SECTION 4. RISK ASSESSMENT

4.4 Hazard Ranking

2022 HMP Changes

- The hazard ranking section has been relocated to Section 4.4.
- The 2022 Update hazard ranking methodology was expanded to include adaptive capacity and climate change.
- The probability of occurrence category was adjusted to include the benchmark value 'unlikely', and modifications to the remaining categories so that 'frequent' aligned with an event that has an annual probability.
- The following hazards of concern's ranking changed at the County level from 2017 to 2022: Coastal Erosion and Sea Level Rise, and Severe Summer Weather.

A comprehensive range of hazards that pose a significant risk to Camden County were selected and considered during the development of this plan; see Section 4.1 (Identification of Hazards of Concern). However, each community has differing levels of exposure and vulnerability to each of these hazards. It is important for each community participating in this plan to recognize those hazards that pose the greatest risk to their community and direct their attention and resources accordingly to most effectively and efficiently manage risk and reduce losses. The hazard ranking for the county and each participating jurisdiction can be found in their jurisdictional annexes in Volume II, Section 9 of this plan.

To this end, a hazard risk ranking process was conducted for Camden County and its municipalities using the method described below. This method includes four risk assessment categories—probability of occurrence, impact (population, property and economy), adaptive capacity, and changing future conditions (i.e., climate change). Each was assigned a weighting factor to calculate an overall ranking value for each hazard of concern. Depending on the calculation, each hazard was assigned a high, medium, or low ranking. Details regarding each of these categories is described below.

4.4.1 Hazard Ranking Methodology

Estimates of hazard risk for the County were developed using methodologies promoted by FEMA's hazard mitigation planning guidance, generated by FEMA's Hazus risk assessment tool, and input from Camden County and participating jurisdictions.

As described in Section 4.2 (Methodology), three different levels of analysis were used to estimate potential impacts: 1) historic loss/qualitative analysis; 2) exposure analysis; and 3) loss estimation. All three levels of analysis are suitable for planning purposes; however, with any risk analysis, there

is underlying uncertainty resulting from assumptions used to describe and assess vulnerability and the methodologies available to model impacts. Impacts from any hazard event within the County will vary from the analysis presented here based on the factors described for each hazard of concern; namely location, extent, warning time, and mitigation measures in place at the time of an event.

The hazard ranking methodology for some hazards of concern is based on a scenario event, while others are based on the potential vulnerability to the County as a whole. In order to account for these differences, the quantitative hazard ranking methodology was adjusted using professional judgement and subject-matter input; assumptions are included, as appropriate, in the following subsections. The limitations of this analysis are recognized given the all scenarios do not have the same likelihood of occurrence; nonetheless, there is value in summarizing and comparing the hazards using a standardized approach to evaluate relative risk. The following categories were considered when evaluating the relative risk of the hazards of concern.

- **Probability of Occurrence** — The probability of occurrence of the scenario evaluated was estimated by examining the historic record and/or calculating the likelihood of annual occurrence. When no scenario was assessed, an examination of the historic record and judgement was used to estimate the probability of occurrence of an event that will impact the County.

- **Impact** — The following three hazard impact subcategories were considered: impact to people; impact to assets (buildings); and impact to the economy. The results of the updated risk assessment and/or professional judgement were used to assign the numeric values for these three impact subcategories. A factor was applied to each subcategory, giving impact on population the greatest weight.

    - Population — Numeric value x 3
    - Buildings — Numeric value x 2
    - Economy — Numeric value x 1

    - **Adaptive Capacity** — Adaptive capacity describes a jurisdiction's current ability to protect from or withstand a hazard event. This includes capabilities and capacity in the following areas: administrative, technical, planning/regulatory and financial. Mitigation measures already in place increases a jurisdiction's capacity to withstand and rebound from events (e.g. codes/ordinances with higher standards to withstand hazards due to design or location; deployable resources; or plans and procedures in place to respond to an event). In other words, assigning 'weak' for adaptive capacity means the jurisdiction does not have the capability to effectively respond, which increases vulnerability; whereas 'strong' adaptive capacity means the jurisdiction does have the capability to effectively respond,

which decreases vulnerability. These ratings were assigned using the results of the core capability assessment with subject-matter input from each jurisdiction.

- **Climate Change (Changing Future Conditions)** — Current climate change projections were considered as part of the hazard ranking to ensure the potential for an increase in severity/frequency of the hazard was included. This was important to Camden County to include because the hazard ranking helps guide and prioritize the mitigation strategy development, which should have a long-term future vision to mitigate the hazards of concern. The potential impacts climate change may have on each hazard of concern is discussed in Sections 4.4.1 through 4.13. The benchmark values in the methodology are similar to confidence levels outlined in the National Climate Assessment 2017.

Hazard Ranking Equation

[Probability of Occurrence x 0.40] + [(Impact on Population x 3) + (Impact on Property x 2) + (Impact on Economy x 1) x 0.40] + [Adaptive Capacity x 0.10] + [Climate Change x 0.10]

Table 4.4-1 summarizes the categories, benchmark values, and weights used to calculate the risk factor for each hazard. Using the weighting applied, the highest possible risk factor value is 9.0. The higher the number, the greater the relative risk. Based on the total for each hazard, a priority ranking is assigned to each hazard of concern (high, medium, or low). The rankings were categorized as follows: Low = Values less than or equal to 3.8; Medium = Values between 3.9 and 4.9; High = Values greater than or equal to 5.0.

Table 4.4-1. Summary of Hazard Ranking Approach

Category		Level / Category	Degree of Risk / Benchmark Value	Numeric Value	Weighted Value
Probability of Occurrence		Unlikely	A hazard event is not likely to occur or is unlikely to occur with less than a 1% annual chance probability.	0	40%
		Rare	Between 1 and 10% annual probability of a hazard event occurring.	1	
		Occasional	Between 10 and 100% annual probability of a hazard event occurring.	2	
		Frequent	100% annual probability; a hazard event may occur multiple times per year.	3	
Impact (Sum of all 3)	Population (Numeric Value x 3)	Low	14% or less of your population is exposed to a hazard with potential for measurable life safety impact, due to its extent and location.	1	40%
		Medium	15% to 29% of your population is exposed to a hazard with potential for measurable life safety impact, due to its extent and location.	2	
		High	30% or more of your population is exposed to a hazard with potential for measurable life safety impact, due to its extent and location.	3	
	Property (Numeric Value x 2)	Low	Property exposure is 14% or less of the total number of structures for your community.	1	
		Medium	Property exposure is 15% to 29% of the total number of structures for your community.	2	
		High	Property exposure is 30% or more of the total number of structures for your community.	3	
	Economy (Numeric Value x 1)	Low	Loss estimate is 9% or less of the total replacement cost for your community.	1	
		Medium	Loss estimate is 10% to 19% of the total replacement cost for your community.	2	
		High	Loss estimate is 20% or more of the total replacement cost for your community.	3	
Adaptive Capacity		Weak	Weak/outdated/inconsistent plans, policies, codes/ordinances in place; no redundancies; limited to no deployable resources; limited capabilities to respond; long recovery.	1	10%
		Moderate	Plans, policies, codes/ordinances in place and meet minimum requirements; mitigation strategies identified but not implemented on a widespread scale; county/jurisdiction can recover but needs outside resources; moderate county/Jurisdiction capabilities.	0	
		Strong	Plans, policies, codes/ordinances in place and exceed minimum requirements; mitigation/protective measures in place; county/jurisdiction has ability to recover quickly because resources are readily available, and capabilities are high.	-1	
Climate Change		Low	No local data is available; modeling projections are uncertain on whether there is increased future risk; confidence level is low (inconclusive evidence).	1	10%

Category	Level / Category	Degree of Risk / Benchmark Value	Numeric Value	Weighted Value
	Medium	Studies and modeling projections indicate a potential for exacerbated conditions due to climate change; confidence level is medium to high (suggestive to moderate evidence).	2	
	High	Studies and modeling projections indicate exacerbated conditions/increased future risk due to climate change; very high confidence level (strong evidence, well documented and acceptable methods).	3	

Note: A numerical value of zero is assigned if there is no impact.

**For the purposes of this exercise, "impacted" means exposed for population and property and estimated loss for economy. For non-natural hazards, although they may occur anywhere in the County, an event will not likely cause countywide impacts; therefore, impact to population was scored using an event-specific scenario.*

In an attempt to summarize the confidence level regarding the input utilized to populate the hazard ranking, a gradient of certainty was developed. A certainty factor of high, medium or low was selected and assigned to each hazard to provide a level of transparency and increased understanding of the data utilized to support the resulting ranking. The following scale was used to assign a certainty factor to each hazard:

- **High** — Defined scenario/event to evaluate; probability calculated; evidenced-based/quantitative assessment to estimate potential impacts through hazard modeling.
- **Moderate** — Defined scenario/event or only a hazard area to evaluate; estimated probability; combination of quantitative (exposure analysis, no hazard modeling) and qualitative data to estimate potential impacts.
- **Low** — Scenario or hazard area is undefined; there is a degree of uncertainty regarding event probability; majority of potential impacts are qualitative.

Table 4.4-2 summarizes the hazard scenario or hazard area evaluated; highlights key impacts to population, buildings/critical assets and the economy; and lists the associated certainty factor assigned for each hazard to convey the level of confidence in the data used. This table is not intended to be a complete and comprehensive list of all hazard impacts determined in the risk assessment and considered for the hazard ranking exercise. Refer to Sections 4.3.1 to 4.3.13 for a complete summary of all estimated impacts for each hazard.

Table 4.4-2. Overview of the Hazard Scenario and Associated Estimated Impacts Considered in the Hazard Ranking

Hazard of Concern	Hazard/ Scenario Area Evaluated	Population		Buildings		Economy		Certainty Factor
Coastal Storm and Sea Level Rise*	100-Year Mean Return Period Event (Tropical Storm Wind Speeds)	100-Year Mean Return Period Event	30	100-year MRP Event Building Loss (Wind Impacts Only)	82	100-year MRP Event Building Loss (Wind Impacts Only)	$798,277,618	High
Dam and Levee Failure	Partial or complete failure of a dam. There are 77 dams in the County; 1 is high hazard according to NJDEP.	Population impacted is dependent on the location and capacity of the dam, the extent of the dam failure inundation area and the severity of the failure.		The number of buildings impacted is dependent on the capacity of the dam, the extent of the dam failure inundation area and the severity of the failure.		Economic impacts include dam/building/infrastructure repairs; debris removal/disposal; utility impacts.		Low
Disease Outbreak	Disease Outbreaks which include: Diseases related to mosquitos, Diseases related to ticks, Influenza Groupings, COVID-19	Population impacted is dependent on the disease and severity of the outbreak; in some cases, immuno-compromised persons are more vulnerable.		Structural impacts due to disease outbreak would be limited.		Economic losses can include County financial impacts to monitor/address outbreaks; lost wages or commercial interruptions; depends on the severity and type of disease outbreak.		Low
Drought	Prolonged drought event - The County is serviced by water supplies who primarily get water from surface water, reservoirs and unconfined groundwater sources.	Entire population exposed. Population on surface water supplies may be impacted first; water restrictions/contamination; increased wildfire risk.		Droughts are not expected to cause direct damage to buildings.		Losses include aesthetic, landscape/nursery/agricultural industry impacts		Low
Earthquake*	100, 500-, 2,500-Year Mean Return Period (MRP) Events evaluated NJDOT Seismic Soils D&E (soft soils that amplify ground shaking are present in the County)	NJDOT Seismic Soils D&E	373,074	NJDOT Seismic Soils D&E	139,897	100-year MRP building damages/loss	$0	High
						500-year MRP building damages/loss	$184,220,761	

Hazard of Concern	Hazard/ Scenario Area Evaluated	Population		Buildings		Economy		Certainty Factor
Extreme Temperature	Extreme temperature event (heat or cold)	Over 65 Population	77,791	Structural impacts due to extreme temperatures would be limited.		Loss of business function is possible due to unexpected repairs (i.e. pipes bursting) or power failures; increased operational costs due to increased use of generators and HVAC; thermal expansion and other impacts to infrastructure.		Low
		Under 5 Population	30,972					
		Population Below Poverty Level	61,187					
Flood*	100- and 500-Year MRP events	1% annual chance (100-year)	8,030	1% annual chance (100-year)	3,557	1% annual chance (100-year)	$6,227,700,086	High
		0.2% annual chance (500-year)	21,884	0.2% annual chance (500-year)	8,528	0.2% annual chance (500-year)	$15,994,592,644	
Flood – Storm Surge	Category 1, 2, 3, and 4 SLOSH	Category 1	166	Category 1	120	Category 1	$658,302,223	High
		Category 2	14,977	Category 2	5,634	Category 2	$14,105,517,732	
		Category 3	41,258	Category 3	15,016	Category 3	$32,310,182,122	
		Category 4	73,636	Category 4	26,726	Category 4	$58,849,654,222	
Geological	High Landslide Susceptibility Areas and Areas developed over carbonate rock	Steep Slope	9,859	Steep Slope	3,664	Steep Slope	$6,674,645,389	Moderate
		Carbonate Bedrock	30,826	Carbonate Bedrock	11,688	Carbonate Bedrock	$12,020,507,041	
High Wind*	100-Year and 500-MRP events	Entire population exposed; the degree of impact to the population depends on the scale of the incident and warning time.		Entire building stock is exposed; the degree of impact depends on the scale of the incident.		100-Year MRP Estimated Damages	$102,063,755	High
						500-Year MRP Estimated Damages	$476,228,577	
Invasive Species and Harmful Algal Bloom	Infestation and Invasive Species including insects and harmful algal bloom	Population impacted will depend on the type and severity of infestation and may cause an increased risk for disease outbreak.		Physical impacts will be limited to indirect impacts from invasive species which affect crops and vegetation.		Economic impact will depend on the type and severity of infestation.		Low
Severe Summer Weather	Severe Weather Event	Entire population exposed; the degree of impact to the population depends on the scale of the incident.		Entire building stock is exposed; The degree of impact depends on the scale of the incident.		Economic impacts depend upon the degree of impact.		Low
Severe Winter Weather	Severe Winter Weather Event	All residents/commuters/visitors are exposed; socially-vulnerable populations may be at increased risk		All buildings are exposed; the degree of impact depends on the scale of the incident.		The cost of snow and ice removal and repair of roads/infrastructure can impact operating budgets.		Low

Hazard of Concern	Hazard/ Scenario Area Evaluated	Population		Buildings		Economy		Certainty Factor
Wildfire	Wildfire Fuel Hazard areas (High, Very High, Extreme)	Population residing in the hazard area	5,322	Number of buildings the hazard area	2,287	Replacement cost value of buildings located in the hazard area	$7,028,841,541	Moderate

Notes:
a Estimated loss in replacement cost values as available from HAZUS-MH.
b The impacts and vulnerability from a hazardous materials event are greatly dependent on the material and its physical and chemical properties, the quantity released, weather conditions, micro-meteorological effects of buildings and terrain, maintenance/mechanical failures, and distance and related response time for emergency response teams.
** HAZUS-MH estimated potential losses based on probabilistic models*
Exposed = This refers to the number of assets located in the hazard area; all of which may not incur losses as a result of the event.
SFHA = Special flood hazard area (1-percent annual chance flood event)
RCV = Replacement cost value based on 2019 RSMeans

Table 4.4-3 summarizes the projected changes in hazard event occurrences in terms of location, extent or intensity and frequency and/or duration. In addition, it lists the associated value assigned to each hazard in the risk factor calculation (i.e., confidence in changing future conditions). Refer to Sections 4.2 to 4.13 for a more detailed discussion of all factors of change discussed for each hazard of concern.

Table 4.4-3. Overview of Projected Future Changes for each Hazard of Concern

Hazard	Projected Change			Confidence in Changing Future Conditions *
	Location	Extent/ Intensity	Frequency/ Duration	
Coastal Erosion and Sea Level Rise	↑	↑	↑	Highly Likely
Dam Failure	↑	↑	↑	Likely
Disease Outbreak	–	–	↑	Likely
Drought	↑	↑	↑	Likely
Earthquake	–	–	–	Uncertain
Extreme Temperature	↑	↑	↑	Highly Likely
Flood	↑	↑	↑	Highly Likely
Geological Hazards	–	–	–	Uncertain
High Winds	↑	↑	↑	Likely
Invasive Species and Harmful Algal Bloom	↑	↑	↑	Likely
Severe Summer Weather	↑	↑	↑	Highly Likely
Severe Winter Weather	–	↓	↓	Likely
Wildfire	↑	↑	↑	Likely

Notes:
Arrow direction indicates a projected increase or decrease based on literature review as described in Sections 4.3.1 through 4.3.13

– *Straight line indicates uncertain and/or no change known at this time*

* *Similar to confidence levels outlined in the National Climate Assessment 2017*

Highly Likely = Studies and modeling projections indicate exacerbated conditions/increased future risk due to climate change; very high confidence level (strong evidence, well documented and acceptable methods).
Likely = Studies and modeling projections indicate a potential for exacerbated conditions due to climate change; confidence level is medium to high (suggestive to moderate evidence).
Uncertain = No local data is available; modeling projects are uncertain on whether there is increased future risk; confidence level is low (inconclusive evidence).
No Change = Studies and modeling projections indicate there is no evidence at this time to indicate conditions may change in the future.

4.4.2 Hazard Ranking Results

Using the process described above, the risk ranking for the identified hazards of concern was determined for Camden County (refer to Table 4.4-4). The hazard ranking is detailed in the subsequent tables that present the step-wise process for the ranking. The countywide risk ranking includes the entire planning area and may not reflect the highest risk indicated for any of the participating jurisdictions. The resulting ranks of each municipality indicate the differing degrees of risk exposure and vulnerability. The results support the appropriate selection and prioritization of initiatives to reduce the highest levels of risk for each municipality. Both the county and the participating jurisdictions have applied the same methodology to develop the countywide risk and local rankings to ensure consistency in the overall ranking of risk; jurisdictions had the ability to alter rankings based on local knowledge and experience in handling each hazard.

This hazard ranking exercise serves four purposes: 1) to describe the probability of occurrence for each hazard; 2) to describe the impact each would have on the people, property, and economy; 3) to evaluate the capabilities a community has with regards to the hazards of concern; and 4) to consider changing future conditions (i.e., climate change) in Camden County.

Table 4.4-4. Ranking for Hazards of Concern for Camden County

Hazard of Concern	Probability		Impact										Adaptive Capacity	Climate Change
			Population			Property			Economy					
	Category	Numeric Value	Impact	Numeric Value	Weighted Value (x3)	Impact	Numeric Value	Weighted Value (x2)	Impact	Numeric Value	Weighted Value (x1)	Total Impact Value)		
Coastal Erosion and Sea Level Rise	Frequent	3	L	1	3	L	1	2	M	2	2	7	2	3
Dam Failure	Rare	1	M	2	6	L	1	2	L	1	1	9	2	3
Disease Outbreak	Frequent	3	H	3	9	L	1	2	L	1	1	11	2	2
Drought	Frequent	3	L	1	3	L	1	2	L	1	1	6	2	3
Earthquake	Rare	1	L	1	3	L	1	2	L	1	1	6	2	1
Extreme Temperature	Frequent	3	L	1	3	L	1	2	L	1	1	6	2	3
Flood	Frequent	3	M	2	6	L	1	2	L	1	1	9	2	3
Geological Hazards	Rare	1	L	1	3	L	1	2	L	1	1	6	2	2
High Wind	Frequent	3	M	2	6	M	2	4	M	2	2	12	2	3
Infestation and Invasive Species	Frequent	3	L	1	3	L	1	2	H	3	3	6	2	3
Severe Summer Weather	Occasional	2	M	2	6	L	1	2	L	1	1	9	2	3
Severe Winter Weather	Frequent	3	M	2	6	L	1	2	M	2	2	10	3	2
Wildfire	Occasional	2	L	1	3	L	1	2	M	2	2	7	2	2

**Historical record is not long to support this evaluation and input is based on Steering Committee judgement*

H = High; L = Low; M = Medium

Table 4.4-5 presents the total calculations for each hazard ranking value for the hazards of concern.

Table 4.4-5. Total Hazard Ranking Values for the Hazards of Concern for Camden County

Hazard of Concern	Probability x 40%	Total Impact x 40%	Adaptive Capacity x 10%	Changing Future Conditions x 10%	Total Hazard Ranking Value
Coastal Erosion and Sea Level Rise	1.2	2.8	0.2	0.3	**4.5**
Dam Failure	0.4	3.6	0.2	0.3	**4.5**
Disease Outbreak	1.2	2.4	0.2	0.2	**4.0***
Drought	1.2	2.4	0.2	0.3	**4.0**
Earthquake	0.4	2.4	0.2	0.1	**3.1**
Extreme Temperature	1.2	2.4	0.2	0.3	**4.1**
Flood	1.2	3.6	0.2	0.3	**5.3**
Geological Hazards	0.4	2.4	0.2	0.2	**3.2**
High Winds	1.2	4.8	0.2	0.3	**6.5**
Invasive Species and Harmful Algal Bloom	1.2	2.4	0.2	0.3	**4.1**
Severe Summer Weather	0.8	3.6	0.2	0.3	**4.9**
Severe Winter Weather	1.2	4	0.3	0.2	**5.7**
Wildfire	0.8	2.8	0.2	0.2	**4.0**

Low = Values less than or equal to 3.8; Medium = Values between 3.9 and 4.9; High = Values greater than or equal 5.0.
**Reduced to medium based on County input*

These rankings have been used as one of the bases for identifying the jurisdictional hazard mitigation strategies included in Section 9 (Jurisdictional Annexes) of this plan. The summary rankings for the County reflect the results of the vulnerability analysis for each hazard of concern and vary from the specific results of each jurisdiction. For example, the high wind hazard may be ranked low in one jurisdiction, but due to the exposure and impact countywide, it is ranked as a high hazard and is addressed in the County's mitigation strategy accordingly. Jurisdictional ranking results are presented in each local annex in Section 9 (Jurisdictional Annexes) of this plan.