Resilient NJ

RISK ASSESSMENT METHODOLOGY

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1. Introduction

Resilient NJ builds on the existing efforts and capabilities within the state to create and implement creative regional planning solutions to address current and future flood-related hazards, environmental resource protection, and the promotion of sustainable/smart growth development in both riverine and coastal communities. This unique program brings together Consultant Teams to help communities imagine creative and implementable solutions to flooding issues that increase resilience, enhance the value and integrity of the ecologic and economic resources in the region, improve public access and recreation opportunities, and reach underserved and socially vulnerable populations.

Conducting this risk assessment, as part of the Resilient NJ program, will help the Consultant Team, along with the Regional Team, understand the flood risk of locally valued assets, understand key regional assets that are significant to the region's function, and identify where interdependencies between assets exist. The risk assessment will be performed by the Consultant Teams, with insight and feedback from the Regional Teams.

The methodology described in this document shall be used to identify and assess flood risk and vulnerability for the Resilient NJ program. Assets identified and prioritized will be assessed for damages and losses using several flooding conditions. Deliverables resulting from the risk assessment will include Asset Risk Profiles, an associated database, and a Risk Assessment Report, which are described in more detail in Section 5 of this document. These risk and vulnerability results shall help inform the development and evaluation of resilience and adaptation scenarios (*Task 4)*.

2. Flooding Conditions

The Resilient NJ risk and vulnerability assessment shall use two current and four future flooding conditions determined and provided by DEP. The flooding conditions consider combinations of increased rainfall (both intensity and depth), storm surge, tidal flooding and sea level rise (SLR). HEC-RAS models of each flooding condition will be provided. Consultant Teams may adjust and refine the models as needed to more accurately reflect local conditions. This should only be done in coordination with, and with approval from DEP. The resultant outputs, flood inundation extents and depths, can then be used to assess risk and vulnerability. More details on the flooding conditions are described below. A complete mapping methodology will be provided after Consultant Teams have been selected for each project.

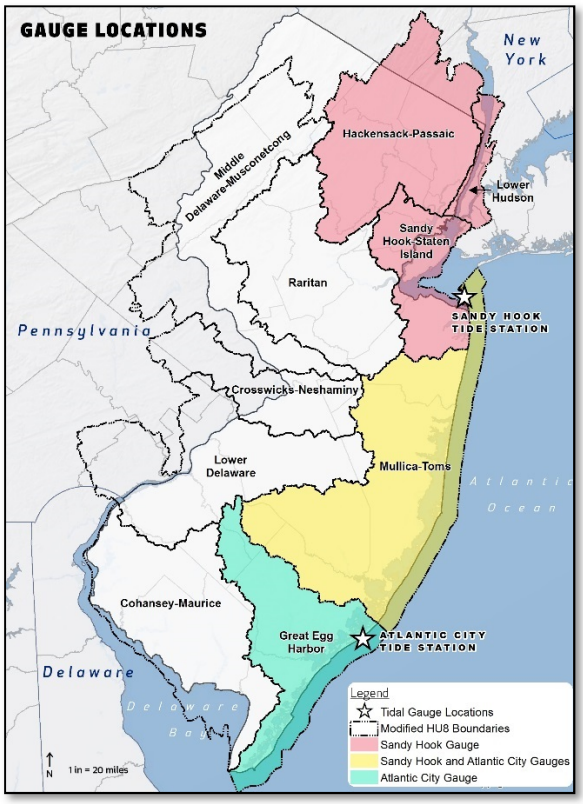
Flooding Condition Development

The development of the flooding conditions are based upon a combination of rainfall, storm surge, sea level rise (SLR), and tidal flooding. Rainfall considers an intense, short-duration event as well as a longer 24-hour event. Storm surge baselines use the Mean Higher High Water

(MHHW) elevations reported at the Sandy Hook tide gauge (for northern regions) and the Atlantic City tide gauge (for southern regions). (For regions within the Mullica-Toms watershed, models were produced using both tide gauges. Since communities in this watershed may find one tide gauge MHHW level more applicable to the region than the other, regions will choose what they view as the appropriate MHHW level to use, with approval from DEP.) An increase of 2.4 feet is used for the 2070 SLR projection, which is the central estimate for the high emissions scenario from 2019 Rutgers University's Science and Technical Advisory Panel's (STAP) report. Finally, a Sandy surge event equivalent, occurring in 2070, was also modeled.

See *Figure 1* for tide gauges and corresponding watershed applicability.

Figure 1 *Map of Divide Between Gauges Used for Mapping*



Using the storm event factors described above, as well as terrain data, soil information, and land use data, floodplains were developed using a two-dimensional (2-D) rain on grid model with HEC-RAS.

Final Flooding Conditions

Six (two current and four future) models displaying different potential flood conditions will be provided to each region. *Table 1* shows the different model inputs used for each of these conditions.

Table 1 Flooding Conditions Available for Risk Assessment

Flooding Condition	Type
Current	a. MHHW + 2% annual chance, 2-hour storm event
	b. MHHW + 1% annual chance, 24-hour storm event
Future	c. MHHW + SLR 2070 (2.4 ft)
	d. MHHW + SLR 2070 (2.4 ft) + (2% annual chance, 2-hour storm event + 10% increase in rainfall)
	e. MHHW + SLR 2070 (2.4 ft) + (1% annual chance, 24-hour storm event + 10% increase in rainfall)
	f. MHHW + SLR 2070 (2.4 ft) + Superstorm Sandy in 2070 (High Water Mark = 8.3 ft)

The two current flooding conditions are provided for insight into present flooding vulnerabilities and areas that may require immediate attention. The four future flooding conditions will be used to assess anticipated flood risk for each region to the year 2070. All flooding conditions should be used in detailing the risk and vulnerabilities within the region and how those risks may change over time. These six flooding conditions will be utilized while developing and evaluating the scenarios.

3. Assets

Within the Resilient NJ regions, there are assets that contribute to the region's identity and future vision. An important component of Resilient NJ will be identifying and recognizing these assets and their regional significance. Through information gathering during the planning context, outreach, and visioning efforts of Resilient NJ, assets important to the region and its future vision will be highlighted and prioritized.

What is an Asset?

Assets are features within a community that are valued. These can include facilities, populations, processes, services, functions, institutions, or networks that are essential to day-to-day life, rapid disaster recovery, and long-term resilience of communities. They are the places, people, events, processes, and things that define communities. Assets may or may not be a physical structure; however, all assets should be assigned a location for the purpose of the Risk Assessment. For the Resilient NJ program, Consultant Teams will work with the communities to identify these assets.

Asset Types

The Resilient NJ regions should consider assets not usually identified in standard risk assessments. Critical facilities may be included, but assets that are valued for cultural, natural, public health, social, economic, governmental services, infrastructure, or housing reasons should

be included as well. Assets can be owned, managed, or provided by local communities, other government entities, non-governmental or private entities.

Assets can relate to communities in both positive and negative ways. Positive assets (business districts, schools, social diversity, festivals, parks, etc.) are assets communities promote and preserve. Negative assets (traffic, prisons, superfund sites, empty retail space, degrading infrastructure, etc.) are assets communities try to fix and improve. Flooding can impact each type so it is important to consider and include both in this program.

Prioritizing Assets

Certain regions may identify hundreds to thousands of assets. In these situations, it is impractical to assess each one against the many flooding conditions for Resilient NJ. As a result, an asset prioritization process should be established and performed. Prioritization should consider frequency and location within each flooding condition first, followed by prioritization based upon community importance using an array of factors determined by the region. Prioritization results are best captured using a scalable ranking system that is either descriptive or numeric. This prioritization methodology will be determined by the Consultant Teams, in coordination with the Regional Team, and will not be determined by DEP.

Once assets are prioritized, the actual number that are included in the risk assessment will depend on the scope and budget of each region.

4. Risk Assessment

Overview

This methodology includes several approaches to assess the risk and vulnerability of the identified assets. Consultant Teams will conduct a Hazus analysis on all primary structures in the region. However, only prioritized assets shall be assessed using the non-Hazus methods, which are monetized, quantitative, and qualitative approaches. Consultant Teams may also use their own discretion when assessing assets with these methods. Not all methods need to be applied to each asset, as some asset losses may be difficult to monetize or quantify. All assets, however, should have a qualitative description of risk and vulnerability.

Teams should also consider unique regional characteristics when assessing risk and vulnerability. For example, there is a temporal nature to the population of Jersey Shore communities. Populations typically swell between Memorial Day and Labor Day while remaining lower outside of the summer season. Risk assessments should be performed accordingly, while also documenting assumptions.

Hazus Analysis

All primary structures in the region, regardless of whether they are considered priority assets or not, shall be assessed using Hazus 4.0 or greater. The purpose is to provide a broad understanding and estimation of structural risk in the region. Only an assessment of individual buildings is needed for this step – census block or tract analyses are not necessary. The results can be helpful in estimating losses avoided for physical structures as part of the scenario evaluation *(Task 4.2)*. Data requirements, methodology, and deliverables are described below.

Hazus Data Requirements

The following geospatial data will be required for the Hazus analysis.

- Tax Parcels with MOD IV Tax Data (2019 or newer)
- Building Footprint Points (Centroids)
- Depth Grids for each Flooding Condition

The tax parcels and MOD IV tax data can be obtained from the NJ Office of GIS. A complete building footprint dataset for each region will likely come from a combination of the following sources, depending on geographic coverage and extent of each region. Only primary structures shall be included. Accessory structures such as garages and sheds are not necessary.

- DEP Building Footprints – available for all FEMA 1% and 0.2% floodplain extents
- Local County or Community Building Footprints
- Microsoft Bing Building Footprints
- Tax Parcels

Tax parcels shall only be used as a last resort, if footprints are not available in any of the prior options. If tax parcels are to be used, a centroid of the parcel shall be created and then adjusted to match the location of the structure, using best available orthoimagery.

Hazus Data Preparation

Building footprint points and flooding condition depth grids are the two inputs Hazus needs to perform a loss analysis. Building footprint points shall be prepared as follows, while the flooding condition depth grids can be used as is, or with regional adjustments to local conditions, with DEP approval.

Building Footprint Point Preparation Steps:

1) Create a comprehensive building footprint point dataset from the sources described in the data requirements section. The point shall represent the centroid of the building.

2) Perform a join of the building footprint points with the Tax Parcels with MOD IV data and assign the following attributes to the points:
   - Construction Type (Wood, Steel, Concrete, etc.)
   - Construction Year
   - Foundation Type
   - Height
   - Number of Stories
   - Occupancy Type (Residential, Commercial, Agriculture, etc.)
     (Convert into Hazus codes: RES1, RES2, COM1, etc.)
   - Square Footage
   - Contents Value
   - Replacement Value of Structure:

$$\text{Replacement Value} = \frac{\text{Assessed Improvement Value (Structure)}}{\text{Total Assessed Value (Structure + Land)}} x \frac{\text{Property Taxes}}{\text{Effective Tax Rate (\%)}}$$

The above equation was developed based the following:

$$\text{General Tax Rate (\%)} = \frac{\text{Property Tax}}{\text{Assessed Value}}$$

$$\text{Effective Tax Rate (\%)} = \frac{\text{Property Tax}}{\text{Equalized Value (Market Value)}}$$

By utilizing the effective tax rate formula, an equalized market value for replacement of the structure can be determined.

Note that some of these attributes are required for Hazus to run. Population of these attributes should be made using readily available data, and assumptions or estimates made as needed and also documented. Extensive data development or field survey is not required. For multiple main buildings on a single parcel, use best judgement to assign values based upon the MOD IV data.

3) Assign a First Floor Elevation (FFE) to each building footprint point using the following order of precedence. Be sure to capture the source in a Source_FFE field as well.
   a. Elevation Certificate (if available)
   b. Ground Elevation at the point using the latest available elevation data plus 0.5 ft

Hazus Methodology

Consultant Teams shall use the User-Defined Facility (UDF) Analyses functionality in Hazus on the prepared building footprint point data for each flooding condition. This will analyze losses on a point-by-point basis, where each point is considered a UDF. Outputs will be estimated structural and content damages in dollars ($) and percentages (%).

Hazus Deliverables

Consultant Teams shall produce deliverables depicting outputs from the Hazus analysis in meaningful ways. This will include narratives, maps and tables that shall summarize and highlight the results, substantially damaged structures, critical facility losses, hot spots and clustering of high losses, and prioritized asset losses.

Non-Hazus Analyses (Monetized, Quantitative and Qualitative Methodologies)

To present a comprehensive understanding of risk and vulnerability to the Regional Teams, Consultant Teams should utilize monetized, quantitative, and qualitative methods as part of the Resilient NJ risk and vulnerability assessment. Given the variation across regions and potential asset prioritization, the Resilient NJ program is not being prescriptive on which methods to use. However, the Consultant Teams, in coordination with members of the Regional Team, should be able to populate the Asset Risk Profile as described in the Deliverables section of this methodology.

Non-Hazus findings should include relevant and valuable information that is captured during the planning processes of Resilient NJ. This can include, but is not limited to, monetized values, quantitative values, indexed values, or qualitative information or assessments. See *Table 2* for examples of Non-Hazus Analyses.

Table 2 Examples of Non-Hazus Analyses that can Inform the Risk Assessment

Non-Hazus Analyses	Examples
Monetized Values	• The cost to close an asset for the duration of the flooding event and associated lost revenue • Lost income due to workplace or transportation closures during and after a flood • Cleanup costs associated with a flooding event
Quantitative Values	• The number of identified assets located in the floodplain/impacted area • Number of people that would be unable to work if the asset were to temporarily or permanently close • Number of days a facility may have to remain closed • Percentage or portions of evacuation routes inundated or impacted
Qualitative Information	• A case study relevant to the specific type of asset describing importance to the community • Analysis of historical trends relevant to an asset and its vulnerability • Information provided during the outreach process on the asset

Non-Hazus findings will vary on an asset by asset basis and therefore should be analyzed and used on an asset by asset basis. Some specific examples of calculating non-Hazus analyses are outlined in *Table 3*.

Table 3 Examples of Specific Non-Hazus Asset Analyses

Loss Type	Analysis Method
Impacted Recreational Assets ($)	The facility closure resulting in lost revenue as well as cleanup and repair costs can be determined.
Impacted Ecosystem Services ($)	The economic value of ecosystem services could be assessed by leveraging the acreage of ecosystem types and a per acre value estimate for each.
Incurred Mental Health Treatment Costs ($)	A per person mental health treatment cost could be applied to the percent of population affected by the disaster.
Evacuation Route Vulnerability to Flooding	Evacuation routes could be assessed in relation to inundation areas and depths. Extent of flooding, as well as average, minimum and maximum depths for certain sections can be reported.
Community Assets in Inundation Areas	The number of identified assets within each flooding condition inundation area may be determined.
Increased Commuting Time	This could be calculated by estimating an assumed increase in travel time per person per direction for daily commutes.
Case Study on Evacuating Assisted Living Facilities in a Flood Event	Case studies on assets could be referenced for relevant research that can inform risk and vulnerability. In the example of an assisted living facility, the procedures used to evacuate residents could help inform evacuation plans, costs, zoning changes, etc.

5. Summary of Results

Results from the risk assessment shall be summarized at the individual level for prioritized assets as well as through a contextual risk assessment summary for the entire region. Each deliverable is described in more detail below.

Deliverables

The Asset Risk Profile is a summary page highlighting the risk assessment findings of each prioritized asset. The intent is to capture Hazus, monetized, quantitative, and qualitative findings in one location. The profile is especially important as a place to capture short narratives on prioritized assets explaining their importance to the community, their risk, implications of permanent loss, and other findings not easily communicated by numbers. The completed profile will allow for a comprehensive understanding of risk and vulnerability at the asset level. The profile format is shown below, with examples using a variety of assets included in ***Appendix A***.

Table 4 Blank Asset Profile

Asset Assessment	
Asset Description	
Asset Name	
Asset Type	
Asset Location	
Why Asset is Important	
Community Value (1-3) (1, Highest, 3 Lower) Include a 1-3 sentence justification on why this value was assigned	
What are the Implications of Permanent Asset Loss to the Community / Region?	
Previous Flooding Event Details	
Flood Event 1:	
Has the Asset Been Damaged During a Recent Flood Event?	
What type of flooding occurred? (nuisance, urban drainage, coastal, riverine, etc)	
Date of Flood Event	
High Water Mark (w/Vertical Datum)	
Depth of Water	
Monetized Loss Associated with the Flood Event	
Description of Loss	
Hazus Estimated Loss (If applicable)	
Current Flood Condition 1	
Current Flood Condition 2	
Future Flood Condition 1	
Future Flood Condition 2	
Future Flood Condition 3	
Future Flood Condition 4	
Non-Hazus Findings	
Finding 1	
Finding 2	

The Asset Risk Profile Database is a Hazus-formatted geospatial database that compiles the risk profile data of each prioritized asset. The database will not be able to capture the longer narrative descriptions located in the profile, but should capture numeric information and shorter text entries. It is a complimentary deliverable to the full profiles, designed for summarizing and querying at the regional level. The database should include the fields and associated data used

for the Hazus analysis (if applicable), as well as numeric and short text entries from the profiles. A template of the database format is shown below. Note that additional fields should be added to capture more than one flooding event, Hazus losses, etc.

Table 5 Asset Risk Profile Database Template

Asset Name	Hazus Fields	Asset Type (String)	Asset Location (String)	Comm Value (Short Integer)	Recent Flood Event 1 (String)	Recent Flood Event 1 Date (String)	High Water Mark (String)	Vertical Datum (String)	Depth of Water (Long Integer)	Monetized Loss (Long Integer)	Hazus FC1 (Double)	Hazus FC2 (Double)	X Coor (Long Integer)	Y Coor (Long Integer)

The Risk Assessment Report is a narrative from the region explaining the risk and vulnerability processes used, assumptions, results, findings, conclusions, and next steps. It is expected that this summary be at least a few pages to adequately describe the effort. This may also include information gathered during the planning context step, as well as during community engagement, in order to tell a complete story of what is at risk in the region. It is anticipated that the findings described in this summary will then be an important part of the scenario development.