



4.4 HAZARD RANKING

2022 HMP Changes

- The hazard ranking section has been relocated to Section 4.4.
- The 2022 HMP 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.

A comprehensive range of hazards that pose a significant risk to Gloucester 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 (Jurisdictional Annexes) of this plan.

To this end, a hazard risk ranking process was conducted for Gloucester 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 Gloucester County and participating jurisdictions.

As described in Section 4.2 (Methodology and Tools), 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 their potential risk 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 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 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 Gloucester 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 4.3.1 through 4.3.16. The benchmark values in the methodology are similar to confidence levels outlined in the National Climate Assessment 2017.



Hazard Ranking Equation

$$[\text{Probability of Occurrence} \times 0.3] + [(\text{Impact on Population} \times 3) + (\text{Impact on Property} \times 2) + (\text{Impact on Economy} \times 1) \times 0.3] + [\text{Adaptive Capacity} \times 0.3] + [\text{Climate Change} \times 0.1]$$

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 6.9. 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 3.9; Medium = Values between 3.9 and 4.9; High = Values greater than 4.9.

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	30%
		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	30%
		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	30%	
	Moderate	Plans, policies, codes/ordinances in place and meet minimum requirements; mitigation strategies	0		



Category	Level / Category	Degree of Risk / Benchmark Value	Numeric Value	Weighted Value
		identified but not implemented on a widespread scale; county/jurisdiction can recover but needs outside resources; moderate county/Jurisdiction capabilities.		
	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%
	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 4.3.16 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 ^a		Certainty Factor
		Coastal Erosion Hazard Area:	21	Coastal Erosion Hazard Area:	13	Coastal Erosion Hazard Area:	\$6,441,846	
Coastal Erosion	Exposure to the Coastal Erosion Hazard Area	Coastal Erosion Hazard Area:	21	Coastal Erosion Hazard Area:	13	Coastal Erosion Hazard Area:	\$6,441,846	Low
Dam/ Levee Failure	Partial or complete failure of a dam. There are 39 dams in the County; 3 are high hazard according to USACE.	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.		Medium
Disease Outbreak	Disease outbreaks include: West Nile Virus, Eastern Equine Encephalitis virus, St. Louis Encephalitis, Lyme disease, Influenza, Ebola virus, and Coronavirus.	Population impacted is dependent on the disease and severity of the outbreak; in some cases, immunocompromised 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.		Moderate
Drought	Prolonged drought event - the County is serviced by private wells or water suppliers 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		Moderate
Earthquake*	100 and 500-Year MRP events NJDOT Seismic Soils D	NJDOT Seismic Soils:	107,065	NJDOT Seismic Soils:	43,255	NJDOT Seismic Soils:	\$38,793,573,609	Low



Hazard of Concern	Hazard/ Scenario Area Evaluated	Population		Buildings		Economy ^a		Certainty Factor
Extreme Temperature	Extreme hot and cold events	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.		Business and commercial losses due to long-term utility outages; repairs to power and utility lines.		Moderate
Flood*	100-MRP event	1% annual chance (100-year)	4,305	1% annual chance (100-year)	2,106	1% annual chance (100-year)	\$2,772,477,118	Moderate
Geological Hazards	Steep slope areas and areas developed over carbonate rock and abandoned mines with increased vulnerability to subsidence.	Steep Slope:	6,619	Steep Slope:	2,426	Steep Slope	\$1,947,263,039	Low
		Carbonate Bedrock:	32,985	Carbonate Bedrock:	12,425	Carbonate Bedrock:	\$9,927,012,456	
Hazardous Materials^b	Release of a hazardous substance from a fixed site or in-transit.	Within 1 mile of HazMat Roadway Routes:	256,407	Within 1 mile of HazMat Roadway Routes:	99,806	Within 1 mile of HazMat Roadway Routes:	\$90,545,087,029	High
		Within 1 mile of HazMat Facility:	162,795	Within 1 mile of HazMat Facility:	64,484	Within 1 mile of HazMat Facility:	\$61,575,683,078	
Hurricane and Tropical Storm	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	\$69,703,663	Moderate
						500-Year MRP Estimated Damages	\$304,905,184	
Infestation and Invasive Species	Infestation and Invasive Species including insects, white-tailed deer and Canada geese, harmful algal bloom	Population impacted will depend on the type and severity of infestation and may cause an increased risk for disease outbreak or car strikes.		Physical impacts will be limited to indirect impacts from invasive species which affect crops, vegetation and trees. Compromised/falling trees may put buildings, infrastructure and public safety at risk.		Economic impact will depend on the type and severity of infestation and harmful algal bloom (i.e., recreation).		Moderate
Nor'Easter	100-Year and 500-Year Mean Return Period Events	Entire population exposed; the degree of impact to the population		Entire building stock is exposed; The degree of		100-Year MRP Estimated Damages	\$69,703,663	Moderate



Hazard of Concern	Hazard/ Scenario Area Evaluated	Population		Buildings		Economy ^a		Certainty Factor
						500-Year MRP Estimated Damages	\$304,905,184	
Severe Weather*	Tornado, Thunderstorm, Lightning, Hail, Strong Wind	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.		High
Severe Winter Weather	Blizzard, Snow, Ice	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 and condition of structures.		The cost of snow and ice removal and repair of roads/infrastructure can impact operating budgets.		Moderate
Wildfire	Wildfire Fuel Hazard areas (High, Very High, Extreme)	Population residing in the hazard area:	3,786	Number of buildings the hazard area:	1,424	Replacement cost value of buildings located in the hazard area:	\$1,205,629,442	Moderate
Utility Failure	Utility Outages from Hazard Events	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.		Business and commercial losses due to long-term utility outages; repairs to power and utility lines.		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 estimated potential losses based on probabilistic models for the wind hazard; refer to Hurricane.

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.

MRP = Mean Return Period

SFHA = Special flood hazard area (1-percent annual chance flood event)

RCV = Replacement cost value based on 2021 RSMMeans



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 4.3.1 to 4.3.16 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 ^a
	Location	Extent/ Intensity	Frequency/ Duration	
Coastal Erosion	-	-	-	Likely
Dam/ Levee Failure	-	-	-	Uncertain
Disease Outbreak	↑	↑	-	Likely
Drought	-	↑	↑	Likely
Earthquake	-	-	-	Likely
Extreme Temperature	-	↑	↑	Likely
Flood	↑	↑	↑	Highly Likely
Geological Hazards	-	-	-	Uncertain
Hazardous Materials	-	-	-	Uncertain
Hurricane and Tropical Storm	↑	↑	↑	Highly Likely
Infestation and Invasive Species	-	↑	↑	Likely
Nor'Easter	↑	↑	↑	Likely
Severe Weather	↑	↑	↑	Highly Likely
Severe Winter Weather	↑	↑	↑	Highly Likely
Wildfire	-	↑	↑	Likely
Utility Failure	↑	↑	↑	Likely

Notes:

Arrow direction indicates a projected increase or decrease based on literature review as described in Sections 4.3.1 through 4.3.16

— Straight line indicates uncertain and/or no change known at this time.

^a Similar to confidence levels outlined in the National Climate Assessment 2018

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.



4.4.1 Hazard Ranking Results

Using the process described above, the ranking for the identified hazards of concern was determined for Gloucester County (refer to Table 4.4-4). The hazard ranking is detailed in the subsequent tables that present the stepwise process for the ranking. The countywide 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 Gloucester County.



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

Hazard of Concern	Probability		Population			Property			Economy			Total Impact Value	Adaptive Capacity	Climate Change
	Category	Numeric Value	Impact	Numeric Value	Weighted Value (x3)	Impact	Numeric Value	Weighted Value (x2)	Impact	Numeric Value	Weighted Value (x1)			
Coastal Erosion	Occasional	2	L	1	3	L	1	2	L	1	1	6	Moderate	H
Dam/ Levee Failure	Occasional	2	M	2	6	M	2	4	M	2	2	12	Moderate	M
Disease Outbreak	Occasional	2	M	2	6	L	1	2	L	1	1	9	Moderate	M
Drought	Occasional	2	M	2	6	L	1	2	M	2	2	10	Moderate	H
Earthquake	Unlikely	0	M	2	6	M	2	4	M	2	2	12	Moderate	L
Extreme Temperature	Occasional	2	M	2	6	L	1	2	M	2	2	10	Moderate	H
Flood	Occasional	2	M	2	6	M	2	4	H	3	3	13	Moderate	H
Geological Hazards	Unlikely	0	L	1	3	L	1	2	L	1	1	6	Moderate	M
Hazardous Materials	Rare	1	H	3	9	H	3	6	H	3	3	18	Moderate	M
Hurricane and Tropical Storm	Occasional	2	M	2	6	M	2	4	M	2	2	12	Moderate	H
Infestation and Invasive Species	Occasional	2	L	1	3	L	1	2	M	2	2	7	Moderate	H
Nor'Easter	Frequent	3	M	2	6	L	1	2	L	1	1	9	Moderate	H
Severe Weather	Frequent	3	H	3	9	L	1	2	M	2	2	14	Moderate	H
Severe Winter Weather	Frequent	3	H	3	9	L	1	2	L	1	1	12	Moderate	M
Wildfire	Frequent	3	L	1	3	M	2	4	L	1	1	8	Moderate	M
Utility Failure	Frequent	3	M	2	6	L	1	2	M	2	2	10	Moderate	M

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 Gloucester County

Hazard of Concern	Probability x 30%	Total Impact x 30%	Adaptive Capacity x 30%	Changing Future Conditions x 10%	Total Hazard Ranking Value
Coastal Erosion	0.6	1.8	0	0.3	2.7
Dam/ Levee Failure	0.6	3.6	0	0.2	4.4
Disease Outbreak	0.6	2.7	0	0.2	3.5
Drought	0.6	3	0	0.3	3.9
Earthquake	0	3.6	0	0.1	3.7
Extreme Temperature	0.6	3	0	0.3	3.9
Flood	0.6	3.9	0	0.3	4.8
Geological Hazards	0	1.8	0	0.2	2
Hazardous Materials	0.3	5.4	0	0.2	5.9
Hurricane and Tropical Storm	0.6	3.6	0	0.3	4.5
Infestation and Invasive Species	0.6	2.1	0	0.3	3
Nor'Easter	0.9	2.7	0	0.3	3.9
Severe Weather	0.9	4.2	0	0.3	5.4
Severe Winter Weather	0.9	3.6	0	0.2	4.7
Wildfire	0.9	2.4	0	0.2	3.5
Utility Failure	0.9	3	0	0.2	4.1

Low = Values less than 3.9; **Medium** = Values between 3.9 and 4.9; **High** = Values greater than 4.9

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 severe storm 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.