BUILDING ECOLOGICAL SOLUTIONS TO COASTAL COMMUNITY HAZARDS (BESCCH)

Borough of Avalon

Municipal Coastal Vulnerability Assessment

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Final Report

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Borough of Avalon Coastal Vulnerability Assessment Report

I. Introduction

Municipal Coastal Vulnerability Assessment

The Municipal Coastal Vulnerability Assessment (CVA) is both a process and tool to help communities make incisive and sound decisions on near and long-term coastal management, reconstruction, and resiliency measures. The CVA categorizes the degree to which a community's assets (e.g. built, natural, social, etc.) will be impacted by projected sea level rise and storm events, and analyzes the consequences those vulnerabilities pose to the community. By accounting for vulnerability and consequence factors associated with future flood events, local officials will be better informed to make long-term decisions about land use planning, mitigation, adaption measures, and public investments.

The CVA was developed by the New Jersey Resilient Coastal Communities Initiative (RCCI), a post-Sandy project funded by the National Oceanic and Atmospheric Administration (NOAA), and managed by the NJ Department of Environmental Protection's Office of Coastal and Land Use Planning. The tool was created in response to the need for municipalities to be better prepared for the increasing rate of sea level rise and extreme storm events.

II. Municipal Background

Location and Demographics

Avalon is a barrier island located along the Atlantic Ocean in the middle-eastern portion of Cape May County. The borough encompasses more than 3,000 acres of land comprised with over 50 miles of shoreline within the Back Bay of the island and along the Atlantic Ocean. Avalon has a year-round population of 1,334 residents according to the 2010 census, and swells to a peak of approximately 36,000 in the summer season. Avalon has a significantly older population, with a median age of 61.8, and 75.5% of the population over age 45. The borough is almost entirely residential, of which the majority are single family homes. As of 2010, there were 5,434 residential units in Avalon, of which 692 were occupied year-round.

Future Flooding

Avalon is faced with a new set of challenges as sea level continues to rise and the intensity and frequency of storms and precipitation persist. Figure 1 shows past and future trends in monthly mean sea level rise using data from Cape May tide gauge station in Cape May, NJ. Additional data and maps regarding future flood projections, precipitation and climate change are available at Climate Central (http://www.climatecentral.org); NJAdapt (http://www.njadapt.org); and the NJ Climate Adaptation Alliance (http://njadapt.rutgers.edu)/

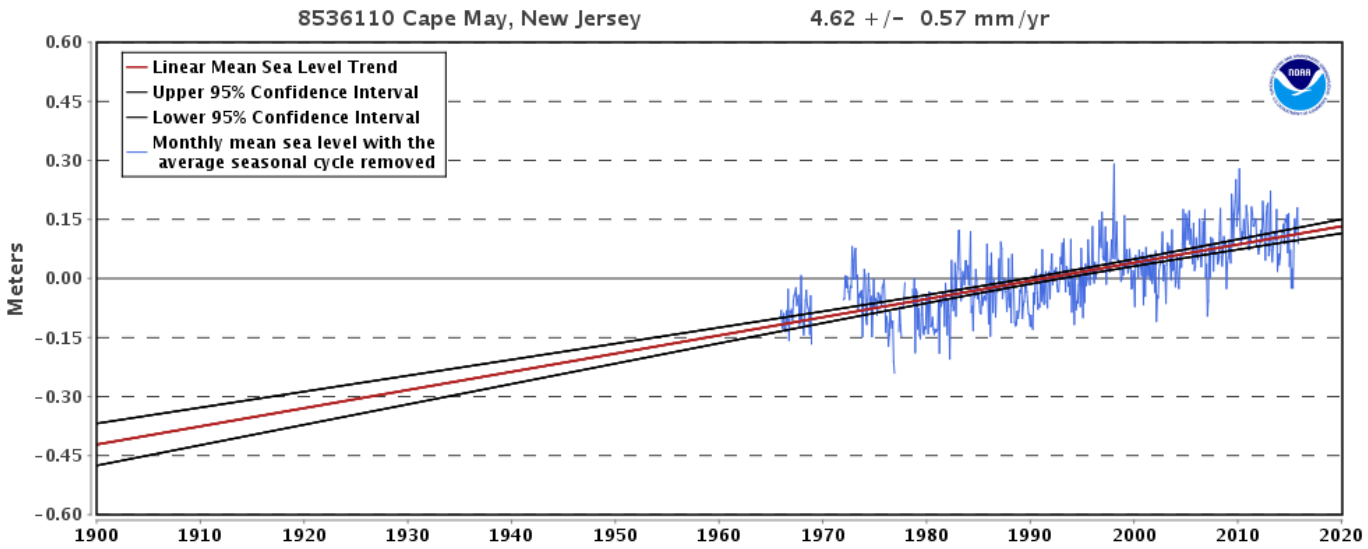


Figure 1. Mean Sea Level Trend at Cape May, NJ (NOAA, 2015)

III. Municipal Coastal Vulnerability Assessment – Methodology

The CVA process is a methodical, step-by-step approach for conducting a comprehensive vulnerability assessment of coastal flooding hazards. It identifies the vulnerability of community assets (identified by the municipality) to a series of future flood hazard scenarios, and the associated consequences to the community. The CVA goes beyond a simple analysis of flooding extent and duration by also examining how flooding will affect the functional capacity of buildings, services, infrastructure, businesses, ecological systems, and residents. The three key steps of the CVA are described below:

✓ *Identify and map community assets and selected coastal flood hazard scenario(s)*

Geographical Information Systems (GIS) maps are the most effective way of locating and analyzing community assets and flood hazards. Community assets are identified among four categories - Critical Facilities & Infrastructure Systems, Community Resources & Amenities, Natural Resources & Ecosystems, and Districts, Neighborhoods, & Population Clusters – and plotted using GIS. Flood hazard scenarios are selected and are also mapped. Communities are encouraged to use both future sea level rise (daily high tide) and storm surge levels for at least 2050, and, preferably, 2030 and 2100, if available.

✓ *Evaluate the vulnerability of community assets.*

Vulnerability is the predisposition of a community asset to be adversely affected by a hazard—in this case, coastal flooding. Vulnerability is measured by the anticipated degree of *exposure* and *sensitivity*.

Exposure is the extent to which community assets may be flooded, measured by magnitude and depth. The magnitude of exposure incorporates the frequency of occurrence (e.g. for high tide, the occurrence would be daily), and the depth of floodwater during the occurrence.

Sensitivity is measured by the extent in which the flooding will impact the following features of the asset[1]:

- Durability of the structure or asset (materials, elevated structure, flood mitigation measures, etc.)

[1] Sensitivity also includes the natural coping capacity of individuals to move out of harm's way. However, contrary to some definitions, it does not include adaptive capacity since by its inherent definition adaptive capacity is a likely future condition that requires action, e.g. elevating structures. The CVA evaluates sensitivity based on the assets' current conditions.

- The ability of an asset to continue to provide its key benefits and operations in the aftermath of a storm event
- The ability to move quickly from harm's way.

Each asset is assigned a single vulnerability rating based on the adverse impacts due to exposure and sensitivity to each hazard. A Vulnerability Rating Key provides guidance in the assignment of these ratings. (See Appendix C).

✓ *Evaluate the overall consequences to the community*

Consequence is the degree of impact on the entire community if an asset will be lost or damaged, or if the assets function is impaired. The degree of impact is measured over eight topic areas that can potentially impact the community. The topic areas include: property damage, population displacement, delivery of services, typical operations / daily life, environment, emergency response, hazardous materials, and municipal budget. The Consequences Rating Key in Appendix D provides guidelines for identifying and rating consequences.

IV. Findings: Vulnerability and Consequences of Community Assets

Avalon identified 52 assets to be included in the vulnerability and consequences assessment, only those assets shown to be impacted by sea level rise and/or a Category1 Hurricane in 2050 were included in the assessment. The assets were identified under four broad categories of potential community assets: Critical Facilities & Infrastructure Systems, Community Resources & Amenities, Natural Assets & Ecosystems, and Districts, Neighborhoods, & Population Clusters. While the majority of assets were assessed individually, some of them were assessed as part of "systems" to ensure the functionality and consequence if one component or asset failed. For example, many of Avalon's sanitary sewer lift stations are linked together and flow to the Cape May County Municipal Utilities Authority facility. The lift stations are intricately linked and if one fails other stations in the series could also fail.

The flood hazards scenarios used for this assessment were projected sea level rise and hurricane category 1 storm surge for 2050. The sea level rise projections are based upon a 2013 study by New Jersey climate scientists,[2] and used the 2050 mid-range projections in that study, or 1.3 feet of sea level rise. The sea level rise projections were then layered on top of the mean higher high water (MHHW). The storm surge maps were developed using the NOAA SLOSH (Sea, Lake, and Overland Surge from Hurricanes) model, combined with the sea level rise projections. The approximate depth of water is based on LiDAR data.[3] Both the 2050 sea level rise and 2050 storm surge maps were obtained from the NJ Department of Environmental Protection (NJDEP).

The community assets were assessed for their vulnerability (exposure and sensitivity) to the above two hazard scenarios, and then for the consequences to the community if the asset was damaged or destroyed. The complete set of data on vulnerability and consequences are included in the CVA Matrix (Appendix A), and summarized in Table 1 below. Since sea level rise is more likely to occur than a Category 1 hurricane, the Borough should particularly focus its attention on the assets with high consequences in the sea level rise column. There are also other considerations for interpreting the data in the Matrix and Table 1. The flood hazard maps are based upon the latest technology and most readily available data, both of which will continue to be updated as new data is

[2] Miller et al. December 2013. "A geological perspective on sea-level rise and its impacts along the U.S. mid-Atlantic coast." http://onlinelibrary.wiley.com/doi/10.1002/2013EF00_0135/pdf

[3] 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.

generated and technology advances. Additionally, there may be existing topographical features or mitigation measures in place that the assessment did not pick up, which could lower the vulnerability rating of an asset. For these reasons, the matrix should be used for general planning purposes and not for specific site planning or design, unless site conditions are field verified. More considerations on the use of the data and recommendations are offered in Section V.

Table 1. Avalon Coastal Vulnerability Assessment Matrix

Asset Name	Asset Category	Asset Function	Vulnerability Rating		Consequences Rating	
			Sea Level Rise	CAT1 Hurricane	Sea Level Rise	CAT1 Hurricane
Avalon Elementary School	Community Resources & Amenities	An elementary school serving students grade kindergarten through 8th grade.	NA	High	NA	Moderate
Avalon Free Public Library	Community Resources & Amenities	The building functions as a library, multi-media center, community space and used as the school library.	NA	Low	NA	Insignificant
U.S. Post Office	Community Resources & Amenities	Post Office	NA	Low	NA	Insignificant
Boardwalk	Community Resources & Amenities	The boardwalk extends over 2,500 feet on top of the dunes along the Atlantic Ocean and serves as a local and tourist attraction.	NA	Low	NA	High
Community Hall	Community Resources & Amenities	The Community Hall serves as a location for civic events.	NA	Low	NA	Low
Parking Lot & Skate Park	Community Resources & Amenities	Parking lot for tourists, beach goers, the skate park, and the community hall.	NA	Insignificant	NA	Insignificant
Beach Patrol Building	Community Resources & Amenities	Headquarters for the Avalon Beach Patrol.	NA	Low	NA	Low
Sports Fishing Center	Community Resources & Amenities	The sports fishing center is used for temporary docking of boats and for launching sports and leisure craft.	NA	Moderate	NA	Moderate
Marina Bay & Kayak Park	Community Resources & Amenities	The Marina Bay serves as a boat launch for sports and leisure crafts. The Kayak Park serves as a staging ground and launching point for seasonal kayak rentals.	Low	Moderate	Moderate	Moderate
Public Piers	Community Resources & Amenities	The public piers located through Avalon's Back Bay are important structures for maintaining the community's Municipal Public Access Program.	Low	High	Insignificant	Moderate
Avalon History Center	Community Resources & Amenities	The Avalon History Center houses collections of items from the borough's historical past.	NA	Low	NA	Insignificant

Table 1. Avalon Coastal Vulnerability Assessment Matrix						
Asset Name	**Asset Category**	**Asset Function**	**Vulnerability Rating**		**Consequences Rating**	
			Sea Level Rise	**CAT1 Hurricane**	**Sea Level Rise**	**CAT1 Hurricane**
Avalon Boulevard (County 601)	Critical Facilities & Infrastructure Systems	Avalon Boulevard serves as the only evacuation route for the community.	Low	Moderate	Insignificant	High
Avalon Blvd Bridge, 25th St. Bridge, 21st St. Bridge, Townsend Inlet Bridge	Critical Facilities & Infrastructure Systems	The bridges function as access routes for residents located along the Back Bay, neighboring communities, and visitors to the island.	NA	Insignificant	NA	Low
Sanitary Sewer Lift Stations (8 Total)	Critical Facilities & Infrastructure Systems	The sanitary sewer lift stations are used to move sewage throughout Avalon from lower to higher elevations, directing the sewage to the Municipal Utility Authority sewage treatment facility.	NA	Moderate	NA	Moderate
Stormwater Pump Stations (12 Total)	Critical Facilities & Infrastructure Systems	Pump stations are used to keep storm water and nuisance flooding from flooding low lying areas in the town.	Low	Moderate	High	Moderate
Borough Hall & Senior Center	Critical Facilities & Infrastructure Systems	Borough Hall functions as the center for municipal activities, houses offices, the court, the clerk's office and conference room space.	NA	Low	NA	Low
Fire Station	Critical Facilities & Infrastructure Systems	The fire department has 3 engines, 2 rescue boats, beach ambulance, regular ambulance and 15 5-ton army surplus vehicle.	NA	Low	NA	Insignificant
Police Station & Emergency Operations Center	Critical Facilities & Infrastructure Systems	All police activities occur in the building. During emergency events the police station acts as the Emergency Operations Center.	NA	Low	NA	Insignificant
Public Works Compound	Critical Facilities & Infrastructure Systems	The Avalon Public Works compound consists of the public works department and houses the major utility equipment for the borough.	NA	Moderate	NA	Low
Water Offices	Critical Facilities & Infrastructure Systems	The building operates as the main water treatment facility in Avalon as well as offices for staff.	NA	Low	NA	Insignificant

Table 1. Avalon Coastal Vulnerability Assessment Matrix						
Asset Name	**Asset Category**	**Asset Function**	**Vulnerability Rating**		**Consequences Rating**	
			Sea Level Rise	**CAT1 Hurricane**	**Sea Level Rise**	**CAT1 Hurricane**
Business District	Districts, Neighborhoods, & Population Clusters	Business are located along Dune & Ocean Drives. The businesses are a mix of retail and restaurants, ranging from low-end to high-end stores and restaurants.	NA	High	NA	High
Hotel District	Districts, Neighborhoods, & Population Clusters	The hotel district functions as the main area in town for tourists. The area consists of five hotels and motels with accommodations for approximately 1,000 people.	NA	Low	NA	High
Helen Diller Home for the Blind	Districts, Neighborhoods, & Population Clusters	The home serves as a seasonal vacation spot for blind individuals coming from urban areas.	NA	Low	NA	Insignificant
High Dunes (Natural System)	Natural Assets & Ecosystems	This system serves as an important natural feature for wildlife habitat but most importantly as a main hazard mitigation for storm protection.	NA	NA	NA	Insignificant
Man-Made Dune System	Natural Assets & Ecosystems	The main function of the dunes is hazard mitigation from storm events.	NA	Low	NA	Low
Beaches	Natural Assets & Ecosystems	The beaches provide recreation, support tourism and serve as a hazard mitigation measure for the town.	Low	Low	Moderate	Moderate
Armacost Park Natural area	Natural Assets & Ecosystems	The park is a community owned open space containing forested areas, wetlands, and other natural vegetation used as wildlife habitat.	Low	Moderate	Low	Low
Wetlands Complex	Natural Assets & Ecosystems	This is a wetlands complex found within the Back Bay of Avalon.	High	Low	High	Low

V. Recommendations

This section offers key steps that the township should consider following the vulnerability assessment, and discusses the long-term planning process that is integral to risk reduction and adaptation planning and implementation.

Considerations

1. Coordinate community outreach and education on flood risks

In order for Avalon to better prepare for the future impacts of sea level rise and hurricane events, it is important to have an engaged and informed community. The results of this report should be shared with the community either at a public meeting or workshop, but at a minimum by posting it on the municipal website. The Borough should

also consider special outreach to residents and property owners in the most vulnerable areas of Avalon, educating them about future flood risks and working together to find solutions that will protect Avalon at large and keep the fabric of the neighborhoods intact.

2. Share the results of the Coastal Vulnerability Assessment with owners and managers of vulnerable and at-risk non-residential properties and work together to develop mitigation and adaptation strategies. Many of Avalon's at-risk assets are owned and managed by private businesses and industries, and public and quasi-public entities. These property owners may be aware of additional risks and vulnerabilities that were not identified in this CVA, or perhaps have already launched efforts to prepare for future risk reduction. Avalon is encouraged to reach out to these property owners to discuss the results of this report and future steps that may be taken individually and collectively to protect the properties from future flood hazards.

Suggestions

- Share the results of the CVA with at-risk non-residential property owners and operators.
- Consider convening a workshop or meeting with at-risk non-residential property owners and operators to discuss opportunities to collaborate on adaptation strategies to minimize risks and potential damage to future flood hazards.
- When working with flood-risk private industries in development proposals, redevelopment or other activities, promote the importance of emergency management planning site remediation and the safe storage of toxic materials.

3. Incorporate the results of the Coastal Vulnerability Assessment into the municipal master plan with short-term and long-term strategies for protecting and adapting the community assets and vulnerable areas. As the primary planning policy document for the community, the master plan should identify areas in the community that will likely be impacted by future flood hazards, and offer measures for mitigation and adaptation strategies to protect the community's assets and properties.

Suggestions

- Include maps of projected sea level rise and future storm events in the land use plan and conservation plan elements of the municipal master plan.
- Identify natural resources that serve as protective flood mitigation measures (e.g. wetlands), and provide recommendations for maintenance and management in the conservation plan element.
- Identify planning policies for mitigation and adaptation strategies to protect properties from future flooding, including sea level rise and extreme storm events, in the land use plan element.

4. Cross-reference the Coastal Vulnerability Assessment in relevant sections of the municipal master plan, floodplain management plan, emergency operations plan and all hazards mitigation plan. Community flood risks are influenced largely by land use and development patterns that are grounded in local master plan policies. Hazard mitigation plans provide strategies to reduce these risks, in the past the plans have typically been stand-alone documents that rely upon structural mitigation measures, with little regard to land use and policy measures. The current trend in hazard mitigation planning is the integration with community plans, a trend which is strongly encouraged for all municipalities. Integrating flood risks and hazard mitigation into all local policy documents, especially master plans and hazard mitigation plans, ensures a coordinated, complementary approach to mitigation, and avoids potential conflicts from competing goals and interests.

Resources

- *Integrating Hazard Mitigation Into Local Planning, Case Studies and Tools for Community Officials*, FEMA, 2013

5. Consider wetland education and outreach campaign on the importance of Avalon's Back Bay wetland complex.

Wetlands serve an important role in flood hazard mitigation. These systems dampen wave height and energy, decreasing the destructive power of a storm surge entering the Back Bay. Community education and outreach will raise awareness of the benefits these systems provide to the community both daily and during a storm event. An education and outreach campaign could include brochures for the boating community or citizen scientist wetland assessment program with a local non-profit. In addition, the municipality may benefit from a more in-depth assessment of the community wetland health, consider consulting with wetland ecologist from academia or the non-profit community.

Resource

- Paddle for the Edge, Barnegat Bay Partnership http://bbp.ocean.edu/pages/380.asp
- Wetlands- Frequently asked questions, municipality of Anchorage http://www.muni.org/Departments/OCPD/Planning/Physical/EnvPlanning/Pages/WetlandFAQs.aspx

6. Consider the use of living shorelines to protect community assets against shoreline erosion

Living shorelines are a shoreline stabilization practice that address erosion using a hybrid approach of strategically placed plants, stone, sand fill and other structural or organic materials. Living shorelines typically have other co-benefits such as flora and fauna habitat, flood mitigation, water quality and attractive, natural appearances. These practices are an alternative to the traditional hard or "gray" infrastructure, e.g. bulkheads, revetment walls, etc., which are especially vulnerable to sea level rise and extreme flood events. Investigate areas within the Back Bay with natural shorelines currently experiencing erosion or infrastructure conflicts to install a living shoreline. Public lands including the Kayak Park would be an ideal location for a community demonstration project.

Resource

- The Nature Conservancy. *Coastal Restoration Explorer Mapping tool*.

7. Consider revising the municipal stormwater management and sewer plans to reflect the results of the CVA

The municipal stormwater management plan provides strategies for addressing current and future stormwater-related impacts that result from land use development, and strives to minimize flooding and protect community's water quantity & quality, groundwater recharge and aquatic habitats. Stormwater management strategies include recommended performance and design standards that are incorporated into ordinances, as well as management and maintenance requirements. Increases in the variability of weather patterns and the frequency of extreme weather events occurring in New Jersey are putting stress on municipal stormwater infrastructure systems. Avalon's stormwater infrastructure, including culverts, retention and detention ponds, inlets, catch basins, and stormwater pipes are all vulnerable to increases in flow of which they were not designed to handle. The Borough should considering updating the municipal stormwater management plan to include the potential impacts of climate change and promote design and infrastructure projects that are more resilient to climate change. In addition the Borough may want to review its stormwater management policies and maintenance plans for municipally-owned facilities to assess for potential climate change impacts and whether changes are desirable to make these systems more resilient.

Resource

- The Borough of Ottawa Wet Weather Infrastructure Management Plan
- The Borough of Ottawa. *Adaptive Approaches in Stormwater Management*.

Adaptation: A Long-Term Planning Process[4]

Planning for the predicted increase in the frequency and severity of flood hazards is a complex and challenging task. Adaptation to these flood hazards requires a longer planning timeframe for which most municipalities are not accustomed. Incremental steps are key to ensuring progress and minimizing public investments on projects that may be compromised by flooding in the near to distant future. This vulnerability assessment is an important first step in planning for these future hazards. The above recommendations provide key steps immediately following the vulnerability assessment to further identify and confirm vulnerabilities and consequences, and to begin thinking about adaptation. This section frames a strategic approach to identifying, assessing, and implementing long-term solutions to reducing flood risks. The process will need to be repeated periodically to respond to new data, changes in the physical environment and the long-term horizon.

Identify plans, studies and activities that are needed prior to identifying adaptation strategies

The Borough should re-convene the CVA committee or any other local flood management committee that includes a similar representation of multiple disciplines, e.g. municipal engineer, floodplain manager, planner, public works official, governing body representative, planning board representative, conservation planner, floodplain manager and emergency management official. This group should determine if there are data gaps or ambiguities in the CVA that need to be addressed to get a complete picture of vulnerability. For example, the community may want to field-verify certain sites or assets to determine if topography or adaptation measures may exacerbate or attenuate the projected flood impacts. If studies or plans are deemed necessary, the committee should identify who might take the lead. Also, the vulnerability and consequence ratings in this assessment should be compared with other current mitigation and planning documents to determine if there are any conflicts that should be addressed. Finally, the committee should determine which of the CVA recommendations will be implemented, if not all, and who should take the lead.

Identify adaptation strategies

Given that the CVA's purpose is to identify vulnerabilities, not pose solutions, the critical next step is to identify and evaluate potential solutions. Using the vulnerability assessment of community assets and other pertinent data and reports (e.g. the hazard mitigation plan, beach nourishment program, flood management reports) identify the broadest range of possible solutions to reduce flood risks. Depending upon the magnitude of the vulnerabilities and consequences, the community may need to consult with coastal engineers outside of the community to fully realize the range of adaptation measures. DEP and other agencies and organizations may be available to provide workshops or host consultation meetings. This process of identifying adaptation strategies could take several months or more to fully understand the options available to the community.

The Borough should also determine whether a regional approach to an adaptation project is appropriate, and, if so, arrange for multi-jurisdictional meetings. The county or NJDEP Office of Coastal and Land Use Planning may be able to assist in scheduling or facilitating these meetings.

Once the broad list of adaptation options is created, the committee should select the most desirable projects and strategies to pursue, along with associated timeframes, funding options and project/task

[4] The term "adaptation" in this document refers to all measures to minimize flood risks, including "mitigation" projects and strategies, a term which is traditionally used by emergency managers and engineers.

leads. The community may also want to conduct a cost-benefit analysis to prioritize adaptation strategies. Most adaptation projects will need to be reviewed the NJ Department of Environmental Protection to ensure they meet permitting requirements. Projects that cannot be approved or funded at this time should be noted and discussed in future iterations of this process.

Engage the Community

Host community meetings to discuss and solicit feedback on the recommended adaptation strategies while also educating the participants about flood risk.

Seek funding opportunities for adaptation planning and mitigation projects. Below is a short list of potential grant programs:

- NJ Department of Community Affairs (DCA) planning assistance grants
- NJDEP Office of Coastal and Land Use Planning
- NJDEP Office of Flood Hazard Risk Reduction Measures
- FEMA Hazard Mitigation grants
- FEMA Pre-Disaster Mitigation grants
- FEMA Flood Mitigation Assistance grants
- US Army Corps of Engineers
- Other Federal grant programs – see the Appendix of the NOAA Adaptation Guide

Develop an implementation strategy

Adaptation strategies should be integrated into the local hazards mitigation plan, capital improvement plan, master plan and ordinances to coordinate all related land use and adaptation policies and projects in the community. Key individuals and municipal departments should be assigned to lead and/or implement each of the adaptation strategies, along with proposed timeframes and funding options.

Schedule annual meetings

Unfortunately, there may not currently be sufficient resources and assistance available to address all of the community's identified vulnerabilities. Federal and State programs for coastal resiliency are still evolving, and grants, technical assistance, best practices and models, will inevitable become available. The committee should flag the issues for which solutions cannot be found and revisit them in the next adaptation planning process. Key staff should be charged with signing up for state and federal email lists that share grant and program information. And the committee should continue to meet at least once a year, even after all current options for making progress have been exhausted, to consider if new programs or solutions have become available.

Appendix A. Borough of Avalon Coastal Vulnerability Assessment Matrix

Asset Name	Asset Category	Asset Description	Asset Function	2050 Depth Projections (feet)		Exposure	Sensitivity	Vulnerability Rating		Consequences	Consequences Rating	
				Sea Level Rise	CAT1 Hurricane			Sea Level Rise	CAT1 Hurricane		Sea Level Rise	CAT1 Hurricane
Avalon Elementary School	Community Resources & Amenities	Public School	The school is an elementary school serving students grade kindergarten through 8th grade. There are approximately 70 students enrolled and approximately 13 teachers. It is the only school in Avalon. This school serves a local disaster shelter (power outages etc.) but not during storms.	NA	3-5.5	No exposure from sea level rise. May see several feet of inundation during a CAT 1 event.	The school is not raised to or above Base Flood Elevation and therefore several feet of flooding may leave the building open to major damage from the effects of flooding. The damage may be limited to the older lower section of school which is built to a lower elevation, while newer sections are elevated (not to base flood elevation) and might not see damage.	NA	High	The floor and the property in the building might be damaged. The financial consequences could be upwards of $100,00 or more in damage. Also school session would be out for an extended period due to required clean up.	NA	Moderate
Avalon Free Public Library	Community Resources & Amenities	Public Library	The building functions as a library, multi-media center, community space and used as the school library. It is ranked a 5 Star Library by the Library Journal, one of three in NJ.	NA	3-4.5	No exposure from sea level rise. May see several feet of inundation during a CAT 1 event.	The library is a raised building and would like not suffer any impacts from a major storm event.	NA	Low	None	NA	Insignificant
U.S. Post Office	Community Resources & Amenities	Post Office	The U.S. Post Office in Avalon serves simply as the post office for mail service.	NA	3.5-5	No exposure from sea level rise. May see several feet of inundation during a CAT 1 event.	The U.S. Post Office was built high and of a solid construction. Impacts from a CAT 1 event would be minimal.	NA	Low	None	NA	Insignificant
Boardwalk	Community Resources & Amenities	Boardwalk	The boardwalk extends over 2,500 feet on top of the dunes along the Atlantic Ocean and serves as a local and tourist attraction allowing for people to walk along the dunes and enjoy picturesque views of the dunes, beaches, and the ocean.	NA	0-3	No exposure from sea level rise. May see several feet of inundation during a CAT 1 event.	The boardwalk would be impacted by flood waters, wave damage and possible erosion from a CAT 1 event. In the past the boardwalk has seen major damage and almost complete destruction from storm events.	NA	Low	The boardwalk is flush with the top of the dune. Though if damaged, repair cost of the boardwalk could be upwards of $2 million. Not many commercial property there, damage would be limited. Timing would be the largest issue, if it occurred during the tourism season the consequences could be much higher than if damaged occurred during the off season.	NA	High
Community Hall	Community Resources & Amenities	Community Hall	The Community Hall servers a location for civic events held within Avalon.	NA	0.5-1.5	No exposure due to sea level rise. May see minor inundation during a CAT 1 event.	The Community Hall is protected by the dunes to the east. During a CAT 1 the building may see minor flooding. The building is not built to or above BFE and thus may see some damage from inundation.	NA	Low	The community hall is on higher ground, though if flooding occurred wood floors would be damaged and would need to be repaired and/or replaced.	NA	Low
Parking Lot & Skate Park	Community Resources & Amenities	Parking Lot & Skate Park	Parking lot for tourists, beach goers, the skate park, and the community hall. During emergencies the parking lot serves as a location for staging and debris removal.	NA	2	No exposure due to sea level rise. May see minor inundation during a CAT 1 event.	The parking and skate park lot may see several feet of flooding during a CAT 1 event however, there are little to no structures that would be impacted. After flood water recedes the parking lot should operate as staging and debris removal area with little delay.	NA	Insignificant	None	NA	Insignificant
Beach Patrol Building	Community Resources & Amenities	Public Safety	Headquarters for the Avalon Beach Patrol, used seasonally during the summer months. No major equipment is stored in the building.	NA	0.5-1	No exposure due to sea level rise. May see minor inundation during a CAT 1 event.	The Beach Patrol building is partially protected by the dunes to the east. During a CAT 1 the building may see minor flooding. The building is not built to or above base flood elevation and thus may see some damage from inundation.	NA	Low	The building does not store any major equipment and if destroyed Borough would rebuild.	NA	Low
Sports Fishing Center	Community Resources & Amenities	Public Marina	The sports fishing center is used for temporary docking of boats and for launching sports and leisure craft.	3.5	4.5	No exposure due to sea level rise. May see several feet of inundation during a CAT 1 event.	Sea level rise will cause higher tides and may raise docks higher on average than current levels. During a CAT 1 event the entire marina can expect several feet of inundation and storm surge from the Back Bay which could cause damage to or destroy the docks present.	NA	Moderate	Most damage would be to the floating docks, replacing could cost up to $500,000. Most boats stored there are rental and charter boats. The rental and charter boats are important to local tourism economy and if the boats and marina were substantially damaged by a major storm the consequences to the businesses could be major.	NA	Moderate
Marina Bay & Kayak Park	Community Resources & Amenities	Public Marina & Park	The Marina Bay serves a boat launch for sports and leisure crafts. The marina includes approximately 33 slips used by local residents. The Kayak Park serves as a staging ground, seasonal storage area and launching point for seasonal kayak rentals.	4.5-6	5-6.5	The marina and kayak park may see several feet of inundation during height tide due to sea level rise. May see major inundation during a CAT 1 event.	The marina boat launch, associated parking lot, and the kayak staging area may become inundated daily during high tide due to sea level rise. A CAT 1 event would cover the entire area in several feet of inundation which could cause damage to shoreline in the park and cause road structure damage to Ocean Drive.	Low	Moderate	Under sea level rise scenarios the park could see loss of land area, which would impact the marina and kayak rental business, and result in a community sense of loss. Lose of the beach or the boat launch would be a final loss and diminish alternative recreational potential in the back bay. The marina and park is heavily used by tourist, so if a CAT1 hit during the summer season the impact would be greater. The town does not have a policy requiring a mandatory evacuation. Most homeowners remove or manage their boats during a storm. Most of the damage would be to the floating dock.	Moderate	Moderate
Public Piers	Community Resources & Amenities	9 Public Piers	The public piers located through Avalon's Back Bay are important structures for maintaining the community's Municipal Public Access Program. The structures are fixed and hardened going directly into and over the waterways of the Back Bay.	8	10	May see major inundation during high tide due to sea level rise. May see major inundation during a CAT1 event.	The fixed public piers are likely to see increasing high tides, which have the potential to overwash the piers. Past storm events have severely damaged and completely destroyed the piers, a CAT 1 event in the future could tender the same results.	Low	High	The public piers are a major portion of Avalon's public access plan, which is needed to maintain funding and receive grant money from the state. The piers have an approximate replacement value of $30,000 a piece.	Insignificant	Moderate

Avalon History Center (Museum & Historical Society)	Community Resources & Amenities	Local Museum & Research Center	The Avalon History Center houses collections of items from the historical past of Avalon. The center also offers research and genealogical services, and hosts local events.	NA	1.5-2	No exposure due to sea level rise. May see minor inundation during a CAT 1 event.	The Avalon History Center is located on slightly elevated ground from the surrounding land. The building may experience a couple feet of inundation during a storm event, but damage, if any, would be minimal.	NA	Low	None	NA	Insignificant
Avalon Boulevard (County 601)	Critical Facilities & Infrastructure Systems	State Designated Evacuation Route	Avalon Boulevard serves as the only evacuation route for the community. The route along Ocean Drive on Townsend Inlet bridge is regularly closed due to flooding and wave cresting the stone barrier.	0-6	2-7	May see major inundation during high tide due to sea level rise. May see major inundation during a CAT1 event.	The evacuation route is sensitive to flooding events however, evacuations are ordered several days prior to a major event. Avalon Boulevard may see daily nuisance flooding during high tide due to sea level rise.	Low	Moderate	Major storm event evacuation occurs prior to the event. The major consequences for the evacuation route is substantial road damage to causeway. Damage seen from waves action is an issue in Avalon Manor and the Parkway entrance which are major low points. Damage to road can result in road closures that impact the ability of residents and emergency services in Avalon and neighboring communities to access the area.	Insignificant	High
Avalon Blvd Bridge(Gravens Thoroughfare), 25th Street Bridge, 21st Street Bridge, Townsend Inlet Bridge	Critical Facilities & Infrastructure Systems	Bridges	The bridges function as access routes for residents located along the Back Bay, neighboring communities, and visitors to the island. The Townsend Inlet bridge is used regularly for day to day commerce between local businesses.	NA	NA	The bridges are built above shown future sea level rise and potential CAT 1 events.	Townsend Inlet Bridge has been closed often for repairs and was reopened with minor repairs but is scheduled for additional repairs. The bridge is regularly closed due to excessive wave cresting along the stone wall located on the approach to the bridge.	NA	Insignificant	Townsend Inlet Bridge is very old and closed regularly, so the consequences to the community will be limited. This bridge connects to Sea Isle to Avalon, so impacts are felt by businesses who now have a more complicated route between the two cities, though more of an inconvenient. Sea isle sees more impact with the bridge loss. Major time inconvenience for Sea isle City. County owns the bridge and control the repairs and maintenance. The consequences to the communities can be a 4-5 month closure with a moderate financial loss.	NA	Low
Sanitary Sewer Lift Stations (8 Total)	Critical Facilities & Infrastructure Systems	Lift Stations	The sanitary sewer lift stations are used to move sewage throughout Avalon from lower to higher elevations, directing the sewage to the Municipal Utility Authority sewage treatment facility.	5.5	6.5	No exposure from sea level rise. All pump stations would see inundation during a CAT 1 event.	All the sanitary lift stations would likely see flooding during a CAT 1 Hurricane, resulting in the shutdown of the lift stations. Shutdown of lift stations would possibly result in the back up of sewage throughout the entire system.	NA	Moderate	The control panels are all above base flood elevation but not above the storm surge. Repairs to the control panels cost approximately $30,000 per panel. There are back-up pumps-with two pumps in each well. To get the pumps back online it would only take a day or two to repair. In the past, the DPW has had to have people go to each lift station with a generator to run and clear the pipes and move on to the next lift station.	NA	Moderate
Stormwater Pump Stations (12 Total)	Critical Facilities & Infrastructure Systems	Pump Stations	Pump stations are used to keep storm water and nuisance flooding from flooding low lying areas in the town. Water is pumped into the Back Bay to the west and to the Atlantic Ocean to the east. The pump stations are enclosed systems that are individually operated, and each has a backflow prevention structure.	5.5	6.5	Pumps located along Ocean Drive may see inundation during height tide due to sea level rise. All pump stations would see inundation during a CAT 1 event.	The 5 pump stations located along Ocean Drive may see daily impact from high tides by 2050. Daily inundation from high tide may result in a pump system that will be stressed and overworked. All the pump stations would likely see flooding during a CAT 1 Hurricane, resulting in the shutdown of all pump stations during a storm event.	Low	Moderate	The pump stations control panels are elevated above base flood elevation. Consequences from sea level rise and the increase heights of flood water would be dependent on the number of times a year these systems are triggered. Currently the pumps are triggered half a dozen times a year to remove flood waters. Backflow prevention structures and ball check valve are two components of the system that may also be stressed. Avalon does have an extensive DPW staff (23) with increased storm events and multiple actions needed to prepare for the storm (equipment removal, clearing debris in the backflow prevention structure and cleaning stormwater systems) staff may be over taxed. With increasing sea level rise and higher high tides the stormwater pumps would cease to be an effective mitigation practice and Avalon will need to consider other options.	High	Moderate
Borough Hall & Senior Center	Critical Facilities & Infrastructure Systems	Local Government Administration & Senior Center	Borough Hall functions as the center for municipal activities, houses offices, the court, the clerks office and conference room space. The senior center serves as an activities center for the senior population within Avalon.	NA	4.5-6.5	No exposure due to sea level rise. May see several feet of inundation during a CAT 1 event.	The borough hall is raised and would be minimally impacted by a storm surge event. All computers are removed from this building prior to storm events, and all Clerk documents have been digitized at a records center, with backups outside the community.	NA	Low	Limited impact to the building, may require some clean up after a storm event.	NA	Low
Fire Station	Critical Facilities & Infrastructure Systems	Fire Station	The fire department has 3 engines , 2 boats rescue, beach ambulance, regular ambulance and 15 5 ton army surplus. Firefighters are all volunteer, Rescue squad is paid.	NA	4-5	No exposure due to sea level rise. May see several feet of inundation during a CAT 1 event.	The fire station may see several feet of water during a flooding event, however the impact may be limited based on the construction of the building, and the fact that all equipment is moved during storm to high ground in Sea View.	NA	Low	None	NA	Insignificant
Police station & Emergency Operations Center	Critical Facilities & Infrastructure Systems	Public Safety	All police activities occur in the building. It is the source of the backup generator which feeds the city hall and fire station. Core of rescue and emergency staff stay during the storm event. Heavy equipment moved to high grounds during storm event to Sea View.	NA	4-5.5	No exposure due to sea level rise. May see several feet of inundation during a CAT 1 event.	The police station may see several feet of water during a flooding event, however the building is constructed to a standard that allows for its use as an emergency operations center during flooding events despite the first floor being inundated with flood waters. Police and other equipment not needed during an emergency are moved to high ground off the island.	NA	Low	None	NA	Insignificant

Public Works Compound	Critical Facilities & Infrastructure Systems	Public Works	The Avalon Public Works compound consists of the offices of the public works department and houses the major utility equipment for the borough.	NA	1.5-5.5	No exposure due to sea level rise. May see several feet of inundation during a CAT 1 event.	The vast majority of heavy equipment is located within the compound. Equipment deemed necessary for disaster recovery is moved to a safe location on the mainland prior to a storm event. Only small equipment is left behind. The buildings may be inundated with computer equipment and furniture inside the building being damaged.	NA	Moderate	Limited consequences to the building as the structure is a metal building with concrete floors and would only need sediment clean up. Inside equipment and furniture would be damaged. Access to the building would be limited at first but could be cleaned up after the event quickly.	NA	Low
Water Offices	Critical Facilities & Infrastructure Systems	Water Treatment Facility	The building operates as the main water treatment facility in Avalon as a wells as offices for staff.	NA	3	No exposure due to sea level rise. May see several feet of inundation during a CAT 1 event.	The building and well head are 1 foot above base flood elevation. The building and facility would experience minimal impact from a CAT 1 event.	NA	Low	None	NA	Insignificant
Business District	Districts, Neighborhoods, & Population Clusters	Business District	Business are located along Dune & Ocean Drives. The major driver of the business district is tourism, but about half the businesses remain open year round. The businesses are a mix of retail and restaurants, ranging from low-end to high-end stores and restaurants.	4-6.5	5-7	May see several feet of inundation during height tide along Ocean Drive due to sea level rise. May see major inundation during a CAT1 event.	Stormwater pumps located along Ocean Drive may provide relief from daily nuisance flooding, but would be shutdown during a CAT 1 event. About half the buildings located within the district are built above BFE and the other half are not. About half the business have flood insurance while the other half do not. Damages from water inundation, rot, and mold have been seen after past events.	NA	High	Ocean Drive business are high, except for Antonios, Wawa and the gas station. Damage would be limited and would have limited consequence to the community and businesses. Dune Drive experiences most damage during flooding with damage to older structures and longer store closures due to repairs and clean up. Stores may be closed for 3-6 month, which depending on the season could have low to high financial consequences, especially if it occurred during the summer season. Supermarket may take the longest to recover with the greatest financial consequence. Debris clean up could take several days. The financial loss for the business owners could be extreme, $100,000 loss or greater.	NA	High
Hotel District	Districts, Neighborhoods, & Population Clusters	Hotel & Motel District	The hotel district functions as the main area in town where tourists come to stay in Avalon. The area consists of five hotels and motels with accommodations for approximately 1,000 people.	0-4	0.5-5	No exposure due to sea level rise. May see several feet of inundation during a CAT 1 event.	All the hotel and motels are above base flood elevation and tourists are evacuate prior to a storm event and before residents.	NA	Low	The consequence to the structures are limited to no impact. If a major storm event were to occur during the summer tourism peak and people were forced to evacuate the financial impact to the hotels and Avalon could be in the millions, depending on how long Avalon was under evacuation.	NA	High
Helen Diller Home for the Blind	Districts, Neighborhoods, & Population Clusters	Disabled Person Facility	The home serves as a seasonal vacation spot for blind individuals coming from urban areas.	NA	3.5-4	No exposure due to sea level rise. May see several feet of inundation during a CAT 1 event.	The vacation home is built above base flood elevation, and thus impacts from a CAT 1 event would be minimal.	NA	Low	None	NA	Insignificant
High Dunes (natural system)	Natural Assets & Ecosystems	Dunes	A natural system (that was previously restored) is a complex high dunes community (rising up to 50ft). The system is fairly stable with minimal maintenance needed. The complex system has multiple hills and valleys containing grass, trees and shrubs serving as an important wildlife habitat. This system serves as an important natural feature both aesthetically, for wildlife habitat but most importantly as a main hazard mitigation for storm protection. The stability of the dunes also support a wider and stable beach area (enhancing the hazard mitigation provided).	NA	NA	No exposure	Very stable dune system, has not been topped or breached.	NA	NA	Since only minor erosion will occur to the high dune system the consequences to the community will be limited. Most damage will occur in the fore-dune section of the dune complex protecting the maritime forest and swales within the high dunes. Small frontal fore dune area which is sacrificed in storms and re-established following storms. Dune work is solely funded by Avalon. New homes in dunes require new stormwater infrastructure to pump to roads and away from dunes. Minimal planting and no sand replenishment for height is required in this section. Damage to this section of the dunes are very limited in-turn providing extensive benefit to the community behind the dunes during storm events.	NA	Insignificant

Man-Made Dune System	Natural Assets & Ecosystems	Dunes	After the 1970's the town started re-establishing dunes along the length of the community beaches from 8th to 80th street. These dunes very in size and require a lot of maintenance. The dunes main function is hazard mitigation from storm events.	NA	NA	No exposure	Maintenance is completed regularly and funded through municipal capital budget and supported by federal funds. During hurricane Gloria these dunes were breached. Through they have been raised and maintained subsequently, the possibility of this occurring again is not impossible.	NA	Low	These dunes are both north and south of the high dunes. Less stable than the high dunes system, in past storms (1962) the northern section was breached. Since then intense maintenance completed on these systems to reduce risk of failure of the systems during a storm but at a large cost to the community. The dune systems provide an enormous protection to the community during a storm. Protection of these systems include beach replenishment to the areas in front of the dunes to provide ample beach area to absorb wave energy prior to reaching the dune toe. Army Corps beach replenishment is planned for every 3 years, but Avalon does beach nourishment as required. These activities include use of earth movers to scrape beach from the South and brings it back up to north beaches. Significant cost in municipal finance every year to maintain beaches and dunes. The town completed a beach replenishment every year since 2005. Dune systems are designed to survive 6-8 hrs. of a CAT1 hurricane surge. Homes in the area are at BFE and new requirements are +3 BFE. Each year, 30,000 yards of sand lost through natural erosion, which is replaced by the municipality. This maintenance averages annually $1.5M. Continuous replenishment and maintenance of the dunes plant community is conducted to help stabilize the dune structure. The town partners with home owners to plant dune vegetation on their property. (removing invasive plants such as Japanese black pines). South end is left alone with some snow fencing, replenished by the northern sand drift.	NA	Low
Beaches	Natural Assets & Ecosystems	Beaches	They serve as both main source of tourism for recreational purposes but also as hazard mitigation for the town. Town is very aware of their function during storm events and how much they protect the community (in conjunction with the dunes).	2-8	3-9	Partially exposed during 2030 and 2050 SLR. Inundated (as should be) during storm events	Beach replenishment occurs regularly 9-23rd Street.	Low	Low	Beach nourishment is funded by US Army Corps agreement for a three year repeating maintenance cycle Beach area included in the nourishment agreement extend to 32nd street (does not include beaches along the high dunes system). Beach sand is seen as sacrificial asset to the town. US Army Corps only provides beach replenishment to the extent of the defined beach profile. The town and Army Corps has a fifty year agreement starting in 1998-99, ending around 2050. Corps is not financially keeping up their commitment. With decreasing beaches comes decreased dune stability, leading to declining beach usage. The consequence to the community of the area would be great both in tourism and flood hazard mitigation. Loss of beach due to sea level rise will diminish the beaches value in storm protection.	Moderate	Moderate
Armacost Park	Natural Assets & Ecosystems	Recreation Park & Wildlife Habitat	The park is a community owned open space containing forested areas, tidal wetlands (connected to bay through culverts), and other natural vegetation used as wildlife habitat. The site includes playground facilities and a few structures.	6.5	7	May see major inundation during high tide due to sea level rise. May see major inundation during a CAT1 event.	Limited structures on the property reduce the damage that will be seen within the property. It is a naturally flooding location and the ecosystem is adapted to such regular and irregular flooding events.	Low	Moderate	This natural area, connected tidally through a culvert to the back bay does experience flooding during storms. This area could provide flooding relief for community around, by redirecting flood water from the back bay to this tidal wetland area. The lose or damage to this natural area could increase the consequences to the surrounding area through increased flooding.	Low	Low
Back Bay Salt Marsh Complex	Natural Assets & Ecosystems	Wetlands Complex	The salt marshes serve as wildlife habitat, storm protection and aesthetic backdrop for the seaside community.	1-5	12-15	The marsh will see major inundation during both high tide and during a CAT1 event.	With continued inundation during daily high tide events these salt marshes will start "drowning" if the rate of sedimentation or wetland platform build-up does not keep pace with sea level rise. Plant die back and continued inundation will convert these systems into mudflats or open water. Critical wildlife habitat will be vanish, important water purification processes occurring in the wetlands will be lost and the storm protection provided by the plants destroyed.	High	High	Salt marshes in the back bay currently provide the town flood mitigation to their adjacent development. Degradation of these salt marshes continued inundation could lead to increased flood hazards in the adjacent residential and commercial areas. The extent of the consequence is yet unknown but could be significant. Fish and Wildlife is doing an experimental thin layer soil application to a portion of the Cape May Wetlands Wildlife management area marsh's. This practices is to assist wetland soil accretion to elevate their platform height. In addition to increasing flood hazards, accelerated storm damage to the wetlands would negatively effect property values within the area.	High	Low

Appendix B – Vulnerability Rating Key

Vulnerability Rating Key	
Level	**Vulnerability Rating Given Hazard Exposure and Sensitivity**
Insignificant	*Exposure to Flooding:* This community asset is located out of harm's way. *Physical/Structural Damage:* No physical/structural damages expected. *Disruption/Impairment:* No disruption in function, accessibility, or development and delivery of basic services and supplies. No apparent impacts to services provided by, typical operations, routine or daily life. *Accessibility:* Key staff able to access facilities or locations without interruption.
Low	*Exposure to Flooding:* The majority of this community asset is located out of harm's way. *Physical/Structural Damage:* Minor physical/structural damages expected. *Disruption/Impairment:* 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. *Accessibility:* Key staff able to access facilities or locations with minimal interruption.
Moderate	*Exposure to Flooding:* A significant portion of this community asset is located in harm's way. *Physical/Structural Damage:* Moderate physical/structural damages sustained. *Disruption/Impairment:* 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 moderately affected by flood hazard scenario. *Accessibility:* Secondary evacuation and access routes available for use if/when primary systems fail.
High	*Exposure to Flooding:* The majority of this community asset is located in harm's way. *Physical/Structural Damage:* Severe level of harm (destruction on property or degradation of function and/or injury) is expected, resulting in a high degree of loss. Asset, amenity or population is unable to withstand flood impacts. *Disruption/Impairment:* Severe, potentially irreparable challenges faced requiring significant changes to asset functioning, community's daily life or "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. *Accessibility:* Severe disruptions to accessibility of asset, amenity or population or the disruption of this assets causes accessibility issues to other community assets. Key individuals, material supplies, core operating systems and functioning interrupted or unavailable.

Appendix B – Vulnerability Rating Key

Vulnerability Rating Key	
Level	**Vulnerability Rating Given Hazard Exposure and Sensitivity**
Insignificant	*Exposure to Flooding:* This community asset is located out of harm's way. *Physical/Structural Damage:* No physical/structural damages expected. *Disruption/Impairment:* No disruption in function, accessibility, or development and delivery of basic services and supplies. No apparent impacts to services provided by, typical operations, routine or daily life. *Accessibility:* Key staff able to access facilities or locations without interruption.
Low	*Exposure to Flooding:* The majority of this community asset is located out of harm's way. *Physical/Structural Damage:* Minor physical/structural damages expected. *Disruption/Impairment:* 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. *Accessibility:* Key staff able to access facilities or locations with minimal interruption.
Moderate	*Exposure to Flooding:* A significant portion of this community asset is located in harm's way. *Physical/Structural Damage:* Moderate physical/structural damages sustained. *Disruption/Impairment:* 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 moderately affected by flood hazard scenario. *Accessibility:* Secondary evacuation and access routes available for use if/when primary systems fail.
High	*Exposure to Flooding:* The majority of this community asset is located in harm's way. *Physical/Structural Damage:* Severe level of harm (destruction on property or degradation of function and/or injury) is expected, resulting in a high degree of loss. Asset, amenity or population is unable to withstand flood impacts. *Disruption/Impairment:* Severe, potentially irreparable challenges faced requiring significant changes to asset functioning, community's daily life or "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. *Accessibility:* Severe disruptions to accessibility of asset, amenity or population or the disruption of this assets causes accessibility issues to other community assets. Key individuals, material supplies, core operating systems and functioning interrupted or unavailable.

Appendix C – Consequences Rating Key

Consequences Rating Key		
Level		**Given Vulnerability of Assets, Rate the Magnitude or Severity of Consequences**
1	Insignificant	*Property Damages:* Only minor property damage. *Typical Operations/Daily Life:* No impacts or disruptions to typical operations, routine or daily life. *Environment:* No lasting environmental degradation. *Emergency Response:* No adverse effects to emergency response. *Hazardous Materials:* No increase or change in community/ecosystem exposure to toxics or hazardous materials. *Municipal Budget:* Negligible operational costs.
2	Minor	*Property Damages:* Limited property in narrow affected area damaged or destroyed. *Typical Operations/Daily Life:* Limited disruption to typical operations, routine or daily life. *Environment:* Minor damage or loss to habitat and species or functioning of the systems as a component of "coastal green infrastructure" of the community. Small loss of natural resource base. Increased, but tolerable stress on ecosystem. *Emergency Response:* Slight decrease in emergency response times and effectiveness *Hazardous Materials:* Limited hazardous materials spill, manageable clean-up and remediation. *Municipal Budget:* Additional but tolerable operational costs.
3	Moderate	*Property Damages:* Substantial property in affected area damaged or destroyed. *Population Displacement:* Long-term population displacement over a broader segment of the population. *Typical Operations/Daily Life:* Daily life is affected such that only redundant systems can be used for an extended duration. *Environment:* Major damage or loss of habitat or functioning of the systems as a component of "coastal green infrastructure" of the community that may be permanent with adverse impacts. *Emergency Response:* Emergency response is strained resulting in significant degradation of response effectiveness and times. *Hazardous Materials:* Large hazardous material spill with significant risk to humans and ecosystems. *Municipal Budget:* High operational costs straining local budgets
4	High	*Property Damages:* Majority of property in affected area damaged or destroyed *Population Displacement:* Permanent and widespread population displacement. *Delivery of Services:* Long-term interruption of supply and services. *Typical Operations/Daily Life:* Majority of community operations, daily life patterns intensely impacted for an extended period. *Environment:* Permanent degradation of habitat or functioning of the systems as a component of "coastal green infrastructure" of the community. *Emergency Response:* Need for emergency services exceeds full capacity and/or services are degraded and not functioning. *Hazardous Materials:* Hazardous material spill that requires multi-year clean-up and poses significant health or ecosystem risk.

Appendix D – Municipal CVA Committee

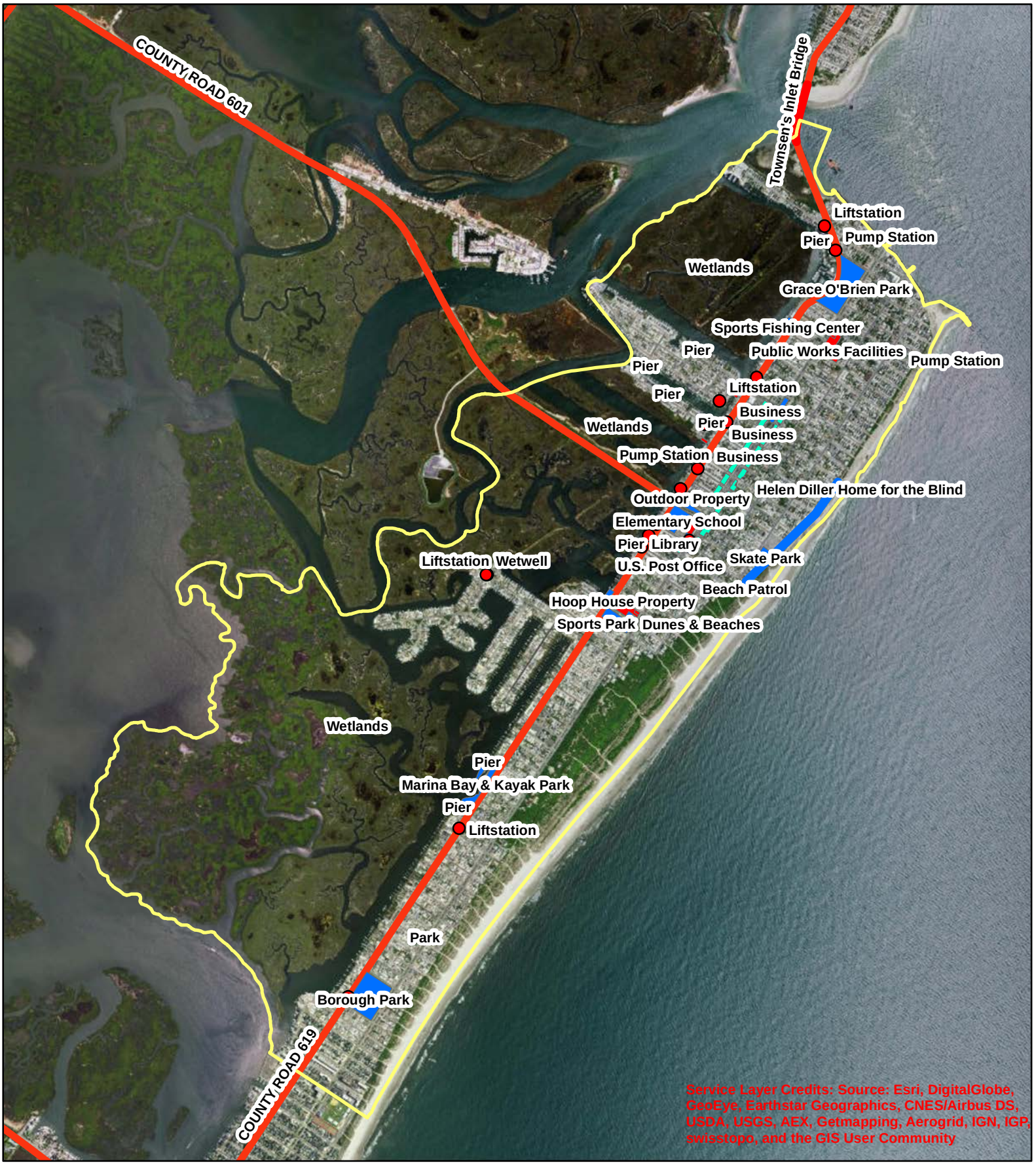
Municipal CVA Committee

Avalon convened a diverse group of municipal representatives and community leaders to participate in the CVA process facilitated by Sustainable Jersey. The meetings were held on September 21st and December 11th, 2015 at the Avalon Borough Hall. The meeting attendees are shown below.

Participant	Title	Affiliation
Marty Pagliughi	Mayor	Borough of Avalon
Michele Petrucci	Green Team Member	Avalon Green Team
C.L. Hensel	Green Team Member	Avalon Green Team
Harrold de Butts	Emergency Manager	Avalon Office of Emergency Management
Scott Walker	Business Administrator	Borough of Avalon
Bill Macomber	Director of Public Works	Borough of Avalon
Tom Thornton	Avalon Borough Engineer	Hatch Mott MacDonald
Bill Burns	Councilmen	Borough of Avalon
Ed Dean	Office of Emergency Management / Fire Department	Borough of Avalon
Jeff Hesley	Tax Assessor / Zoning Officer	Borough of Avalon
Bill Purdie	Planner	NJ DEP
Rick Brown	Planner	NJ DEP
Kelley Pflicke	Planner	NJDEP
Jack Heide	Resiliency Manager	Sustainable Jersey
Emma Melvin	Green Infrastructure Coordinator	Sustainable Jersey

Appendix E – Avalon Coastal Vulnerability Assessment Maps

Table of Maps



Borough of Avalon Community Assets

Municipal Boundaries

Community Assets

Categories

- Community Resources & Ammenities
- Critical Facilities & Infrastructure Systems
- Districts, Neighborhoods & Population Clusters
- Evacuation Routes

Prepared by Sustainable Jersey
February 2016

0 0.125 0.25 0.5 0.75 1
Miles

N

Borough of Avalon (North) Community Assets

Municipal Boundaries

Community Assets

Categories

- Community Resources & Ammenities
- Critical Facilities & Infrastructure Systems
- Districts, Neighborhoods & Population Clusters
- Evacuation Routes

Prepared by Sustainable Jersey
February 2016

0 0.05 0.1 0.2 0.3 0.4 Miles

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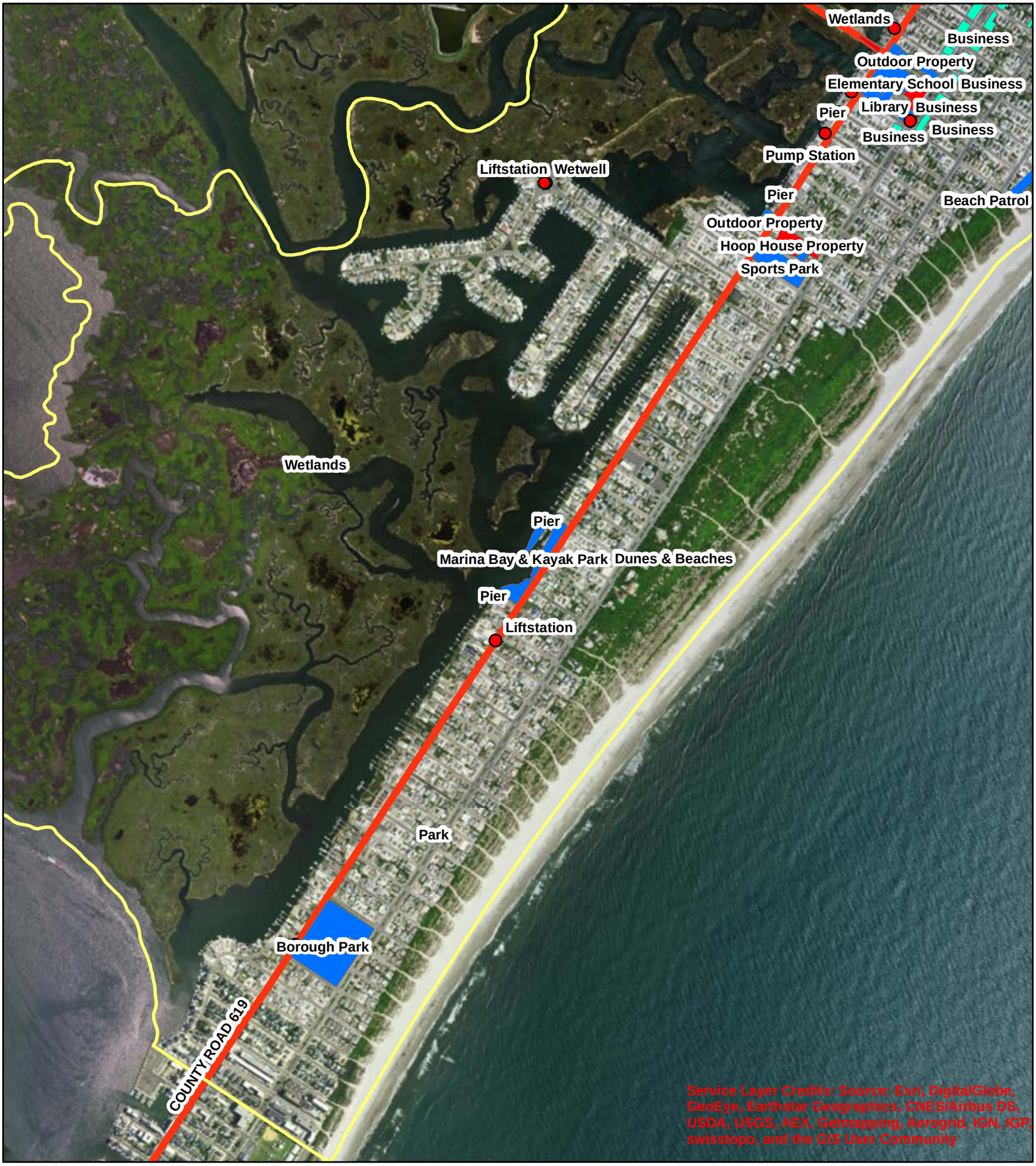


Borough of Avalon (South) Community Assets

Municipal Boundaries

Community Assets

Categories

- Community Resources & Ammenities
- Critical Facilities & Infrastructure Systems
- Districts, Neighborhoods & Population Clusters
- Evacuation Routes

Prepared by Sustainable Jersey
February 2016

0 0.075 0.15 0.3 0.45 0.6
Miles

N

Borough of Avalon (North) 2050 Sea Level Rise

Municipal Boundaries

Community Assets

Categories

- Community Resources & Ammenities
- Critical Facilities & Infrastructure Systems
- Districts, Neighborhoods & Population Clusters
- Evacuation Routes

2050 Sea Level Rise

Depth

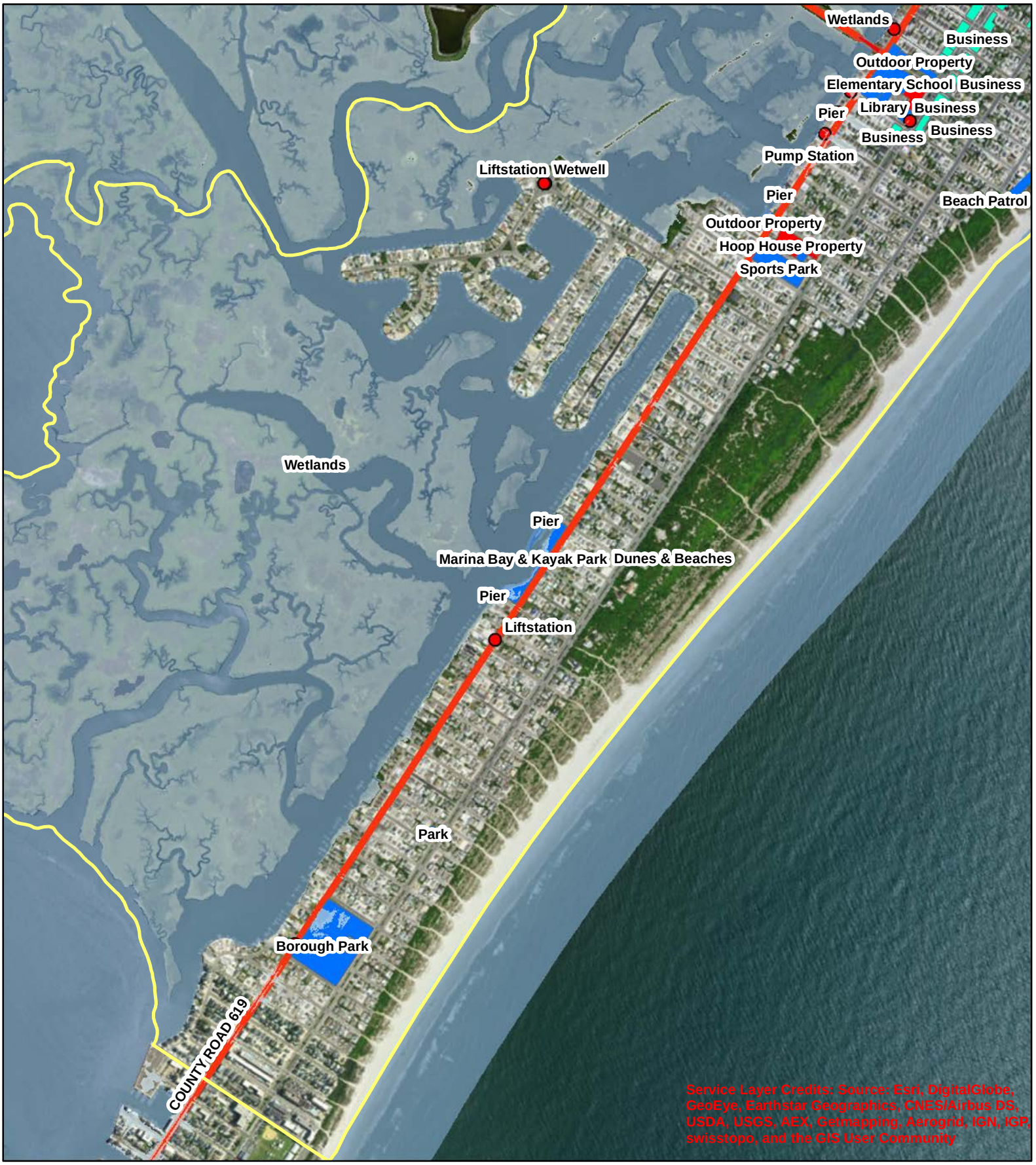
High : 50 ft.

Low : 0 ft.

0 0.05 0.1 0.2 0.3 0.4 Miles

N

Prepared by Sustainable Jersey
February 2016



Borough of Avalon (South) 2050 Sea Level Rise

Municipal Boundaries

Community Assets

Categories

- Community Resources & Ammenities
- Critical Facilities & Infrastructure Systems
- Districts, Neighborhoods & Population Clusters
- Evacuation Routes

2050 Sea Level Rise

Depth

High : 50 ft.

Low : 0 ft.

0 0.075 0.15 0.3 0.45 0.6

Miles

N

Prepared by Sustainable Jersey
February 2016

Borough of Avalon (North) 2050 CAT1 Hurricane

Municipal Boundaries

Community Assets

Categories

- Community Resources & Ammenities
- Critical Facilities & Infrastructure Systems
- Districts, Neighborhoods & Population Clusters
- Evacuation Routes

2050 CAT1 Hurricane

Depth

High : 60 ft.

Low : 0 ft.

0 0.050.1 0.2 0.3 0.4

Miles

N

Prepared by Sustainable Jersey
February 2016

Borough of Avalon (South) 2050 CAT1 Hurricane

Municipal Boundaries

Community Assets

Categories

- Community Resources & Ammenities
- Critical Facilities & Infrastructure Systems
- Districts, Neighborhoods & Population Clusters
- Evacuation Routes

2050 CAT1 Hurricane

Depth

High : 60 ft.

Low : 0 ft.

0 0.075 0.15 0.3 0.45 0.6 Miles

N

Prepared by Sustainable Jersey
February 2016