4.2 METHODOLOGY AND TOOLS

Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from identified hazards. It allows emergency management personnel to establish early response priorities by identifying potential hazards and vulnerable assets. The process focuses on the following elements:

- **Hazard identification**—Use all available information to determine what types of hazards may affect a jurisdiction, how often they can occur, and their potential severity.
- **Exposure identification**—Estimate the total number of people and properties in the jurisdiction that are likely to experience a hazard event if it occurs.
- **Vulnerability identification and loss estimation**—Assess the impact of hazard events on the people, property, environment, economy, and lands of the region, including estimates of the cost of potential damage or cost that can be avoided by mitigation.

The risk assessment for this hazard mitigation plan update evaluates the risk of natural hazards prevalent in the planning area and meets federal requirements for hazard mitigation planning (44 CFR, Section 201.6(c)(2)). The following describes the methodology and tools used to conduct the risk assessment for the Burlington County Hazard Mitigation Plan 2024 update.

4.2.1 Risk Assessment Tools

Mapping

National, state, and county databases were reviewed to locate available spatially based data relevant to this planning effort. Maps were produced using geographic information system (GIS) software to show the spatial extent and location of hazards when such datasets were available. These maps are included in the hazard profile chapters of this document.

Hazus

FEMA's Hazus model is a GIS-based software program used to support risk assessments, mitigation planning, and emergency planning and response. It provides a wide range of inventory data, such as demographics, building stock, critical facility, transportation and utility lifeline, and multiple models to estimate potential losses from earthquakes, floods, and hurricanes. The program maps and displays hazard data and the results of damage and economic loss estimates for buildings and infrastructure. Its advantages include the following:

- Provides a consistent methodology for assessing risk across geographic and political entities.
- Provides a way to save data so that it can readily be updated as population, inventory, and other factors change and as mitigation planning efforts evolve.

- Facilitates review of mitigation plans because it helps to ensure that FEMA methodologies are incorporated.
- Supports grant applications by calculating benefits using FEMA definitions and terminology.
- Produces hazard data and loss estimates that can be used in communication with local stakeholders.
- Is administered by the local government and can be used to manage and update a hazard mitigation plan throughout its implementation.

Hazus provides default data for inventory, vulnerability, and hazards; the default data can be supplemented with local data to provide a more refined analysis. The model can carry out three levels of analysis, depending on the format and level of detail of information about the planning area:

- Level 1—All of the information needed to produce an estimate of losses is included in the software's default data. This data is derived from national databases and describes in general terms the characteristic parameters of the planning area.
- Level 2—More accurate estimates of losses require more detailed information about the planning area. To produce Level 2 estimates of losses, detailed information is required about local geology, hydrology, hydraulics, and building inventory, as well as data about utilities and critical facilities. This information is needed in a GIS format.
- Level 3—This level of analysis generates the most accurate estimate of losses. It requires detailed engineering and geotechnical information to customize it for the planning area.

4.2.2 Risk Assessment Approach

The risk assessments in this plan describe the risks associated with each identified hazard of concern. The following steps were used to define the risk of each hazard:

- **Identify and profile each hazard**—The following information is given for each hazard:
  - Geographic areas most affected by the hazard
  - Event frequency estimates
  - Severity estimates
- **Determine exposure to each hazard**—Exposure was assessed by overlaying hazard maps with an inventory of structures, facilities, and systems to decide which of them would be exposed to each hazard.
- **Assess the vulnerability of exposed facilities**—Vulnerability of exposed structures and infrastructure was evaluated by interpreting the probability of occurrence of each event and assessing structures, facilities, and systems that are exposed to each hazard. Tools such as GIS and FEMA's hazard-modeling program Hazus were used for this assessment for the earthquake, flood, and hurricane analyses. Outputs similar to those from Hazus were generated for other hazards, using data generated through GIS.

Dam Failure

Burlington County has 10 high hazard dams. Dam failure inundation maps and downstream hazard areas are considered sensitive information and were not available for review in the Burlington County Hazard Mitigation Plan. To assess the County's risk to dam failure, a qualitative review was implemented.

Disease Outbreak

All of Burlington County is exposed to disease outbreak events. A qualitative assessment was conducted. Research from the Centers for Disease Control and Prevention (CDC), World Health Organization (WHO), and the New Jersey Department of Health (NJDOH) was utilized to qualitatively assess the identified infectious diseases.

Drought

To assess the vulnerability of Burlington County to drought and its associated impacts, a qualitative assessment was conducted. The U.S. Department of Agriculture (USDA) Census of Agriculture 2017 was used to estimate economic impacts. Information regarding the number of farms and farmland area was extracted from the report and summarized in the vulnerability assessment. Additional resources from New Jersey's 2019 State Hazard Mitigation Plan and FEMA's National Risk Index were used to assess the potential impacts on the population from a drought event.

Earthquake

Probabilistic assessment was conducted for Burlington County for the 500-year and 2,500-year mean return periods (MRPs) through a Level 2 analysis in Hazus (v6.0) to analyze the earthquake hazard and provide a range of loss estimates. The probabilistic method uses information from historical earthquakes and inferred faults, locations, and magnitudes, and computes the ground shaking levels that may be experienced during an event of a given recurrence period by census tract.

As noted in the Hazus Earthquake User Manual, "Although the software offers users the opportunity to prepare comprehensive loss estimates, it should be recognized that uncertainties are inherent in any estimation methodology, even with state-of-the-art techniques. Any region or city studied will have an enormous variety of buildings and facilities of different sizes, shapes, and structural systems that have been constructed over a range of years under diverse seismic design codes. There are a variety of components that contribute to transportation and utility system damage estimations. These components can have differing seismic resistance" (FEMA 2020). However, Hazus' potential loss estimates are acceptable for the purposes of this HMP.

Ground shaking is the primary cause of earthquake damage to man-made structures, and soft soils amplify ground shaking. One contributor to the site amplification is the velocity at which the rock or soil transmits shear waves (S-waves). The National Earthquake Hazard Reductions Program (NEHRP) has developed five soil classifications defined by their shear-wave velocity, which impacts the severity of an earthquake. The soil classification system ranges from A to E, where A represents hard rock that reduces

ground motions from an earthquake and E represents soft soils that amplify and magnify ground shaking and increase building damage and losses. Class D and E NEHRP soils are the two classes most susceptible to amplified ground motion during an earthquake.

The default assumption is a magnitude 7.0 earthquake for all return periods. Although damage is estimated at the census tract level, results are presented at the municipal level.

Damage estimates are calculated for losses to buildings (structural and non-structural) and contents; structural losses include load carrying components of the structure, and non-structural losses include those to architectural, mechanical, and electrical components of the structure, such as nonbearing walls, veneer and finishes, HVAC systems, boilers, etc.

Extreme Temperature

All of Burlington County is exposed to extreme temperature events. A qualitative assessment was conducted for the extreme temperature hazard. Information from the National Weather Service (NWS), the CDC, stakeholder plans/reports, the 2019 New Jersey Hazard Mitigation Plan, USDA, the FEMA National Risk Index, and the Planning Partnership were used to assess potential impacts on the County's assets.

Flood

The 1-percent and 0.2-percent annual chance flood events were examined to evaluate the County's risk from the flood hazard. These flood events are generally those considered by planners and evaluated under federal programs such as NFIP. The following data was used to evaluate exposure and determine potential future losses for this plan update:

- Burlington County effective FEMA Digital Flood Insurance Rate Map (DFIRM) dated August 28, 2019
- A depth grid developed using data from USGS's 1-meter-resolution Digital Elevation Model from 2021.

To estimate exposure to the 1-percent and 0.2-percent annual chance flood events, the effective DFIRM flood boundaries were overlaid on the centroids of updated assets (population, building stock, and critical facilities) Centroids that intersected the flood boundaries were totaled to estimate the building replacement cost value and population vulnerable to the flood inundation areas. A Level 2 Hazus riverine flood analysis was performed in Hazus (v6.0). The critical facility and building inventories were formatted to be compatible with Hazus and its Comprehensive Data Management System. Once updated with the inventories, the Hazus riverine and coastal flood models were run to estimate potential losses in Burlington County for the 1-percent annual chance flood event. A user-defined analysis was also performed for the building stock. Buildings located within the floodplain were imported as user-defined facilities to estimate potential losses to the building stock at the structural level. Hazus calculated the estimated potential losses to the population (default 2020 U.S. Census data across dasymetric blocks),

potential damage to the general building stock, and potential damage to critical facility inventories based on the depth grid generated and the default Hazus damage functions in the flood model.

Sea-level rise 1-foot and 3-foot hazard data was sourced from NOAA. For this risk assessment, the sea level rise hazard area data was utilized to determine what assets are exposed. Population, general building stock, critical facility, and anticipated new development datasets were overlaid with the hazard area. Assets with their centroid in the hazard area were totaled to estimate the risk associated with impacts from a sea level rise hazard event, in regard to building replacement cost value (RCV) and vulnerable populations.

Severe Weather

All of Burlington County is exposed to severe weather. A qualitative analysis was conducted for this hazard and information from the New Jersey 2019 Hazard Mitigation Plan, NWS, NOAA, the FEMA National Risk Index, and the Planning Partnership were used to develop the hazard profile and to determine risk and exposure.

Hurricane Winds

A Hazus probabilistic analysis was performed to analyze the wind hazard losses for Burlington County for the 100- and 500-year MRP events. The probabilistic Hazus hurricane model activates a database of thousands of potential storms that have tracks and intensities reflecting the full spectrum of Atlantic hurricanes observed since 1886 and identifies those with tracks associated with Burlington County. Hazus contains data on historical hurricane events and wind speeds. It also includes surface roughness and vegetation (tree coverage) maps for the area. Surface roughness and vegetation data support the modeling of wind force across various types of land surfaces.

Default demographic and updated building and critical facility inventories in Hazus were used for the analysis. Although damage is estimated at the census tract level, results were presented at the municipal level. Because there are multiple census tracts that contain more than one jurisdiction, a density analysis was used to extract the percentage of building structures that fall within each tract and jurisdiction. The percentage was multiplied against the results calculated for each tract and summed for each jurisdiction.

Storm Surge

Category 1, 2, and 3 hazard areas were assessed using the National Hurricane Center's SLOSH (Sea, Lake, and Overland Surges from Hurricanes) model to estimate exposure to storm surge. The SLOSH boundaries (sourced from NOAA) were overlaid on the centroids of updated assets (population, building stock, and critical facilities), as well as on the centroids of anticipated new development. Centroids that intersect the SLOSH boundaries were totaled to estimate the building RCV and populations vulnerable to the SLOSH Category 1, 2 and 3 hazard areas.

Severe Winter Weather

All of Burlington County is exposed and vulnerable to the severe winter weather hazard. In general, structural impacts include damage to roofs and building frames, rather than building contents. Current modeling tools are not available to estimate specific losses for this hazard. Information and data from the New Jersey 2019 Hazard Mitigation Plan, NWS, NOAA, the FEMA National Risk Index, and the Planning Partnership were used to develop the hazard profile and to determine risk and exposure.

Wildfire

Wildfire hazard data was obtained through the New Jersey Forest Fire Service (NJFFS 2012). For this risk assessment, Extreme, Very High, and High Fuel Risk hazard areas were combined and used as the "Wildfire Fuel Risk" hazard area. To determine what assets are exposed to wildfire, the inventory datasets (critical facilities, general building stock, population, and new development) were overlaid with the hazard area. Assets with their centroid located in the hazard area were totaled to estimate the totals and values at risk from a wildfire event.

4.2.3 Sources of Data Used in Hazus Modeling and Exposure Analysis

Burlington County assets were identified to assess potential exposure and loss associated with the hazards of concern. For the HMP update, Burlington County assessed exposure and vulnerability of the following types of assets: population, buildings, and critical facilities/infrastructure. Some assets may be more vulnerable because of their physical characteristics or socioeconomic uses. To protect individual privacy and the security of critical facilities, information on properties assessed is presented in aggregate, without details about specific individual private or public properties.

Building and Cost Data

A custom general building stock inventory was created for Burlington County. The general building stock development was created utilizing MOD4 Assessor and Parcel data provided by Burlington County (2023), in addition to MOD4 Assessor data sourced from NJOGIS (2023) and Microsoft Bing Maps footprints (2022). The building inventory attributes were updated using the MOD4 datasets from Burlington County and NJOGIS, and the parcel data from Burlington County. Attributes provided in the associated files were used to further define each structure, such as year built, number of stories, basement type, occupancy class, and square footage. The centroids of each building footprint were used to estimate a building location. Where there was no existent building footprint data, but there was evidence of a structure, which displayed an improvement value, parcel centroids were preserved to fill in the structure inventory gap and to estimate the building location.

Structural and content RCV was calculated for each building using the available assessor data, the building footprint, and RSMeans 2022 values. A regional location factor for Burlington County was applied based on the individual building stock's zip code location, as shown in Table 4.2-1.

Table 4.2-1. Zip-Code-Based RCV Regional Location Factors for Burlington County

Zip Code	RCV Regional Location Factor	
	Residential	Non-Residential
080xx	1.10	1.06
081xx	1.17	1.12
082xx	1.21	1.09
085xx	1.17	1.13
086xx	1.17	1.17

RCV is the current cost of returning a destroyed asset to its pre-damaged condition using present-day cost of labor and materials. Total RCV consists of both the structural cost to replace a building and the estimated value of building contents. The occupancy classes available in Hazus were condensed into the categories of residential, commercial, "all other" to facilitate analysis and presentation of results. Residential loss estimates cover both multi-family and single-family dwellings.

Critical Facilities and Lifelines

The 2024 HMP critical facility inventory, which includes essential facilities, utilities, government offices, transportation features and user-defined facilities, was updated by Burlington County. The update involved a review for accuracy, additions, or deletions of new/moved critical assets. It identified backup power for each asset (if known) and whether the critical facility is considered a lifeline in accordance with FEMA's definition. To protect individual privacy and the security of assets, information is presented in aggregate, without details about specific individual properties or facilities.

Population

Burlington County used the total population statistics from the 2020 Decennial Census and the 2017-2021 American Community Survey (ACS) 5-year estimates for vulnerable populations. Population data was used to estimate the exposure and potential impacts on the county's population in place of the 2020 U.S. Census block estimates. Statistics were extracted directly from the Census Bureau. Limitations of these analyses are recognized, and thus the results are used only to provide a general estimate for planning purposes.

Vulnerable populations in Burlington County included in the risk assessment are children, elderly, non-English speaking, disabled, and people living in low-income households.

FEMA's Hazus program was used to model estimated potential losses due to earthquake, flood, and wind hazards. Hazus contains 2020 U.S. Census data and was used to estimate sheltering and injuries as part of the hazard analysis.

Hazus Data Inputs

The following hazard datasets were used for the Hazus Level 2 analysis conducted for the risk assessment:

- **Earthquake**—A Hazus earthquake probabilistic analysis was performed to analyze the earthquake hazard losses for the 500- and 2500-year MRP events.
- **Flood**—The 2019 effective DFIRM for the County was used to delineate flood hazard areas and estimate potential losses from the FEMA 1-percent-annual chance flood event. Using the DFIRM floodplain boundaries and base flood (1-percent-annual chance flood) elevation information, and the USGS 1-meter digital elevation model data, flood depth grids were generated and integrated into the Hazus model.
- **Hurricane**—A Hazus probabilistic analysis was performed to analyze the wind hazard losses for the 100- and 500-year MRP events.

Other Local Hazard Data

Locally relevant information on hazards was gathered from a variety of sources. Frequency and severity indicators include past events and the expert opinions of geologists, emergency management specialists, and others.

No GIS format datasets appropriate for an exposure analysis were identified for the following hazards: dam failure, disease outbreak, drought, extreme temperatures, and severe winter weather.

Data Source Summary

Table 4.2-2 summarizes the data sources used for the risk assessment for this plan.

Table 4.2-2. Risk Assessment Data Source Summary

Data	Source	Date	Format
Population Data	U.S. Census Bureau; American Community Survey 5-Year Estimates; Stats America	2020; 2017-2021	Digital (.csv) Format
New Development	Burlington County Planning Partnership	2023	Digital (GIS) Format
Building Inventory	Burlington County; NJOGIS; Microsoft Bing	2023; 2023; 2022	Digital (GIS) Format
Critical Facilities and Lifelines	Burlington County; Burlington County Planning Partnership	2023	Digital (GIS) Format; Excel
Digitized Effective FIRM Data	FEMA	2019	Digital (GIS) Format
1-meter Digital Elevation Model	USGS	2021	Digital (GIS) Format
Sea Level Rise	NOAA	2022	Digital (GIS) Format
SLOSH	NOAA	2022	Digital (GIS) Format
Wildfire	NJFFS	2012	Digital (GIS) Format

Notes: NJOGIS = New Jersey Office of GIS; FEMA = Federal Emergency Management Agency; USGS = United States Geological Survey; NOAA = National Oceanic and Atmospheric Association; NJFFS = New Jersey Forestry Fire Service

4.2.4 Limitations

Loss estimates, exposure assessments, and hazard-specific vulnerability evaluations rely on the best available data and methodologies. Uncertainties are inherent in any loss estimation methodology and

arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from the following:

- Approximations and simplifications necessary to conduct a study
- Incomplete or outdated inventory, demographic, or economic parameter data
- The unique nature, geographic extent, and severity of each hazard
- Mitigation measures already employed
- The amount of advance notice residents have to prepare for a specific hazard event

These factors can affect loss estimates by a factor of two or more. Therefore, potential exposure and loss estimates are approximate and should be used only to understand relative risk. Over the long term, Burlington County will collect additional data to assist in estimating potential losses associated with other hazards.