for StormReady status. Having the City achieve StormReady status would set a good example to residents to also become prepared.

### ***7. Perth Amboy should identify, map, and keep data on areas of coastal erosion and consider creating erosion protection programs.***

City staff noted that the southern waterfront and beach are consistently experiencing erosion, requiring replenishment of sand and the consideration of changing the current groin configuration. Erosion can become a problem in coastal areas. Areas that should be closely monitored could include any waterfront that is not bulkheaded and has experienced erosion. Factors that could amplify erosion (sea level rise, surge) should be defined. The City should make an effort to identify, document, and quantify the areas of erosion. Identifying erosional hot spots and their potential impacts on homes and infrastructure can allow for mitigation actions that may prevent erosion from becoming a future problem. In the same mindset, unwanted deposition from shoaling and runoff can also be problematic for stormwater management near outfall pipes and navigation in waterways. Erosional hot spots like the Perth Amboy Beach could then be monitored for change, allowing for more ability to request funding for shoreline restoration projects. This information should be used to supplement a Shoreline Management Plan.

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## **MUNICIPAL ORGANIZATION**

### ***9. Transfer personal knowledge, documents, and other records of coastal storm and flooding event damages to digital format and place on a shared City computer drive to allow for access by multiple municipal departments.***

Memories of historical storm events, specifically ones that were not documented by state and federal agencies, are useful tools that can be used to plan for impending storms. However, information from these memories can be made available for all municipal staff. This information should be gathered and documented from current municipal staff, past municipal staff, and public input and may be very useful to identify past surge extents, conditions that caused amplification of storm damages, and vulnerable areas not shown by mapping. Hard copies of documents and other records should also be digitized for preservation and access. Having all storm and flooding related information on a shared

drive will help educate the staff and allow for access without having to coordinate an exchange of information.

**10. Have City municipal officials participate in FEMA training courses.**

While going through the GTR questionnaire, it was noted that FEMA accredited trainings may be useful to City officials. FEMA offers in person training and independent study programs. To find more information about in person training topics and dates please visit <http://training.fema.gov/> and <http://www.fema.gov/training-1> and for independent study programs please visit <http://training.fema.gov/is/>. Through the Coastal Training Program, the JC NERR offers free courses for municipal staff and elected/appointed officials. JC NERR is willing to work with the City to understand training needs and provide relevant courses when possible.

**11. Utilize the Community Vulnerability Assessment Tool, Risk and Vulnerability Assessment Tool, Hazard Assessment Tool, and HAZUS-MH to identify potential hazards, risks, and vulnerabilities and keep mapping information on file.**

There are numerous hazard, risk, and vulnerability assessment tools available to municipalities. It is recommended that the members of the municipal staff are familiar with the use of these tools. The importance of identifying hazard, risk, and vulnerability cannot be overstressed. Use of these tools can be beneficial in the CRS, hazard mitigation planning, creating municipal plans, zoning, and writing construction codes.

- The Community Vulnerability Assessment Tool is used to conduct a community vulnerability assessment to a wide range of hazards. It is often used in conjunction with the Risk and Vulnerability Assessment. <http://csc.noaa.gov/digitalcoast/training/roadmap>
- The Risk and Vulnerability Assessment Tool is used to identify people, property, and resources that are at risk of injury, damage, or loss from hazardous incidents or natural hazards. <http://csc.noaa.gov/digitalcoast/training/roadmap>
- The Hazard Assessment Tool is a risk assessment process which will help identify hazards, profile hazard events, inventory assets, and estimate losses. <http://www.fema.gov/hazard-mitigation-planning-risk-assessment>
- HAZUS-MH is a software package that uses models and Geographic Information Systems (GIS) technology for estimating physical, economic, and social impacts from various hazards such as floods and hurricanes. <http://www.fema.gov/hazus>

**12. Maintain efforts to supplement the Middlesex County special needs database.**

While the City and County have undertaken efforts to identify residents that would need assistance during an evacuation, it is important to revisit these efforts and expand upon them in order to keep the list updated to ensure resident safety. Perth Amboy could also consider establishing a municipal



specific program and refer residents to the NJ Register Ready Program as well. ([http://www.ready.nj.gov/plan/special\\_needs7.html](http://www.ready.nj.gov/plan/special_needs7.html))

## **FEMA MAPPING**

### ***13. Adopt the latest version of FEMA's flood maps and rewrite elevation and freeboard requirements in the Flood Damage Prevention Ordinance as based upon the Best Available Flood Hazard Data or the most stringent version of FEMA's flood maps.***

The City should amend the current 2010 Flood Damage Prevention Ordinance by using language available in the current NJ DEP recommended Ordinance to include the state mandated 1 foot freeboard requirements. Also, by writing new requirements as related to the Best Available Flood Hazard Data, it should allow for change over time as FEMA's maps are redrawn regularly. While it had been decades since FEMA had remapped the FIRMs in our area, the remapping process was long overdue and can be anticipated to take place with a much higher frequency in the future. Best Available Flood Hazard Data is defined by NJ DEP as the most recent available flood risk guidance FEMA has provided. The Best Available Flood Hazard Data may be depicted on but not limited to Advisory Flood Hazard Area Maps, Work Maps or Preliminary FIS and FIRM. For more information on NJ DEP recommended Flood Damage Prevention Ordinances, visit <http://www.nj.gov/dep/floodcontrol/modelords/modelde-bestavail.doc>.

By adding "or the most stringent version of FEMA's flood maps" to this ordinance, higher standards may be instituted that may result in the town becoming more resilient. For example, the Advisory Base Flood Elevation maps may have a more expansive V-zone than the Flood Insurance Rate Maps. By requiring building to adhere to the stricter requirements of the Advisory Base Flood Elevation maps, more homes will be built to higher standards. Likewise, a higher freeboard requirement may result in a safer community. An amended ordinance may also include some of the newer information coming out on FEMA's maps including the Limit of Moderate Wave Action (LiMWA). That information can also be used to enhance the building standards.

### ***14. Ensure the public is aware of any changes to FEMA's flood maps as they are updated and if those updates result in changes to the City's building requirements.***

Ensuring that the information on the maps is understood by all municipal leaders and staff prior to discussions with the public is critical to ensure that the correct information is disseminated by the City. For every release of a map update, the City could make a public announcement to its citizens and businesses and detail if any changes were made to the prior map, including if additional information such as the Limit of Moderate Wave Action has been added. Notifying the public of a new map product is an example of outreach that can be done by the City's PPI. Including information on what changes occur when new maps are released on the City's Flood Information webpage may help to alleviate questions the public may have as each map is updated, thereby reducing the workload on City staff.

The new RISK map products from FEMA include a GIS layer depicting the “changes since last FIRM” which will help the City in describing the changes in flood zones on individual properties and for the City as a whole. A description of this data set can be found at: <http://www.region2coastal.com/flood-risk-tools/tool-descriptions> and the new data layer is being developed as part of the preliminary FIRM process. This data is in draft form now but will be released at the [www.region2coastal.com](http://www.region2coastal.com) website soon. The more familiar the citizens and businesses are with the maps, the more likely they will take appropriate actions.

***15. Make sure all flood maps are available on the town website, at City Hall, and at the local libraries.***

Perth Amboy has made Flood Insurance Rate Maps (FIRMs) available in the past but must ensure that these maps are accessible and easy to find. Having the most up to date FEMA issued floodplain maps available at numerous locations in different forms of dispersal is critical to ensuring your citizens and businesses are informed. Maintaining a link to FEMA’s website on the City website is highly recommended and should highlight a section that deals specifically with flooding and other storm hazards.

***PLANNING***

***16. Consider creating a City specific Continuity of Operations Plan.***

A Continuity of Operations Plan (COOP) is separate from an Emergency Operations Plan and ensures that primary essential functions continue to be performed before, during, and after a wide range of emergencies. It is developed and maintained to enable each department, agency, and other governmental entity to continue to function effectively in the event of a threat or occurrence of any disaster or emergency that could potentially disrupt governmental operations and services. A COOP can protect essential facilities, equipment, vital records, and other assets. It can reduce or mitigate disruptions to operations. It can facilitate decision-making during an emergency. While Middlesex County has a County government plan, Perth Amboy should consider creating their own plan. JC NERR is able to provide example COP plans from the Borough of Avalon ([http://www.prepareyourcommunitynj.org/media/27952/Avalon\\_COOP\\_COG.pdf](http://www.prepareyourcommunitynj.org/media/27952/Avalon_COOP_COG.pdf)) and Brick Township. FEMA also provides a Continuity Plan Template (<http://www.fema.gov//media-library/assets/documents/90025>) that can be used as a starting point for local governments.

***17. Focus on including numerous possible mitigation projects in the Middlesex County Multi-Jurisdictional Hazard Mitigation Plan update and incorporate those projects into the Capital Improvements Plan.***

With Middlesex County going through an Multi-Jurisdictional Hazard Mitigation Plan update, it is important to have numerous City officials and staff come together to identify potential mitigation projects for Perth Amboy. Sandy has shown the need for numerous potential projects but funding is

always an issue. By including these “wish list” projects in the Multi-Jurisdictional Hazard Mitigation Plan, it leaves the door open for grant programs to fund the projects. The last Plan included four projects. Adding additional resilience projects could allow for them to be funded through future Hazard Mitigation funding opportunities. Projects that are not listed in the Multi-Jurisdictional Hazard Mitigation Plan will struggle to find funding sources. A crosswalk of possible mitigation projects should be included in the Capital Improvements Plan which should be updated during the Master Plan rewrite. Perth Amboy could reference FEMA’s “Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards” for mitigation project ideas.

<https://www.fema.gov/media-library/assets/documents/30627>

***18. Continue to work with New Jersey Transit to plan to replace Raritan Bay Drawbridge.***

During meetings, City officials noted that the Raritan Bay Drawbridge could create a number of challenges during storm events. At its current size, modern large barges are unable to get through, impeding commerce upriver. Additionally, clearance during high tide under normal conditions is only 5 feet. During large surge events, this puts the structure in the water, leading to the potential for increased damage. With anticipated sea level rise, the bridge will be impacted more and more often as clearance between the bridge and sea level is reduced. After Sandy, there were issues with the foundation of the bridge that led to closure of the bridge. In addition, if winds are greater than 30 mph, the bridge is shut down. Any closure of the bridge also results in lack of access for fire and EMS boats upriver, a dangerous situation given the large amount of development upriver. As a step towards increasing resilience, Perth Amboy should continue to attempt to work in collaboration with New Jersey Transit to develop a plan for replacement of the Raritan Bay Drawbridge.

***19. Create an action plan for precipitation flooding events.***

Perth Amboy frequently receives flooding during heavy rain events at numerous locations, including Outer State Street, Smith Street, Market, and the New Brunswick underpass, prompting street closures and emergency response. By drawing upon the knowledge of past events and topographical information, an action plan could be created to identify how much rain it takes to create flooding at certain locations. When heavy rain events are forecast, the City would be able to preemptively prepare staff and resources to address the anticipated issues. In addition, the development of this action plan could result in the understanding of the cause for flooding, possibly allowing mitigation of causes such as clogged or undersized stormwater pipes. Such mitigation actions could then be included in the All Hazards Mitigation Plan.

***20. Collaborate with the Utility Service Affiliates to create plans to update wastewater treatment facilities in conjunction with a stormwater management plan.***

The NJ DEP is looking to issue final New Jersey Pollution Discharge Elimination System (NJPDDES) permits to Perth Amboy and other cities with combined sewer systems by January 2015. This would then start a three year window for Perth Amboy to create a Long Term Control Plan to address the issues associated with combined sewer systems. Combined sewer overflow systems discharge

untreated water into local waterways, leading to pollution and fines from the United States Environmental Protection Agency through the Clean Water Act. These releases take place when the volume of water reaching the treatment plant exceeds the facility's ability.

As Perth Amboy and Utility Service Affiliates create plans to address issues, steps should be taken to update the wastewater treatment facility. New Jersey has seen a marked increase in heavy precipitation events and this should be expected to sustain or continue to increase, increasing the volume of water needing to be treated. In addition, plans should also look to mitigate flooding issues at pump stations and take into account possible impacts of sea level rise on flooding events. The state required plans for addressing long term issues should complement a new stormwater management plan for the City that is created by both the Utility Service Affiliates and City planners to ensure that the stormwater management plan complements other planning documents. For ideas for long term combined sewer overflow upgrades, visit [http://www.nyc.gov/html/dep/html/stormwater/combined\\_sewer\\_overflow.shtml](http://www.nyc.gov/html/dep/html/stormwater/combined_sewer_overflow.shtml).

***21. Create a shoreline management plan and consider a dune protection ordinance***

The City has seen a high erosion rate take place on the beaches of the south shoreline. While groins currently exist to reduce erosion, they have not been effective. Staff noted that a redesign of the groins may be needed. As shorelines are dynamic systems, it is important to have a well researched and documented plan that takes into account the forces at play and the desired uses for the beach and neighboring shoreline areas. The shoreline management plan should work in conjunction with the Recreation Master Plan to ensure that the shoreline and beach are able to be utilized for many years without being too costly to maintain.

The inclusion of dunes to the beach is an excellent use of soft engineering to mitigate wave energy during large storm events. However, the current design may not offer the maximum amount of desired protection. The sand berm is pushed against the retaining wall for the waterfront walkway and is not high enough to provide protection that would exceed that of the retaining wall. In addition, as dune grass captures more sand and the dune grows, the City may have the undesirable side effect of the dune migrating over the wall and onto the walkway. It would be best to have the dune sit slightly farther away from the retaining wall to prevent this from taking place and allow the dune to properly grow in elevation to provide proper wave energy protection. In order to protect the dune grass to allow it to grow the dune, the City should also consider a dune protection ordinance to allow for signs to be posted with possible fines to keep people off of the dunes.

***22. Perth Amboy should identify sea level rise as a hazard in municipal plans and consider disclosing hazard risks.***

Perth Amboy will experience impacts due to sea level rise and like all potential hazard impacts, this risk should be identified in town plans to ensure proper response. Historical rates of sea level rise should be defined as part of this action and future predicted sea levels should be taken into account

when making land use decisions, construction standards, etc. The historical rate of sea level rise along the New Jersey coast over the past half century was 3-4 mm/yr (or 0.12 -0.16 in/yr), while projected future rates are expected to increase. In the recent paper entitled “A geological perspective on sea-level rise and its impacts along the U.S. mid-Atlantic coast” Miller and Kopp state that for 2050, the “best” estimate for sea level rise is 1.3 feet along the Jersey Shore. By 2100, the “best” estimate for sea level rise is 3.1 feet along the Jersey coast. “Best” refers to a 50% likelihood of that level of sea level rise occurring, meaning that actual sea levels may be lower or higher than the “best” estimates.

While sea level rise is a monumental challenge to coastal areas, the challenge cannot be tackled until it is properly identified. Several counties have included sea level rise in their All Hazard Mitigation plans, setting the example that should be followed by Middlesex County during their rewrite. Once this takes place, local plans should reflect sea level rise as a hazard as well.

***23. Examine municipal plans, strategies, and ordinances and consider rewriting sections to include the previous recommendations or reflect the risks, hazards, and vulnerabilities explored in the Getting to Resilience process.***

In order to fully embrace resiliency, municipal plans, strategies, or ordinances should incorporate resiliency recommendations and findings. These should include the Municipal Master Plan, All Hazards Mitigation Plan, Floodplain Management Plan, Evacuation Plan, Emergency Response Plan, Continuity of Operations Plan, Disaster Recovery Plan, Post Disaster Redevelopment Plan, Capital Improvements Plan, Economic Development Plan/Strategy, Coastal Plan, Shoreline Restoration Plan, Open Space Plan, Stormwater Management Plan, Historic Preservation Plan, Zoning Ordinance, Flood Damage Prevention Ordinance, and Building Code. If these plans, strategies, or ordinances do not currently exist, it is highly recommended the Borough move to create them. Further content regarding this recommendation can be found below in the section titled, “Coastal Hazard Incorporation in Planning”. Perth Amboy should contact the New Jersey Resiliency Network ([www.njresiliency.com](http://www.njresiliency.com)) for additional assistance as they are able to provide technical assistance and resources on risk and vulnerability assessments, model plans and ordinances for mitigation and recovery, and adaptation strategies for community resilience.

***24. Begin the long term planning process to prepare for sea level rise.***

Perth Amboy, like most other coastal municipalities, will experience impacts from sea level rise in the form of regular tidal flooding and heightened storm impacts, requiring mitigation actions. However, Perth Amboy’s higher elevations in most of town results in a far more limited number of properties, facilities, and infrastructure that will need to have a plan in place to mitigate or respond to these heightened flooding threats when compared to neighboring communities. A lower scope of vulnerability to sea level rise does not mean that Perth Amboy should not prepare. Planning and informed decision making can start now. The range of options include buyouts, elevating properties, and hardening techniques to name a few, but the use of these options must be weighed, discussed, and decided upon.

The Blue Acres program is currently being administered by the NJDEP throughout the state and other buyout programs are also available. It would be prudent to look into repetitive loss properties that will also be threatened by sea level rise in the future to determine if buyouts of these properties would be an effective way to plan for sea level rise. If the City feels that buyouts are not a good option, mitigation strategies should be investigated. However, not only will the individual mitigation options need to be examined, but the time frame of their effectiveness should be a factor. Cost-benefit analysis should accompany all mitigation projects to ensure that the lifespan of the mitigation and effectiveness when compared to rate of sea level rise is weighed against anticipated protection. In some instances, it may be determined that the cost of protecting already flood prone areas against sea level rise will be less effective than property acquisition. This may lead the City to reconsider mitigation measures such as buyout programs.

JC NERR recommends Perth Amboy consider learning from the resiliency planning process undertaken by Guilford, CT and described in “Town of Guilford Community Coastal Resilience Plan Report of Options to Increase Coastal Resilience”:  
(<http://www.ci.guilford.ct.us/pdf/Coastal%20Resilience%20Plan,%20Report%20&%20Options.pdf>).

The goal of their Coastal Resilience Plan was to address the current and future social, economic, and ecological resilience of the Town of Guilford to the impacts of sea level rise and anticipated increases in the frequency and severity of storm surge, coastal flooding, and erosion. The Town has drafted the report of options for increased coastal resilience as a step toward developing a Community Coastal Resilience Plan.

The four basic steps of the Coastal Resilience Plan are:

1. Generate awareness of coastal risk;
2. Assess coastal risks and opportunities;
3. Identify options or choices for addressing priority risks and vulnerabilities (short term); and
4. Develop and implement an action plan to put selected options or choices into place (long term).

Similar to Perth Amboy, Guilford’s coastal neighborhoods are diverse and it is likely that each will be faced with a combination of vulnerabilities to sea level rise and the increased incidence and severity of coastal storms. A combination of adaptation measures will therefore be necessary in each neighborhood in order to reduce risks and increase resilience. Likewise, neighborhood-scale resilience planning will likely be important. Steps should be taken to evaluate individual adaptation measures and determine how comprehensive solutions can be developed and implemented for building coastal resilience.

A comprehensive risk and vulnerability assessment for Perth Amboy should include the following municipal sectors:

- Social – Residents, business community, and visitors.
- Economic – Residential Properties, commercial/industrial businesses, municipal resources,

tourism, and future development.

- Infrastructure – Roads, bridges, railroads, stormwater, seawalls, tide gates, the marina, and municipal facilities.
- Utilities – Public and private water supplies, septic systems, telecommunications, and electricity.
- Emergency Services – Fire, police, medical, sheltering, evacuation/egress.
- Natural Systems – Tidal wetlands and other coastal landforms.

When considering options for coastal resilience, the following three types of adaptation responses are typically considered:

- **Protection** involves hard structures such as sea walls and dikes, as well as soft solutions such as dunes and vegetation, to protect the land from the sea so that existing land uses can continue.
- **Accommodation** implies that people continue to use the land at risk but do not attempt to prevent the land from being flooded. This option includes erecting emergency flood shelters, elevating buildings on piles and elevating roadways.
- **Retreat** involves no effort to protect the land from the sea. The coastal zone is abandoned and ecosystems shift landward. This choice can be motivated by excessive economic or environmental impacts of protection. In the extreme case, an entire area may be abandoned.

Included in a 2010 NOAA's Office of Ocean and Coastal Resource Management manual titled, "Adapting to Climate Change: A Planning Guide for State Coastal Managers" is a thorough discussion of adaptation strategies and methods.

(<http://coastalmanagement.noaa.gov/climate/docs/adaptationguide.pdf>). Perth Amboy could consider some of the options presented in this document for long and short-term resiliency planning. Many of these suggestions complement the suggestions provided earlier in this GTR Recommendations report:

#### **Impact Identification and Assessment**

- Research and Data Collection – Predict possible social and economic effects of climate change on communities. Calculate cost-to-benefit ratios of possible adaptation measures. Encourage adaptation plans that are tailored to specific industries.
- Monitoring – A comprehensive monitoring program that incorporates multiple tools and considers a variety of systems and processes can provide input to the vulnerability assessment and adaptation strategy.
- Modeling and Mapping – Map which areas are more or less susceptible to sea level rise in order to prioritize management efforts.

#### **Awareness and Assistance**

- Outreach and Education – Create scientific fact sheets about climate change addressing community members, visitors, elected officials, businesses and industries. Use multiple forms of communication such as news media, radio, brochures, community meetings, social

networks, blogs and websites.

- Real Estate Disclosure – The disclosure of a property’s vulnerability to coastal hazards enables potential buyers to make informed decisions reflecting the level of impacts they are willing and able to accept.
- Financial and Technical Assistance – Provide flood insurance discounts for properties that exceed floodproofing standards by one or two feet. Encourage hazard mitigation by providing grants to areas that implement adaptation measures.

### **Growth and Development Management**

- Zoning – Zoning can be used to regulate parcel use, density of development, building dimensions, setbacks, type of construction, shore protection structures, landscaping, etc. It can also be used to regulate where development can and cannot take place, making it an invaluable tool in efforts to protect natural resources and environmentally sensitive areas and guide development away from hazard-prone areas.
- Redevelopment Restrictions – Combining restrictions with acquisition/demolition/relocation programs provides safer options to property owners in the wake of the loss of or damage to their homes or businesses.
- Conservation Easements – A conservation easement is a legal agreement between a landowner and a land trust or government agency that can be used to restrict development in sensitive and hazard-prone areas.
- Compact Community Design – The high density development suggested by compact community design can allow for more opportunities to guide development away from sensitive and hazard-prone areas.

### **Loss Reduction**

- Acquisition, Demolition, and Relocation – The most effective way to reduce losses is to acquire hazard-prone properties, both land and structures, demolish or relocate structures, and restrict all future development on the land.
- Setbacks – Setbacks can protect structures from hazards by keeping the structures away from a property’s most vulnerable areas.
- Building Codes – Building codes that regulate design, construction, and landscaping of new structures can improve the ability of structures in hazard-prone areas to withstand hazard events.
- Retrofitting – Existing structures can be protected from hazards through retrofitting.
- Infrastructure Protection – Infrastructure protection entails fortification against the impacts of climate change.
- Shore Protection Structures – Shore protection structures protect existing development allowing it to stay in place. They often damage or destroy other valuable coastal resources and create a false sense of security; nevertheless in some cases, for the purposes of protecting existing development, there may be no other acceptable or practical options.

### **Shoreline Management**

- Regulation and Removal of Shore Protection Structures – To protect the natural shoreline



and the benefits it provides, regulations can be used to limit shoreline hardening as well as promote alternative forms of protection.

- Rolling Easements – Rolling easements are shoreline easements designed to promote the natural migration of shorelines. Typically, rolling easements prohibit shore protection structures which interfere with natural shoreline processes and movement, but allow other types of development and activities. As the sea rises, the easement moves or “rolls” landward, wetland migration occurs, and public access to the shore is preserved.
- Living Shorelines – Living shorelines can be effective alternatives to shore protection structures in efforts to restore, protect, and enhance the natural shoreline and its environment. Living shorelines use 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 or reduce wave energy.
- Beach Nourishment – Beach nourishment is the process of placing sand on an eroding beach, typically making it higher and wider, to provide a buffer against wave action and flooding.
- Dune Management – Dunes may be restored or created in conjunction with a beach nourishment project or may be managed as part of a separate effort.
- Sediment Management – Dredging and placing sediment, building shore protection structures and other structures that trap or divert sediment.

#### **Coastal Ecosystem Management**

- Ecological Buffer Zones – Ecological buffers are similar to setbacks (and may be included within setbacks) but are typically designed to protect the natural environment by providing a transition zone between a resource and human activities.
- Open Space Preservation and Conservation – Open space preservation and conservation can be accomplished through the management of lands dedicated as open space through a number of the measures previously discussed, such as zoning, redevelopment restrictions, acquisition, easements, setbacks, and buffers.
- Ecosystem Protection and Maintenance – In the context of coastal adaptation, ecosystem protection largely involves the protection of tidal wetlands and other ecosystems. The facilitation of wetland migration is an important aspect of this.
- Ecosystem Restoration, Creation, and Enhancement – Similar to the above, ecosystem restoration and creation can replace tidal wetlands that are lost to sea level rise.

#### **Water Resource Management and Protection**

- Stormwater Management – Drainage systems may be ill-equipped to handle the amount of stormwater runoff that will accompany the more intense rainfall events expected in the future, and those in low-lying areas will be further challenged by losses in elevation attributed to rising sea levels.
- Water Supply Management – Climate change will negatively affect both water quantity and quality, and coastal populations will continue to grow, so water supply managers must be

prepared to respond to associated challenges to water supply.

Examples of adaptation measures considered in Guilford's plan include management of coastal real estate and structures, shoreline protection and management of coastal and nearshore lands, roadway alterations, and protection or replacement of water supply wells and septic systems. All these adaptation measures are presented with a variety of options for consideration.

Perth Amboy may also gain some planning insight from the public participation process associated with Guilford's resiliency planning. Guilford found their public believes that physical changes are needed to address sea level rise and increase coastal resilience, but that there are societal and institutional obstacles. Common themes noted from the public comments included:

- Coastal resilience planning – and many of the solutions that are implemented – may be best accomplished at the neighborhood scale; and neighborhood planning groups may need to be organized to begin looking at appropriate solutions;
- The tax base associated with coastal properties would need to be preserved in the short term and then some of the tax base may need to be shifted in the long term;
- Education and technical assistance are needed and desired by homeowners, and education could also be accomplished in the schools;
- Comprehensive solutions will be needed such as: addressing water and wastewater at the same time in neighborhoods where these systems will struggle or fail; ensuring that roadway improvements in one location are effective because improvements are also made elsewhere in the transportation network; and working on coordinated roadway and railroad improvements.

In thinking of their own public participation in resilience planning, Perth Amboy could likely expect similar themes to emerge and could be prepared to offer the long-term planning options that may be under consideration by the municipality.

### **Coastal Hazard Incorporation in Planning**

Incorporation of coastal hazards into municipal planning is highly recommended to accurately reflect the risks of coastal living. Life in coastal communities largely revolves around weather and water conditions and planning should include consideration for current and future coastal hazards. While including information on coastal hazards in Emergency Response Plans and Evacuation plans is an easy connection to make, the path to incorporation of coastal hazards into documents such as a Master Plan may be more challenging to realize. However, to foster a community of resiliency, it is important to keep hazards in mind throughout all planning documents. The Master Plan should be used to catalogue and document the goals of all other planning documents. The following is an example of how identification of coastal hazards can be introduced to a Municipal Master Plan through the Floodplain Management section. This sort of language and related content can be utilized

in various other planning documents and then rediscussed in the Master Plan under the corresponding sections.

### **Municipal Master Plan Example**

The following excerpts are adapted from a comprehensive plan for Worcester County in Maryland, the equivalent to a municipal master plan. This comprehensive plan incorporates coastal hazards throughout the entire document to form an integrated approach to resiliency. Coastal hazards are often identified in the document as “current and anticipated challenges”. Individual sections (such as the Floodplain Management section given in this example) identify objectives and recommendations that should be mirrored in individual plans (a Floodplain Management Plan in this example). In doing so, all municipal plans are organized under the master plan and share the same language and goals. Many of the recommendations in this municipal master plan example are closely tied to goals already addressed in the current City Master Plan. If choosing to update the Floodplain Management Plan, it is highly recommended to do so by following the guidelines set in Section 510 of the CRS which can result in large CRS credits. Refer to the following link for the Worcester County Comprehensive Plan for more ideas and examples of a planning document drafted with resiliency in mind.

<http://www.co.worcester.md.us/cp/finalcomp31406.pdf>

#### ***Sample Introduction***

*Realizing that air, water, and land could be overused and despoiled, the plans organized within this document increasingly moved toward resource protection. If such damage occurred, local residents' quality of life and tourism, the economic linchpin, would suffer. Preserving the City's natural resources and character will therefore, continue to be this plan's main purpose.*

*The plan's purpose is to provide the following:*

- 1. An official statement of goals, objectives, policies and aspirations for future growth, development and the quality of life;*
- 2. A set of guidelines for the government and private sectors to maximize the City's quality of life;*
- 3. A strategy addressing current and anticipated challenges ; and*
- 4. Sufficient policy guidance to effectively manage natural, human and financial resources.*

#### ***Sample Floodplain Management Section***

*Floodplains, lands along waterways subject to flooding, locally have low relief and sedimentary soils. Floodplains are defined by how often they flood. A 100-year floodplain has a 1% probability of flooding in a given year and is not tidally influenced. Local flooding can occur in major storm events. Many areas of the City of Perth Amboy's 100-year floodplain are highly developed. Residential, industrial, and commercial uses exist within this floodplain. Most of the time a floodplain is available for use. However, during floods they can be dangerous. Superstorm Sandy reinforced this fact. Floods injure people physically and emotionally and cause economic damage. Beyond this, emergency personnel are put at risk when called upon to rescue flood victims. In Perth Amboy, flooding must be taken very seriously. To protect public safety and property, limiting future building in floodplains and stringent construction*

*standards will help reduce injuries and property damage. Federal, state, and local policies should be consistent to implement this approach.*

### **Objectives**

*The City's objectives for floodplain protection are:*

- *Limit development in floodplains*
- *Reduce imperviousness of existing and future floodplain development where possible*
- *Preserve and protect the biological values and environmental quality of tidal and non-tidal floodplains, where reasonable and possible to do so.*

*Developed floodplains have a reduced capacity to absorb stormwater, resulting in increased flooding. For example, development results in new impervious surfaces (roads, sidewalks, roofs, etc.), which limit the effectiveness of the floodplain by reducing the land's absorption capacity. This increases the potential for flooding. It is therefore important that the natural floodplain character be maintained, wherever reasonable, to promote public safety, to reduce economic losses, and to protect water quality and wildlife habitat.*

*Perth Amboy faces additional flooding issues. Several areas of the City commonly flood during storms with heavy precipitation. Sea level rise will increase flooding hazards as stormwater systems will become less effective. New Jersey is particularly vulnerable to sea level rise. During this century, as sea level rises, shorelines could retreat significantly in parts of the City. Narrow river beaches and wetlands at low elevations, both important habitats, would be lost to even a modest rise in sea level and erosion of the riverfront would increase. Currently, the state recognizes a right to protect shores with hard structures (e.g. riprap). As sea level rises, these hard structures will prevent "migration" of beaches and wetlands, and these natural features will be lost.*

### **Programs and Policies**

*Flooding from coastal storms is a serious threat to life and property with the potential for extensive damage and disruptions. To reduce potential damage, the county is developing a hazard mitigation plan. This first step will provide guidance for pre-disaster activities. The second phase of addressing disasters is to develop a post disaster plan. Confusion and rapid decision-making follow a disaster. Advance planning can position the City to reduce its exposure to future disasters and reduce the need for ad hoc decision-making. Superstorm Sandy has taught us that effective post-disaster planning is necessary for an effective recovery process.*

### **Recommendations**

1. *Work with federal and state federal agencies to regularly update the City floodplain maps, with first priority being areas that are mapped as 100-year floodplain without base flood elevation established.*
2. *Limit new development and subdivisions in the floodplain.*

3. *Promote uses, such as open space easements, natural areas, and recreational open space to reduce impervious surfaces in floodplains.*
4. *Work to acquire properties in the lowest lying portions of the 100-year floodplain, and return them to a natural state.*
5. *Reevaluate the effectiveness of the current floodplain protection regulations.*
6. *Discourage the location of new homes and roadways in the “V” or wave velocity zone and the 100-year floodplain.*
7. *Work with the county to complete a hazard mitigation plan for flooding, wildfire, and other natural hazards.*
8. *Develop and implement a post-disaster recovery and reconstruction plan to facilitate recovery and to reduce exposure to future disasters.*
9. *Consider code changes that will limit impervious surfaces.*
10. *Develop a sea level rise response strategy (including a two foot freeboard requirement for properties exposed to flooding and discourage further shoreline hardening).*

## **Mapping**

The following maps can be found in the appendices of this document. Maps were either requested by City staff or recommended by JC NERR staff during GTR meetings. As part of updates to the Getting to Resilience website, the site will host community profiles that include municipal mapping profile packets that will be available for future download. These maps can and should be used to help write and update the Municipal Master Plan, All Hazards Mitigation Plan, Floodplain Management Plan, Evacuation Plan, Emergency Response Plan, Continuity of Operations Plan, Disaster Recovery Plan, Post Disaster Redevelopment Plan, Capital Improvements Plan, Economic Development Plan/Strategy, Coastal Plan, Shoreline Restoration Plan, Open Space Plan, Stormwater Management Plan, Historic Preservation Plan, Zoning Ordinance, Flood Damage Prevention Ordinance, and Building Code.

### ***Sea Level Rise 1-3 feet with Critical Facilities***

Over the past hundred years, sea level has risen slightly higher than one foot in New Jersey. Due to a variety of factors including melting land ice and thermal expansion, it is anticipated that the rate of sea level rise will increase substantially in the future. While sea level rise poses it's own threat to coastal communities, it also will increase the severity of storm surge and erosion. By examining sea level rise maps, the City can better understand future flooding risk and plan accordingly. As a portion of the City is near current sea level, including some municipal property, Sea Level Rise maps should be utilized heavily for municipal planning documents.

### ***Storm Surge (SLOSH Category 1, SLOSH Category 2, & SLOSH Category 3)***

SLOSH or Sea, Lake, and Overland Surge from Hurricanes is a computerized model from the National Hurricane Program. SLOSH takes into account various factors to compute surge inundation above ground level or simple inundation. These factors include storm size, storm pressure, storm speed, storm path, wind speed, bathymetry, and topography. With this set of

factors, SLOSH determines the worst surge impacts that can be expected from hurricanes according to category. SLOSH maps are vital tools for Emergency Operations Center managers for making decisions about evacuation orders, timing of evacuation, and staging of emergency equipment prior to tropical weather systems.

### ***Marsh Migration 1-3 feet***

Marsh reaction to sea level rise has been mapped according to the Sea Level Affecting Marshes Model (SLAMM). Marshes provide various environmental and storm protection functions to communities and should be preserved. As sea level rises, many marshes will convert to open water or tidal mud flats. However, if suitable land is connected to current marshes, conversion of ecosystems may occur which could allow marshes to “migrate” further inland in balance with sea level. Upland areas that are deemed to be suitable marsh migration areas should be identified and preserved if possible and barriers to marsh migration should be eliminated. In doing so, the environmental and storm protection functions of marshes may persist despite sea level rise.

### ***Preliminary Flood Insurance Rate Map***

FEMA’s Preliminary Flood Insurance Rate Map (PFIRM) represents the current best available data for Perth Amboy concerning 1% and 0.2% flooding scenarios. Base Flood Elevations and wave modeling are established for the 1% flood. Flood Insurance Rate Maps should be used to assist in zoning and building code decisions. Additional mapping information about floodplain maps can be accessed off of FEMA’s [www.Region2Coastal.com](http://www.Region2Coastal.com).

### ***Preliminary Flood Insurance Rate Map Table***

FEMA’s Preliminary Flood Insurance Rate Map (PFIRM) represents the current best available data for Perth Amboy concerning 1% and 0.2% flooding scenarios. This table displays the coverage for the 0.2% zone, AE zone, and VE zone in terms of square miles and percent coverage. This table can be used to better understand the City’s floodplain and be used as reference for various decisions concerning zoning, building, etc.

### ***Sandy Surge Extent***

FEMA has mapped the limits of the storm surge caused by Superstorm Sandy. This map can be used as a reference for this historical flooding event.

### ***Topographic Maps***

City staff asked for elevation mapping to be able to identify low spots in town and likely flooding areas. These maps can be used to create an action plan for precipitation events and supplement FEMA’s base flood elevation maps.

## **Other Suggested Maps**

### ***Repetitive Loss & Severe Repetitive Loss***

Repetitive Loss and Substantial Damage maps can be used to identify “problem” areas. Depending on the location and size of these areas, the City can make decisions about how to prevent repetitive loss from occurring. These options can range from utilizing Blue Acres funding and returning the properties to a natural state to creating protective infrastructure projects in order to help protect from risk.

### ***Shoreline Change***

Shorelines are constantly in a state of change, be it from tidal fluctuations or erosional and depositional forces. Shoreline change can create large scale shifts in risk. Erosion may move shoreline closer to buildings and infrastructure, reducing natural buffers and heightening impacts. Deposition that moves shorelines or near shore features such as sandbars may in turn reduce rates of flow of streams and stormwater management systems and cause greater risk of precipitation driven flooding. Deposition can also cause navigation hazards to waterways and navigation channels. Shoreline Change maps can identify trends and should be incorporated into appropriate municipal plans.

### ***Overlays of Hazards and Populations, Infrastructure, and Building Footprints***

Though it is the goal of this report to guide the City of Perth Amboy towards resiliency, risk will always exist. By overlaying hazards such as sea level rise and surge with population information, infrastructure, and building footprints, the City will be able to identify areas of highest risk and plan accordingly.

### ***Natural Resources, Historical Resources, Cultural Resources, & Economic Resources***

Mapping of a community's resources is an extremely useful tool, not only for creating a catalogue of a community's strengths, but also for identifying areas that should be protected. Overlaying hazards such as sea level rise and surge may lead Perth Amboy to make decisions on protecting certain resources through retrofitting historical buildings or protecting natural resources by allowing for natural floodplain functions.

### ***Additional Mapping Resources***

NJADAPT ([www.NJAdapt.org](http://www.NJAdapt.org)) is a New Jersey-based website being built to host and apply climate science and impacts data. The objective of the NJADAPT platform is to provide communities with the ability to develop municipal profiles of various risks that may potentially impact their areas by making climate projection data for NJ more accessible. The initial development of the platform has been supported by the New Jersey Recovery Fund and NOAA.

The Flood Exposure Profiler is the first tool developed as part of the larger All Climate Hazards tools being developed through the NJADAPT initiative. The Profiler is broken into four major themes:

- Flooding (which shows the flooding hazards individually)
- Society (demographic data that shows information about populations, businesses, and employees)

- Infrastructure (provides information on facility and infrastructure locations that should be considered when planning for disaster events),
- Environment (data on coastal land use areas - marsh, open space, land use land cover).

Each of the profiles allow you to see the themed data and then overlay a hazard layer of your choice to see what the potential impacts may be. This tool allows you to create maps that you can then package and share links to or create pdfs from for further use.

## **Sea Level Rise and Surge Vulnerability**

While most of the City of Perth Amboy is significantly elevated above sea level, fluctuations in sea level through surge events and trends towards higher sea level are still of great significance for areas bordering Arthur Kill and the Raritan River. Analysis of SLOSH maps show that as hurricane strength increases, potential surge impacts will increase in scope and severity as one would expect. SLOSH models indicate flooding should be expected on a similar scale of Sandy for powerful Category 1 hurricanes, specifically the areas near the immediate waterfront, Arthur Kill Tributary, and Woodbridge Creek. SLOSH models for Category 2 and 3 storms show increased vulnerability and intensity. Areas that had inundation depths of 0-3 feet during a Category 1 storm are capable of depths of 6-9 feet in a Category 2 storm. Flooding also has the potential to impact nearly the entire area east of County Road 611 and north of State Highway 440. SLOSH maps for Category 3 show an extreme scenario. Areas that were flooded during Sandy and even some that did not see any flooding have the potential to be submerged with over 9 feet of floodwaters. The extent of the surge also increases much further inland. Luckily, the areas most likely to be influenced by storm surge are either open space or non-residential. It is important to note that in all SLOSH mapping for Category 1, 2, and 3, the critical evacuation routes of County Road 611 North and State Highway 440 near the Outer Bridge Crossing are threatened by surge. As storm strength increases, the likelihood of safe use of these evacuation routes decreases. Although storms of this magnitude are very rare for our area, they remain a possibility that requires attention and planning.

While the relatively low end scenario of one foot of sea level rise will not result in flooding of Perth Amboy, there will be an increased threat of flooding from storm events, in the form of coastal flooding in low lying areas and precipitation based flooding in areas along Woodbridge Creek. Scientists anticipate the arrival of one foot of sea level rise before 2050. As sea level rise is expected to accelerate this century, three feet of sea level rise is very likely before 2100. In the table below, the “low”, “high”, and “best” estimates for sea level rise projections for New Jersey for the years 2050 and 2100 are displayed. “Best” refers to a 50% likelihood of that level of sea level rise occurring.



<b>Total sea level rise projections for New Jersey.</b>			
	Total	Total	Total
	cm	inches	feet
<b>2050 best</b>	<b>40</b>	<b>16</b>	<b>1.3</b>
2050 low	23	9	0.7
2050 high	60	24	2.0
<b>2100 best</b>	<b>96</b>	<b>38</b>	<b>3.1</b>
2100 low	50	20	1.6
2100 high	147	58	4.8
All values with respect to a year 2000 baseline.			









NJ sea level rise projection ranges and best estimates. Miller AK, Kopp RE, Horton BP, Browning JV and Kemp AC. 2013. A geological perspective on sea-level rise and its impacts along the U.S. mid-Atlantic coast. Earth's Future 1(1):3-18.

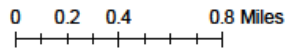
While one and two feet of sea level rise do not significantly impact Perth Amboy, three feet of sea level rise will mean regular tidal flooding of the northeast industrial area near the base of Outerbridge Crossing. Any level of inundation due to regular tidal flooding will have impacts on emergency response. Sea level rise will also result in greater impact of storm events as a surge atop a higher sea level will have a greater impact than the same surge atop a lower sea level. Necessary adaptation to sea level rise and the heightening of other hazards such as surge must be taken into account when planning for the future.

# Appendix

## 1 foot of Sea Level Rise Perth Amboy

### Legend

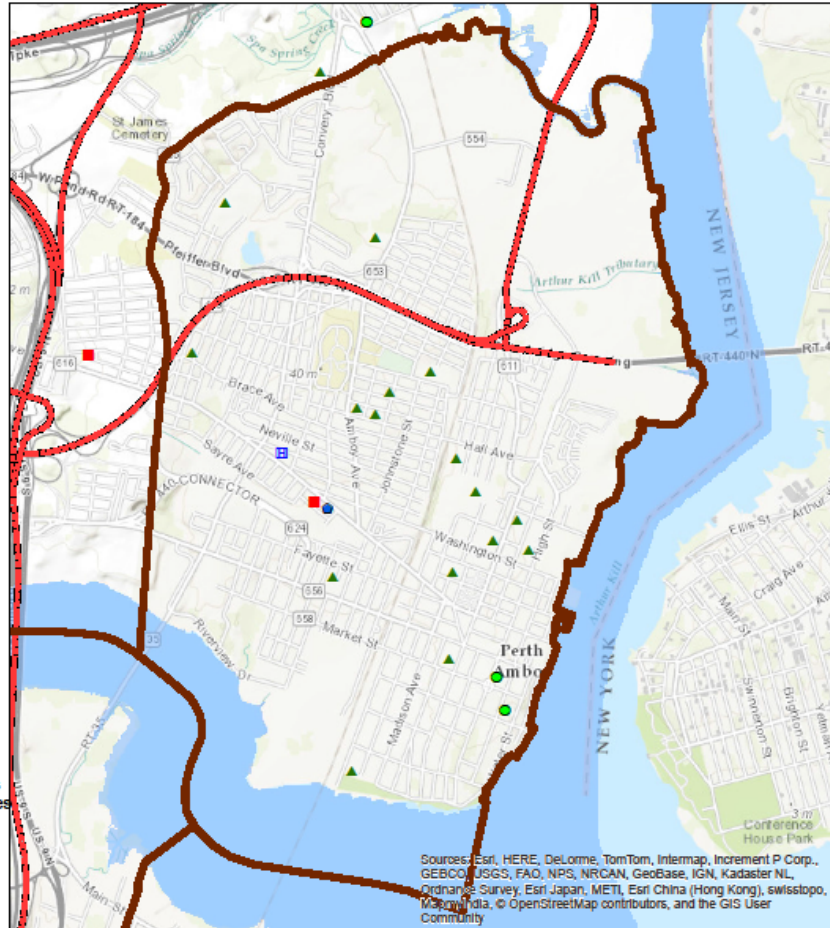
-  Municipality
-  Schools
-  Fire Stations
-  Law Enforcement
-  Assisted Living
-  Hospitals
-  Evacuation Routes
-  1ft SLR



Year 2010 Population: 50814

According to Kenneth G. Miller et al. in the 2013 study "A Geological Perspective on Sea-Level Rise and its Impacts Along the U.S. Mid-Atlantic Coast" a probable threat is the 1ft sea level rise condition that could be expected by 2050. This map depicts that sea level rise as well as the proceeding projections thereafter and is centered on target municipalities









Map Authors: Rachael Sacatelli and Bryan Serino  
Rutgers, New Brunswick  
Center for Remote Sensing  
and Spatial Analysis




Sources: Esri, HERE, DeLorme, TomTom, Intermap, Increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), Swisstopo, Mapbox India, © OpenStreetMap contributors, and the GIS User Community

## 2 feet of Sea Level Rise Perth Amboy

### Legend

-  Municipality
-  Schools
-  Fire Stations
-  Law Enforcement
-  Assisted Living
-  Hospitals
-  Evacuation Routes
-  2ft SLR

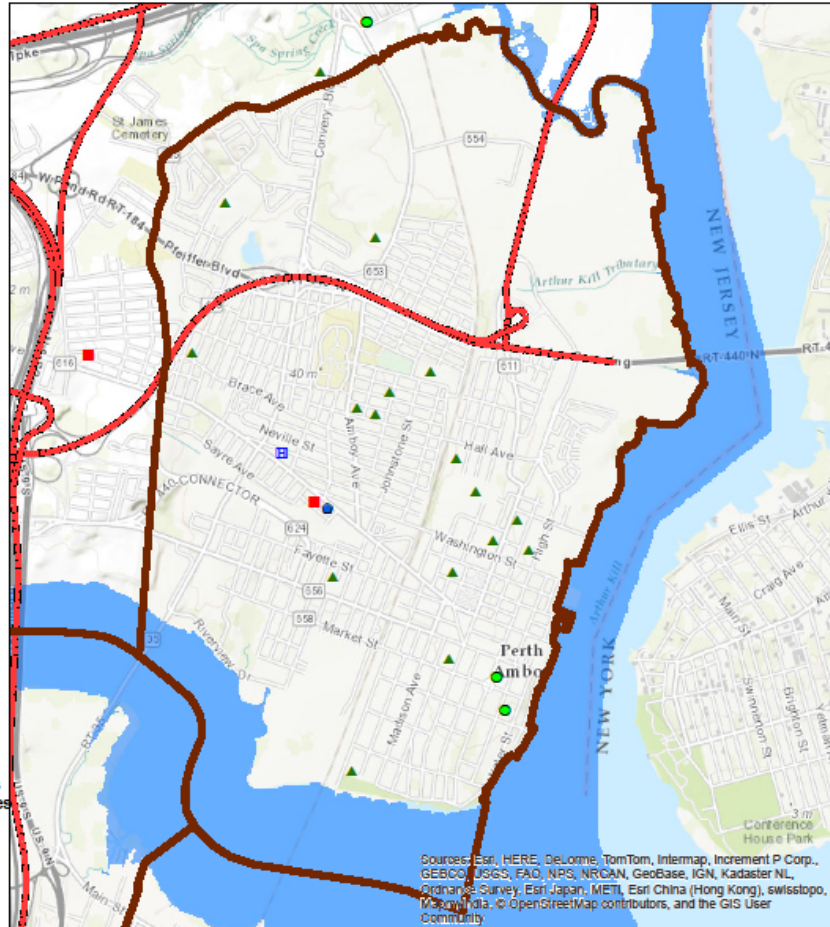
0 0.2 0.4 0.8 Miles



Year 2010 Population: 50814

According to Kenneth G. Miller et al. in the 2013 study "A Geological Perspective on Sea-Level Rise and its Impacts Along the U.S. Mid-Atlantic Coast" a probable threat is the 1ft sea level rise condition that could be expected by 2050. This map depicts that sea level rise as well as the proceeding projections thereafter and is centered on target municipalities

Map Authors: Rachael Sacatelli and Bryan Serino  
Rutgers, New Brunswick  
Center for Remote Sensing  
and Spatial Analysis



Sources: Esri, HERE, DeLorme, TomTom, Intermap, InCREMENT P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, Mapbox, Swatch, © OpenStreetMap contributors, and the GIS User Community

### 3 feet of Sea Level Rise Perth Amboy

#### Legend

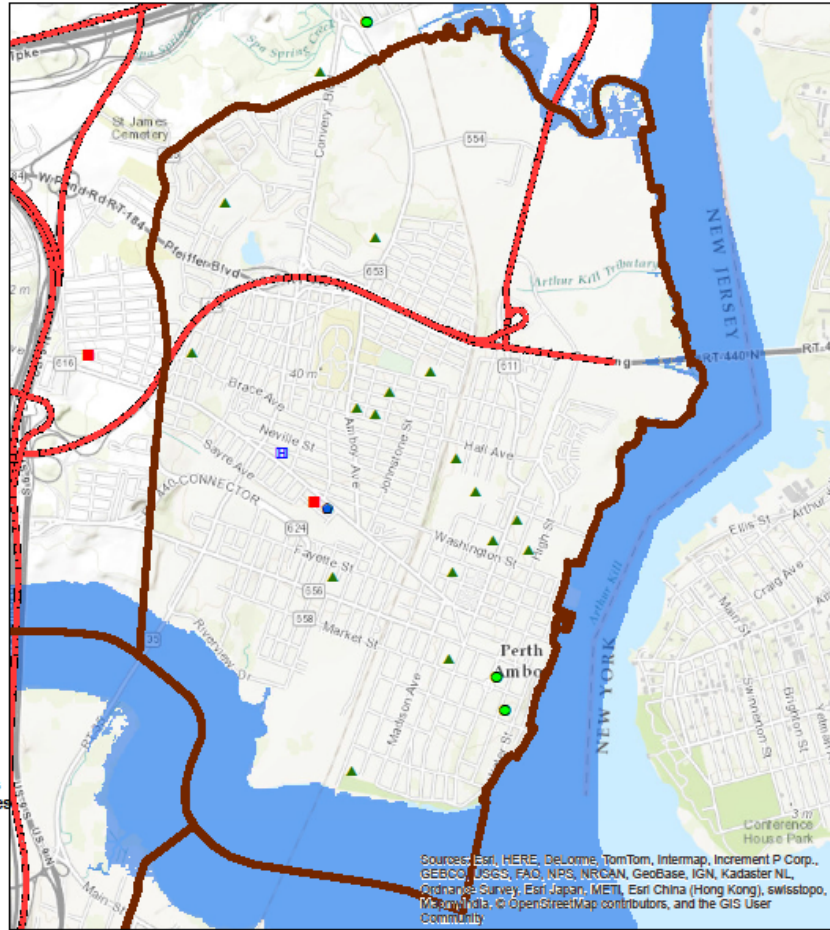
- Municipality
- ▲ Schools
- Fire Stations
- Law Enforcement
- Assisted Living
- H Hospitals
- Evacuation Routes
- 3ft SLR

0 0.2 0.4 0.8 Miles

Year 2010 Population: 50814

According to Kenneth G. Miller et al. in the 2013 study "A Geological Perspective on Sea-Level Rise and its Impacts Along the U.S. Mid-Atlantic Coast" a probable threat is the 1ft sea level rise condition that could be expected by 2050. This map depicts that sea level rise as well as the proceeding projections thereafter and is centered on target municipalities








Map Authors: Rachael Sacatelli and Bryan Serino  
Rutgers, New Brunswick  
Center for Remote Sensing  
and Spatial Analysis







Sources: Esri, HERE, DeLorme, TomTom, Intermap, InCREMENT P Corp., GEBCO, JGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, Mapbox, © OpenStreetMap contributors, and the GIS User Community

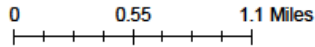
**Category 1 SLOSH Model  
Perth Amboy**

**Legend**

-  Municipality
-  Schools
-  Assisted Living
-  Law Enforcement
-  Hospitals
-  Fire Stations
-  Evacuation Routes

**Category 1 SLOSH**

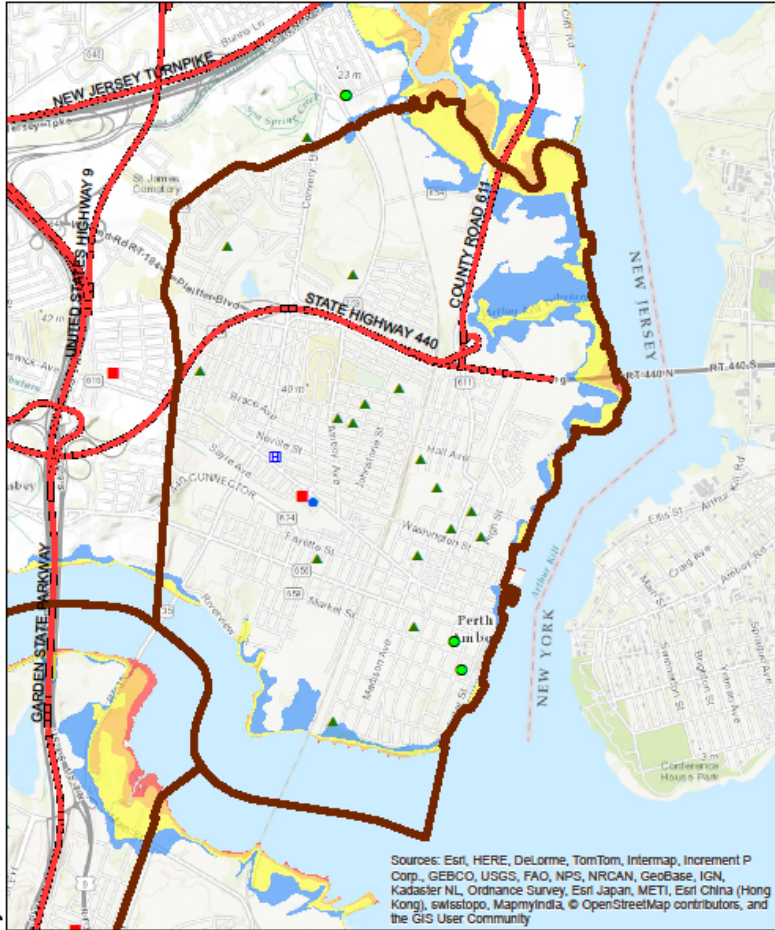
-  0 - 3 Feet Above Ground Level
-  3 - 6
-  6 - 9
-  > 9



Year 2010 Population: 50814

This map depicts the SLOSH model extents provided by NOAA. The depths are ranged from 0-9 or greater feet of inundation above ground level and are categorized in the legend above.








Map Authors: Rachael Sacatelli and Bryan Serino  
Rutgers, New Brunswick  
Center for Remote Sensing  
and Spatial Analysis







Sources: Esri, HERE, DeLorme, TomTom, Intermap, Incent P Corp., GEBCO, USGS, FAD, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), Swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

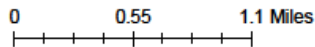
**Category 2 SLOSH Model  
Perth Amboy**

**Legend**

-  Municipality
-  Schools
-  Assisted Living
-  Law Enforcement
-  Hospitals
-  Fire Stations
-  Evacuation Routes

**Category 2 SLOSH**

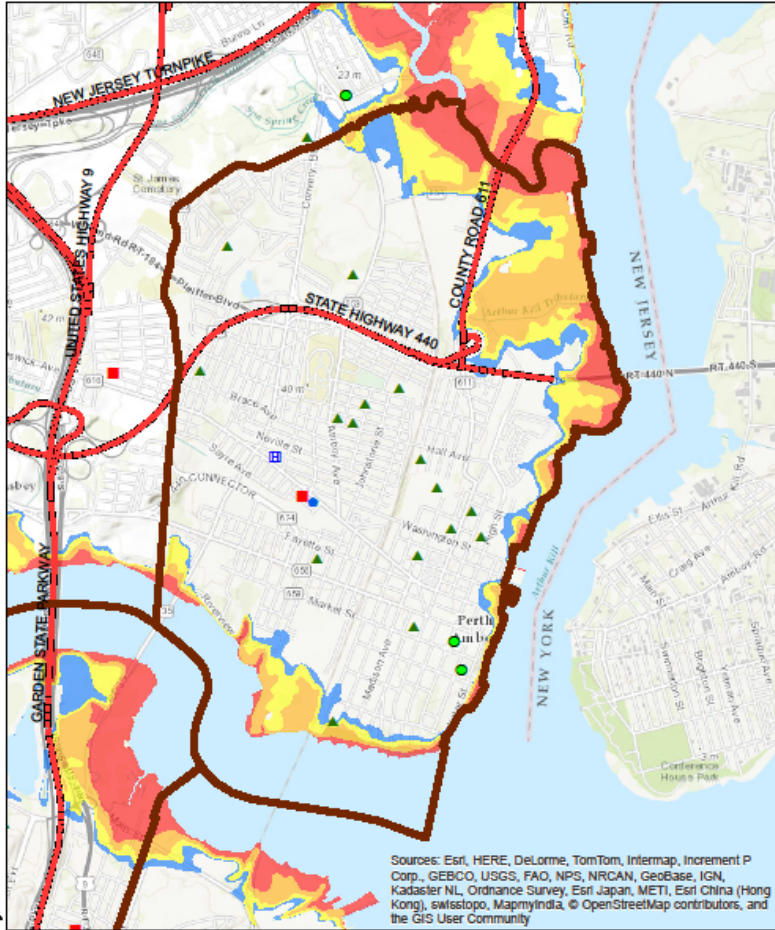
-  0 - 3 Feet Above Ground Level
-  3 - 6
-  6 - 9
-  > 9



Year 2010 Population: 50814

This map depicts the SLOSH model extents provided by NOAA. The depths are ranged from 0-9 or greater feet of inundation above ground level and are categorized in the legend above.








Map Authors: Rachael Sacatelli and Bryan Serino  
Rutgers, New Brunswick  
Center for Remote Sensing  
and Spatial Analysis







Sources: Esri, HERE, DeLorme, TomTom, Intermap, Incent P Corp., GEBCO, USGS, FAD, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), Swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

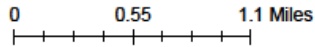
**Category 3 SLOSH Model  
Perth Amboy**

**Legend**

-  Municipality
-  Schools
-  Assisted Living
-  Law Enforcement
-  Hospitals
-  Fire Stations
-  Evacuation Routes

**Category 3 SLOSH**

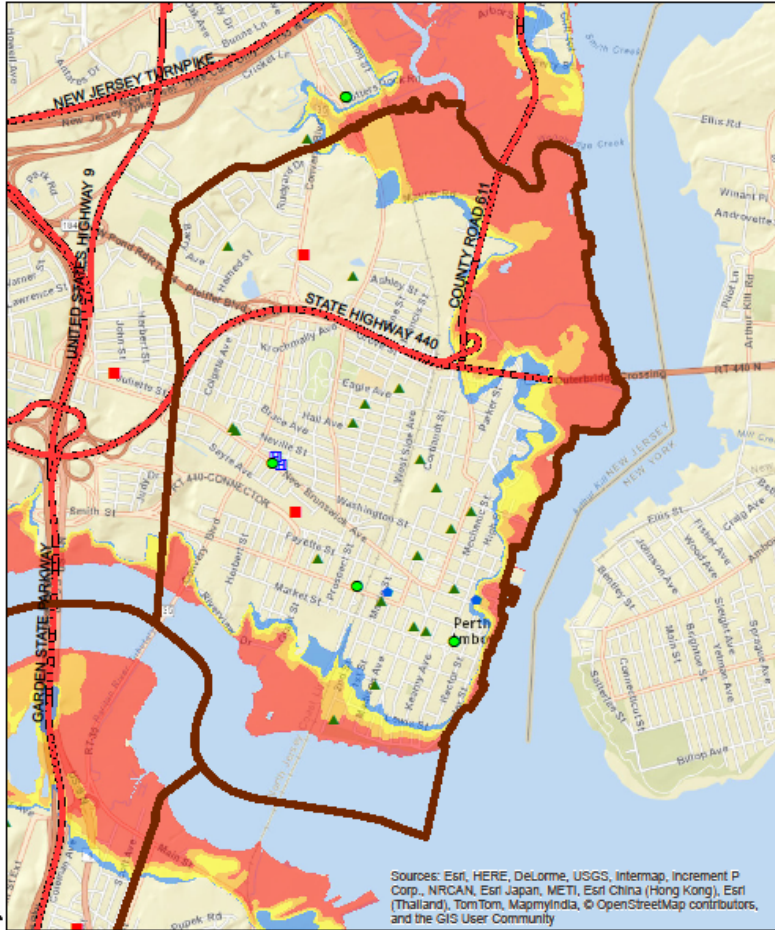
-  0 - 3 Feet Above Ground Level
-  3 - 6
-  6 - 9
-  > 9



Year 2010 Population: 50814

This map depicts the SLOSH model extents provided by NOAA. The depths are ranged from 0-9 or greater feet of inundation above ground level and are categorized in the legend above.

Map Authors: Rachael Sacatelli and Bryan Serino  
Rutgers, New Brunswick  
Center for Remote Sensing  
and Spatial Analysis








Sources: Esri, HERE, DeLorme, USGS, Intermap, Incent P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

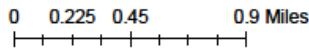
## Marsh Retreat at 1 feet of Sea Level Rise Perth Amboy

### Legend

-  Municipality
-  Schools
-  Assisted Living
-  Law Enforcement
-  Hospitals
-  Fire Stations
-  Evacuation Routes

### Marsh Retreat at 1ft SLR

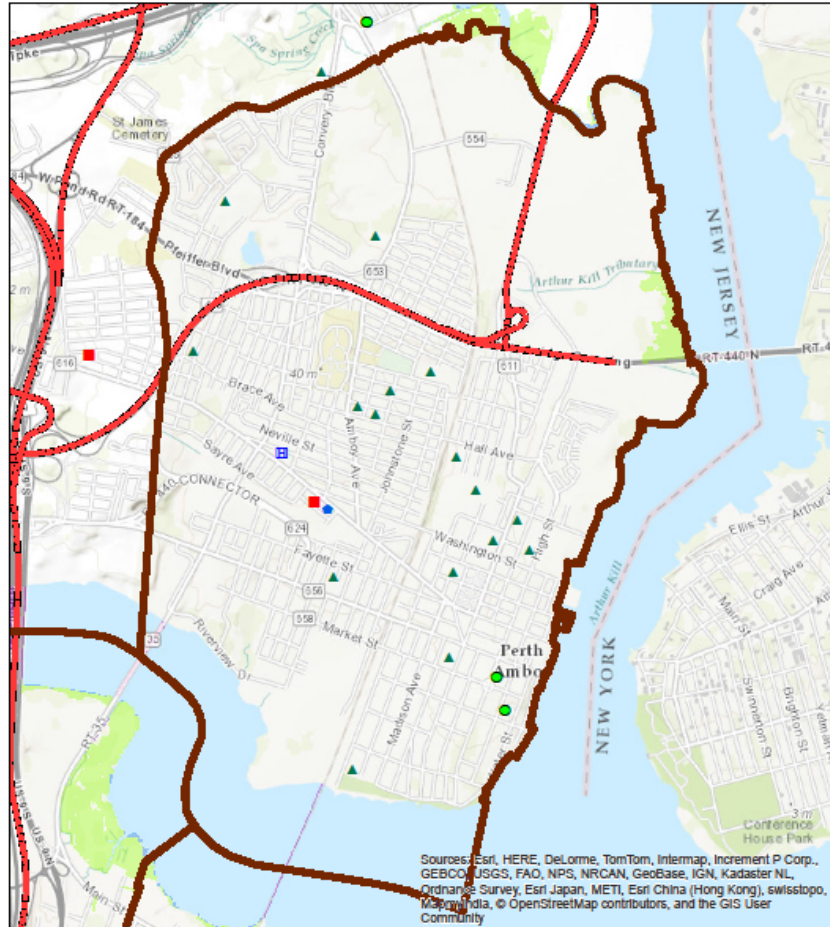
-  Unimpeded Marsh Retreat Zone
-  Impeded Marsh Retreat Zone
-  Marsh Conversion: Unconsolidated Shore
-  Marsh Conversion: Open Water
-  Unchanged Tidal Marsh



Year 2010 Population: 50814

According to Kenneth G. Miller et al. in the 2013 study "A Geological Perspective on Sea-Level Rise and its Impacts Along the U.S. Mid-Atlantic Coast" a probable threat is the 1ft sea level rise condition that could be expected by 2050. This map depicts the marsh retreat caused by sea level rise centered on target municipalities.

Map Author: Rachael Sacatelli  
Rutgers, New Brunswick  
Center for Remote Sensing  
and Spatial Analysis



Sources: Esri, HERE, DeLorme, TomTom, Intermap, Increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, Mapbox, © OpenStreetMap contributors, and the GIS User Community








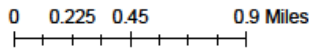
## Marsh Retreat at 2 feet of Sea Level Rise Perth Amboy

### Legend

-  Municipality
-  Schools
-  Assisted Living
-  Law Enforcement
-  Hospitals
-  Fire Stations
-  Evacuation Routes

### Marsh Retreat at 2ft SLR

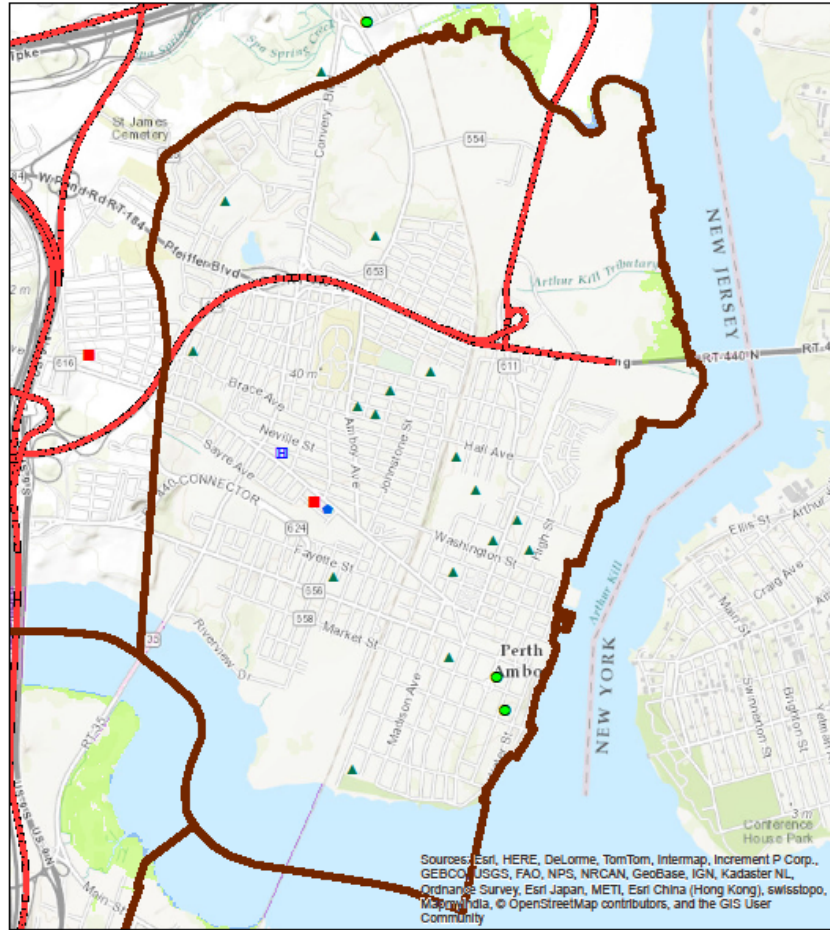
-  Unimpeded Marsh Retreat Zone
-  Impeded Marsh Retreat Zone
-  Marsh Conversion: Unconsolidated Shore
-  Marsh Conversion: Open Water
-  Unchanged Tidal Marsh



Year 2010 Population: 50814

According to Kenneth G. Miller et al. in the 2013 study "A Geological Perspective on Sea-Level Rise and its Impacts Along the U.S. Mid-Atlantic Coast" a probable threat is the 1ft sea level rise condition that could be expected by 2050. This map depicts the marsh retreat caused by sea level rise centered on target municipalities.

Map Author: Rachael Sacatelli  
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and Spatial Analysis







Sources: Esri, HERE, DeLorme, TomTom, Intermap, Increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, Mapbox, © OpenStreetMap contributors, and the GIS User Community

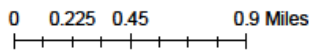
## Marsh Retreat at 3 feet of Sea Level Rise Perth Amboy

### Legend

-  Municipality
-  Schools
-  Assisted Living
-  Law Enforcement
-  Hospitals
-  Fire Stations
-  Evacuation Routes

### Marsh Retreat at 3ft SLR

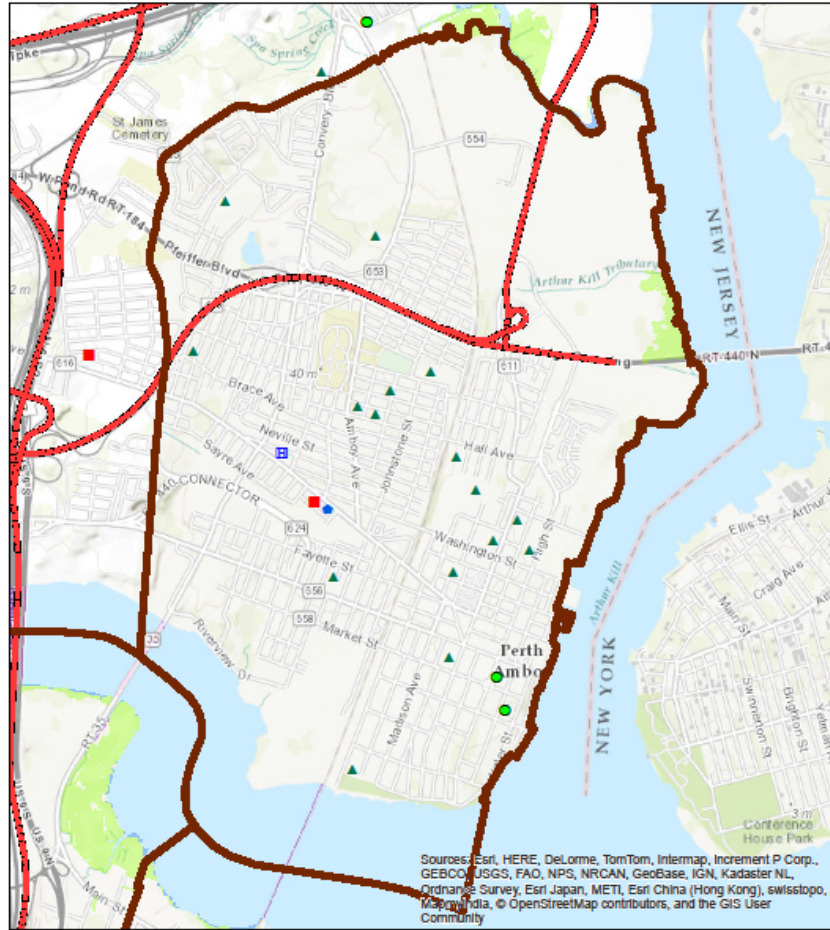
-  Unimpeded Marsh Retreat Zone
-  Impeded Marsh Retreat Zone
-  Marsh Conversion: Unconsolidated Shore
-  Marsh Conversion: Open Water
-  Unchanged Tidal Marsh



Year 2010 Population: 50814

According to Kenneth G. Miller et al. in the 2013 study "A Geological Perspective on Sea-Level Rise and its Impacts Along the U.S. Mid-Atlantic Coast" a probable threat is the 1ft sea level rise condition that could be expected by 2050. This map depicts the marsh retreat caused by sea level rise centered on target municipalities.








Map Author: Rachael Sacatelli  
Rutgers, New Brunswick  
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and Spatial Analysis









Sources: Esri, HERE, DeLorme, TomTom, Intermap, InCREMENT P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, Mapbox, © OpenStreetMap contributors, and the GIS User Community

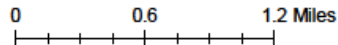
**FEMA's PFIRM Flood Zones for New Jersey  
Perth Amboy**

**Legend**

-  Municipality
-  Schools
-  Assisted Living
-  Law Enforcement
-  Hospitals
-  Fire Stations
-  Evacuation Routes

**PFIRM**

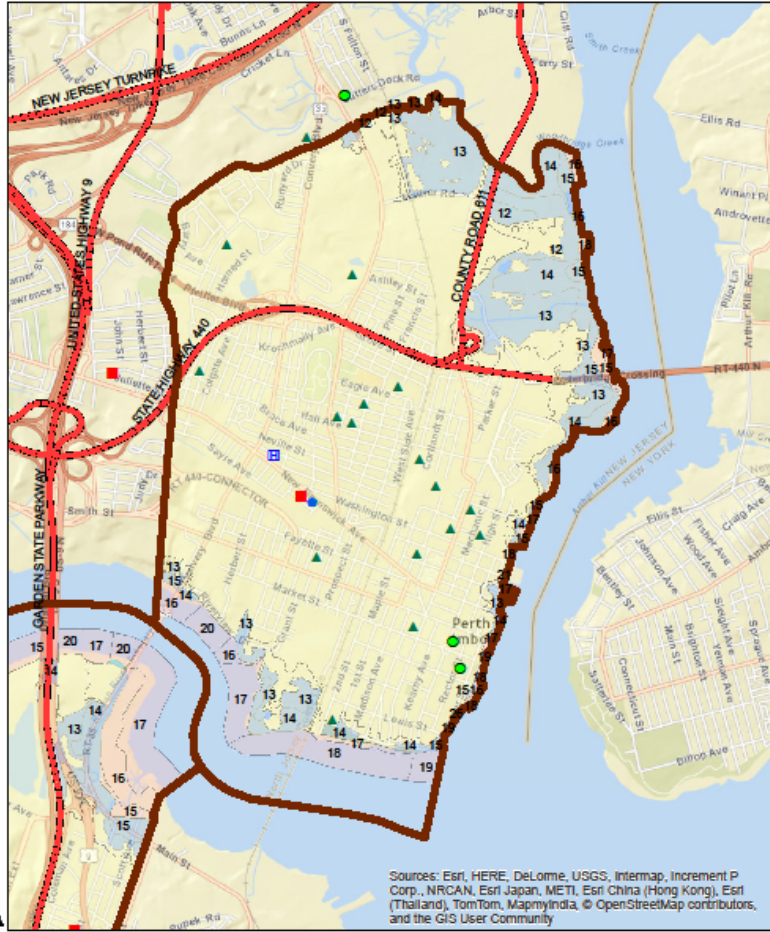
-  Zone X - 0.2% Annual Chance
-  A
-  AE
-  AO
-  D
-  VE



Year 2010 Population: 50814

This map shows the extents of FEMA's latest flood insurance rate maps for the state of New Jersey. The numerical label in the zones portrays the static ABFE zone. Please refer to the index for more information.

Map Authors: Rachael Sacatelli and Bryan Serino  
Rutgers, New Brunswick  
Center for Remote Sensing  
and Spatial Analysis




Sources: Esri, HERE, DeLorme, USGS, Intermap, Incent P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Taiwan), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

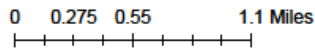
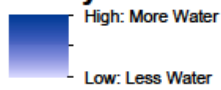
<b>PFIRM Zones</b>				
<b>Municipality</b>	<b>Flood Zone</b>	<b>Coverage (Sq. Mi.)</b>	<b>Percent Coverage</b>	<b>Municipality Size (Sq. Mi)</b>
	<b>0.2 PCT ANNUAL CHANCE FLOOD HAZARD</b>			
Perth Amboy City		0.22	4.29	5.17
Perth Amboy City	AE	0.63	12.10	5.17
Perth Amboy City	VE	0.30	5.82	5.17

# Sandy Storm Surge Perth Amboy

## Legend

-  Municipality
-  Schools
-  Law Enforcement
-  Fire Stations
-  Assisted Living
-  Hospitals
-  Evacuation Routes

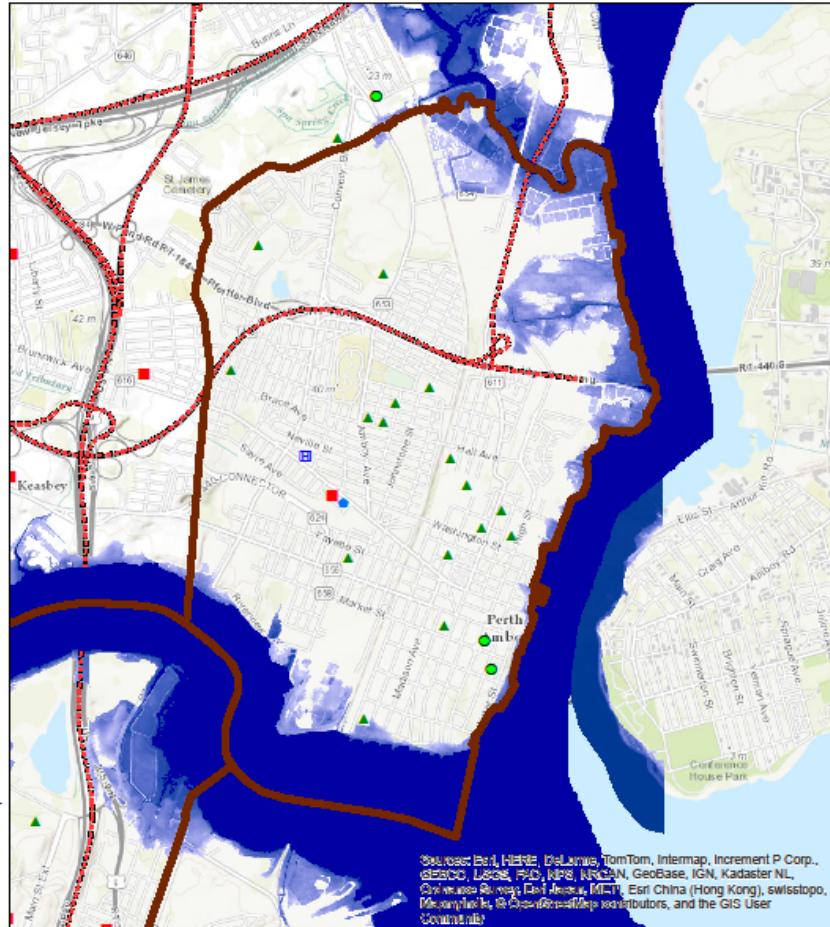
## Sandy Storm Surge



Year 2010 Population: 50814

This map depicts the Sandy Storm Surge extents provided by FEMA. The depths are ranged in meters of inundation above ground level and are categorized in the legend above.

Map Authors: Rachael Sacatelli and Bryan Serino  
Rutgers, New Brunswick  
Center for Remote Sensing  
and Spatial Analysis



Source: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri, Swisstopo, Mapbox, Swisstopo, and the GIS User Community

