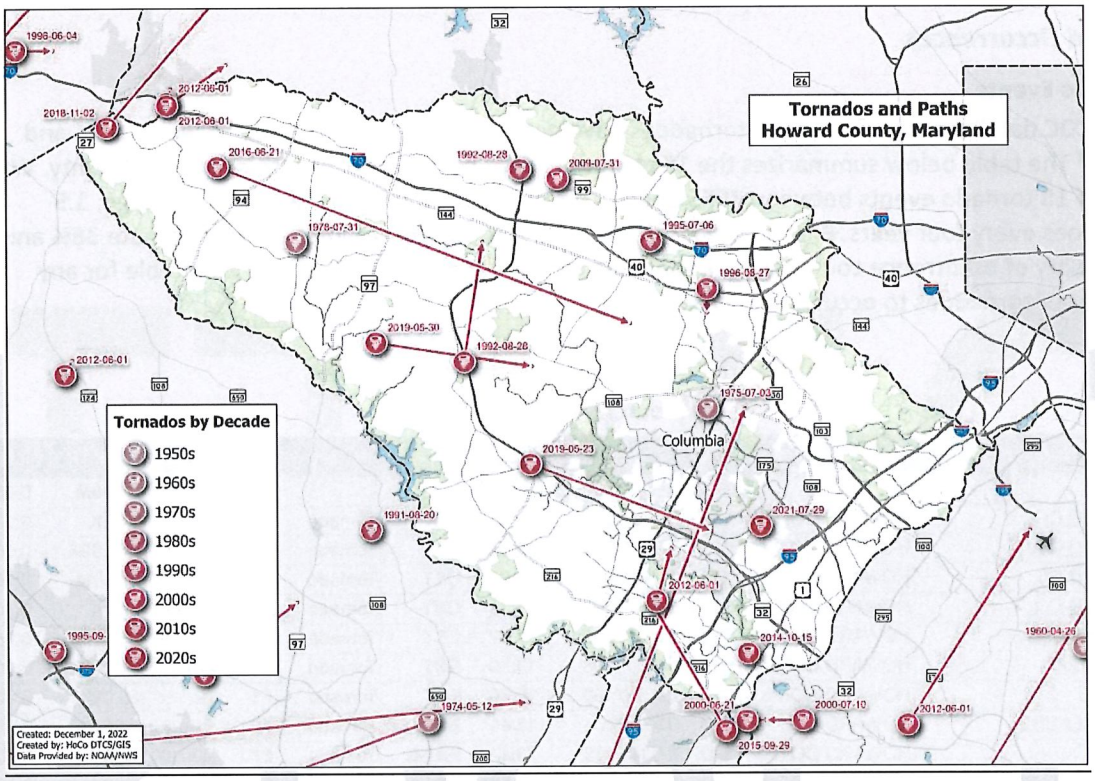
The figure below identifies the tornado tracks for Howard County and the surrounding area between 1950 and 2022.[62]

FIGURE 45: TORNADO TRACKS FOR HOWARD COUNTY AND SURROUNDING AREA, 1950-2022

(Source: NOAA, Howard County GIS)



Notable Tornado Incidents in Howard County

**The damage figures have been adjusted for inflation and are detailed in 2022-dollar values

July 1978	On July 31st, 1978 (EF2), a tornado was estimated to be 40 yards wide and travelled for a length of $^{8}/_{10}$ mile, causing $1.2 million in damage.
July 1996	On July 6th, 1996 (EF0), a small tornado briefly touched down in a wooded area, just south of Interstate 70 near the Marriottsville Road Exit. The tornado was only 20 yards wide and traveled $^{1}/_{10}$ mile. One house between Marriottsville and Ellicott City was heavily damaged by a falling tree. In total, an estimated $192,982 in property damage occurred.
August 1996	On August 27th, 1996 (EF0), a small tornado caused damage to several subdivisions along Frederick Road north of Columbia. A total of four trees were knocked down, including two trees that were blown into a home on Pine Bluffs Drive. The NCDC database estimates that there was $38,558 in property damages.
July 2000	On July 10th, 2000 (EF1), the tornado touched down three miles southeast of Savage. It brought down several trees and power lines. It also blew over two trailers and three

[62] This data does not contain Howard County's most recent tornadoes, including tornadoes that occurred after 2015.

	semi-tractor trailers. In Howard County, the tornado was 100 yards wide and traveled $^{6}/_{10}$ mile before moving into Anne Arundel County. The tornado resulted in $106,763 in property damage.
September 2001	On September 24th, 2001 (EF2-EF3), a tornado originated in Prince George's County as an EF3 and travelled north-northeast from Hyattsville, through College Park, and into Laurel. Along its destructive path, the tornado killed two and injured 55. Just before the tornado crossed into Howard County, it weakened from an EF3 to an EF2 tornado. In Howard County, the tornado caused severe damage to several townhomes in Settler's Landing, a subdivision in North Laurel. As the tornado continued northward, it slowly dissipated and ended one mile east-southeast of Columbia. The tornado traveled a total distance of six miles in Howard County and had a width of 100 yards. Along its destructive path, the tornado uprooted trees, blew off rooftops, and blew out car windows. Many homes were deemed unsafe for a period, and one was severely damaged. Property damage in Howard County was estimated at $166.1 million. The figure below shows the College Park tornado track as it moved northeast from Beltsville to Laurel.
June 2012	On June 1st, 2012 (EF1), a tornado traveled 2.07 miles in Watersville Junction. Property damage totaled to $6,395. Roughly, 30-40 large hardwood trees were uprooted or snapped
June 2012	On June 1st, 2012 (EF0), a tornado traveled 1.58 miles in Scaggsville. It brought down several trees, caused roof damage to several homes, and a Day Care Center's chimney blew over. The property damage totaled to $127,915 according to the NCDC/NOAA database.
June 2016	On June 30th, 2016 (EF0), a tornado traveled nearly 13 miles through Western Howard County. There were no injuries or deaths associated, hundreds of trees were knocked down and several homes had serious damage from falling debris. The path of debris was over 500 yards wide at some points.
November 2018	On November 2nd, 2018 (EF1), a tornado traveled 0.59 miles through Long Corner. There were no deaths or injuries reported, however, several wooden power poles were snapped along Penn Shop Road according to the NCDC/NOAA database.
May 2019	On May 23rd, 2019 (EF1), a tornado traveled 5.53 miles through Highland, near Clarksville. There was one injury reported and no deaths according to the NCDC/NOAA database. Several trees were uprooted or snapped, one falling onto the roof of a house. Additionally, an office building lost part of its roof.
May 2019	On May 30th, 2019 (EF1), a tornado traveled 4.49 miles through Knollwood. There were no deaths or injuries reported according to the NCDC/NOAA database. The tornado ripped sections of roofing desk from homes, ripped off barn roofing, uprooted trees, and downed powerlines. Additionally, the tornado damaged the Howard County highway maintenance facility. At the facility, the tornado ripped off its tin roofing, damaged some roof framing, tore a large section of fabric from a salt dome, destroyed garage bay doors, and damaged fencing.

Windstorm Events

Windstorms are broken down into two categories, thunderstorm winds and high wind events based on how data is recorded in the NCDC. The NCDC database reports that 232 thunderstorm and high wind event(s) have occurred in Howard County between 1969 and September 2019.[63] Of the 232 events, 37 included winds of 60 kts (69 mph) or greater.[64]

The database indicates that there were eight thunderstorm wind events that caused at least $50,000 damages since 1950. On May 15th, 1994, a thunderstorm, with winds exceeding 50 kts, damaged several homes and knocked down numerous trees in the central and eastern portions of the County. The total impact was estimated to be $85,301 in property damages. On May 13th, 2002, a 75-mph downburst occurred within a 10 square block area Northwest of Ellicott City. Numerous trees were downed, and the downburst caused widespread power outages. Two homes were heavily damaged by downed trees. The estimated total property damage for the downburst was $212,488.

With a total of 232 thunderstorm/high wind events between 1969 and 2019, Howard County experiences on average 4.6 thunderstorm/high wind events per year. With about five per year, there is a 100% annual probability of a thunderstorm wind event occurring in Howard County. Based on the history of past thunderstorm/high wind events, there is a high probability of these events occurring in Howard County in the future. Although the probability is high, the impact on life and property in the County will probably be minimal as compared to other hazards. The table below summarizes the seven thunderstorm/high wind Events in Howard County with greater than 60 kt winds since 2017.

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[63] *Storm Events Database*, NOAA NAT'L CTRS. FOR ENV'T INFO., https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=(C)+Thunderstorm+WindandbeginDate_mm=01andbeginDate_dd=01andbeginDate_yyyy=1969andendDate_mm=10andendDate_dd=01andendDate_yyyy=2019andcounty=HOWARD:27andhailfilter=0.00andtornfilter=0andwindfilter=000andsort=DTandsubmitbutton=Searchandstatefips=24,MARYLAND (last visited Apr. 3, 2023).

[64] *Storm Events Database*, NOAA NAT'L CTRS. FOR ENV'T INFO., https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=(C)+Thunderstorm+WindandbeginDate_mm=01andbeginDate_dd=01andbeginDate_yyyy=1969andendDate_mm=10andendDate_dd=01andendDate_yyyy=2019andcounty=HOWARD:27andhailfilter=0.00andtornfilter=0andwindfilter=000andsort=DTandsubmitbutton=Searchandstatefips=24,MARYLAND (last visited Apr. 3, 2023).

Howard County: Thunderstorm Wind Events Over 60 Knots, Excluding Tornado Winds, 2017 – 2022

(Source: NOAA/NCDC)

Location	County/Zone	St.	Date	Time	T.Z.	Type	Mag	Dth	Inj	PrD	CrD
Totals:								0	0	1.170M	0.00K
LISBON	HOWARD CO.	MD	03/01/2017	13:40	EST-5	Thunderstorm Wind	61 kts. EG	0	0	0.00K	0.00K
LONG CORNER	HOWARD CO.	MD	11/02/2018	19:18	EST-5	Thunderstorm Wind	61 kts. EG	0	0	0.00K	0.00K
HIGHLAND	HOWARD CO.	MD	05/23/2019	14:23	EST-5	Thunderstorm Wind	61 kts. EG	0	0	0.00K	0.00K
CLARKSVILLE	HOWARD CO.	MD	05/23/2019	14:30	EST-5	Thunderstorm Wind	61 kts. EG	0	0	0.00K	0.00K
GLENELG	HOWARD CO.	MD	05/23/2019	14:30	EST-5	Thunderstorm Wind	61 kts. EG	0	0	0.00K	0.00K
SAVAGE	HOWARD CO.	MD	05/23/2019	14:32	EST-5	Thunderstorm Wind	61 kts. EG	0	0	0.00K	0.00K
SAVAGE	HOWARD CO.	MD	05/23/2019	14:36	EST-5	Thunderstorm Wind	70 kts. EG	0	0	0.00K	0.00K
ALPHA	HOWARD CO.	MD	05/26/2019	20:13	EST-5	Thunderstorm Wind	61 kts. EG	0	0	0.00K	0.00K
MC ALPINE	HOWARD CO.	MD	06/22/2020	16:45	EST-5	Thunderstorm Wind	60 kts. EG	0	0	150.00K	0.00K
DAISY	HOWARD CO.	MD	08/13/2021	15:45	EST-5	Thunderstorm Wind	60 kts. EG	0	0	20.00K	0.00K
OAKLAND MILLS	HOWARD CO.	MD	06/08/2022	18:50	EST-5	Thunderstorm Wind	65 kts. EG	0	0	1.000M	0.00K
Totals:								0	0	1.170M	0.00K

65

Additional Significant thunderstorm/windstorm events that have impacted Howard County are described below. For purpose of this document a significant thunderstorm/high wind event is an event over 60 kt wind speeds.

Notable Windstorm Incidents in Howard County

**The damage figures have been adjusted for inflation and are detailed in 2022-dollar values

July 1996	On July 30th, 1996, a severe thunderstorm moved from east to west across the County. The storm brought down trees and power lines and caused an estimated $24,237 in property damage and another $3,635 in crop damage.
August 2003	On August 26th, 2003, a line of severe thunderstorms with winds up to 78 mph moved across the County during the afternoon hours. There were numerous reports of downed trees and power lines throughout the County and caused an estimated $23,838 in property damage.
June 2006	On June 1st, 2006, a strong storm system moved through the area. The winds from these storms caused $36,364 in damage.
September 2006	On September 28th, 2006, as a cold front moved into the region during the afternoon, it spawned several thunderstorms. The most intense thunderstorm occurred along the Interstate 95 Corridor. In total, the storms caused an estimated $50,910 in property damage.
June 2012	On June 29th, 2012, a linear formation of strong thunderstorms, known as a derecho, traveled from the Midwest (Indiana) to the Mid-Atlantic region, impacting the County. The straight-line winds related to this event were above 60 mph, with reports of winds exceeding 80 mph. the damage to trees and electric power infrastructure was extensive and widespread. In total, the storms caused $37,494 in reported property damage.

[65] *Storm Events Database*, NOAA NAT'L CTRS. FOR ENV'T INFO., https://www.ncdc.noaa.gov/stormevents/listevents.jsp?windfilter=060&sort=DT&statefips=24%2CMARYLAND&county=HOWARD%3A27&eventType=%28C%29+Thunderstorm+Wind&beginDate_yyyy=2017&beginDate_mm=01&beginDate_dd=01&endDate_yyyy=2022&endDate_mm=12&endDate_dd=31 (last visited Apr. 3, 2023).

NOAA categorized high wind events separately on their database. There were eight high wind events reported between 1950 and October 2019 in Howard County. Additionally, there was only one significant high wind event was reported between 1950 and October 2019. That event occurred in Long Corner, Howard County, Maryland, on November 2nd, 1997, causing $1,598 in property damage.[66]

Howard County: High Winds from 1950 to October of 2019

(Source: NOAA/NCDC)

Location	County/Zone	St.	Date	Time	T.Z.	Type	Mag	Dth	Inj	PrD	CrD
Totals:								0	0	0.00K	0.00K
CENTRAL AND SOUTHEAST HOWARD (...	CENTRAL AND SOUTHEAST HOWARD (...	MD	02/14/2015	11:15	EST-5	High Wind	50 kts. MG	0	0	0.00K	0.00K
CENTRAL AND SOUTHEAST HOWARD (...	CENTRAL AND SOUTHEAST HOWARD (...	MD	04/03/2016	09:08	EST-5	High Wind	50 kts. EG	0	0	0.00K	0.00K
NORTHWEST HOWARD (ZONE)	NORTHWEST HOWARD (ZONE)	MD	02/12/2017	22:55	EST-5	High Wind	52 kts. EG	0	0	0.00K	0.00K
CENTRAL AND SOUTHEAST HOWARD (...	CENTRAL AND SOUTHEAST HOWARD (...	MD	02/12/2017	22:58	EST-5	High Wind	52 kts. EG	0	0	0.00K	0.00K
CENTRAL AND SOUTHEAST HOWARD (...	CENTRAL AND SOUTHEAST HOWARD (...	MD	03/02/2018	05:00	EST-5	High Wind	50 kts. EG	0	0	0.00K	0.00K
NORTHWEST HOWARD (ZONE)	NORTHWEST HOWARD (ZONE)	MD	03/02/2018	05:00	EST-5	High Wind	50 kts. EG	0	0	0.00K	0.00K
NORTHWEST HOWARD (ZONE)	NORTHWEST HOWARD (ZONE)	MD	02/25/2019	04:21	EST-5	High Wind	50 kts. EG	0	0	0.00K	0.00K
CENTRAL AND SOUTHEAST HOWARD (...	CENTRAL AND SOUTHEAST HOWARD (...	MD	02/25/2019	04:21	EST-5	High Wind	50 kts. EG	0	0	0.00K	0.00K
Totals:								0	0	0.00K	0.00K

[67]

Hazard Future Likelihood- High

SMEs considered that the future likelihood of tornadoes occurring within the County may increase due to climate change and the recent pattern of the storms occurring more frequently within the County. The future annual probability of the event is 11-30% chance of annual occurrence, or one event every three to nine years. Based on the history of tornadoes in Howard County there is a high probability of future tornadoes occurring in the County.

The following table anticipates the future occurrence rate of the hazard based on historical likelihood and future trends.

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[66] *Storm Events Database*, NOAA NAT'L CTRS. FOR ENV'T INFO., https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=(Z)+Strong+WindandbeginDate_mm=01andbeginDate_dd=01andbeginDate_yyyy=1950andendDate_mm=10andendDate_dd=01andendDate_yyyy=2019andcounty=HOWARD:27andhailfilter=0.00andtornfilter=0andwindfilter=000andsort=DTandsubmitbutton=Searchandstatefips=24,MARYLAND (last visited Apr. 3, 2023.

[67] *Storm Events Database*, NOAA NAT'L CTRS. FOR ENV'T INFO., https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=(Z)+High+WindandbeginDate_mm=01andbeginDate_dd=01andbeginDate_yyyy=1950andendDate_mm=10andendDate_dd=01andendDate_yyyy=2019andcounty=HOWARD:27andhailfilter=0.00andtornfilter=0andwindfilter=000andsort=DTandsubmitbutton=Searchandstatefips=24,MARYLAND (last visited Apr. 3, 2023).

Future Likelihood of a Tornado/Windstorm in Howard County	
Historical Average (time period)	18 events (1975-2022)
Historical Annual Probability	30%+ chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No
Future Annual Probability	11-30% chance of annual occurrence
Future Likelihood Score	3 (Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

Drought (Risk Score 2.0)

Hazard Description

According to NOAA, Drought is a complex phenomenon which is difficult to monitor and define. Drought is the *absence* of water. It is a creeping phenomenon that slowly sneaks up and impacts many sectors of the economy and operates on many different time scales. Drought usually refers to a period of below-normal rainfall but can also be caused by drying bores or lakes, or anything that reduces the amount of liquid water available. The climatological community has defined four types of drought:[68]

- Meteorological drought - happens when dry weather patterns dominate an area.
- Hydrological drought- occurs when low water supply becomes evident, especially in streams, reservoirs, and groundwater levels, usually after many months of meteorological drought.
- Agricultural drought - happens when crops become affected.
- Socioeconomic drought - relates the supply and demand of various commodities to drought.

The following table presents the Risk Score for drought in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Drought Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	2.4 Infrequent-Likely		50%
CONSEQUE	**Impact**	1.3 Limited-Significant	2.7 Significant-Critical	40%
	Warning Time	1	1	5%

[68] *Definition of Drought,* NOAA NAT'L CTRS. FOR ENV'T INFO., https://www.ncdc.noaa.gov/monitoring-references/dyk/drought-definition (last accessed Mar. 22, 2023).

		Very Long	Very Long	
	Duration	4 Very Long	4 Very Long	5%
TOTAL RISK SCORE		**2.0**	**2.5**	

Hazard Location

Drought is a recurring feature of nearly all the world's climatic regions, and it may occur anywhere in the United States.[69] Different regions may be affected by drought conditions differently, depending on normal meteorological conditions (such as precipitation and temperature) and geological conditions (such as soil type and subsurface water levels).

Drought is possible throughout the State, and in the central Maryland region in general. As there is no defined geographic boundary for this hazard, all properties within Howard County are exposed equally to the risk of drought. The probability of a drought occurring in any specific region depends on atmospheric and climatic conditions.

Hazard Extent

A drought's severity depends on numerous factors, including duration, intensity, and geographic extent as well as regional water supply demands by humans and vegetation. The severity of drought can be aggravated by other factors, such as high temperatures, high winds, and low humidity. This can also increase the risk of wildfires. Due to its multi-dimensional nature, drought is difficult to define in exact terms, which makes comprehensive risk assessments difficult. One method used by scientists to calculate the severity and duration of a drought is the Palmer Drought Severity Index (PDSI). The PDSI "uses readily available temperature and precipitation data to estimate relative dryness[70]. The PDSI is an important climatological tool for evaluating the scope, severity, and frequency of prolonged periods of abnormally dry or wet weather[71].

The equation for the PDSI was empirically derived from the monthly temperature and precipitation scenarios of 13 instances of extreme drought in Western Kansas and Central Iowa and by assigning an index value of -4 for these cases. Conversely, a +4 represents extremely wet conditions. From these values, seven categories of wet and dry conditions can be defined. The table below identifies when values used to define the PDSI.

---

[69] For additional information about droughts, visit the National Integrated Drought Information System (NIDIS), www.drought.gov (last accessed September 24, 2022).

[70] *Climate Data Palmer Drought Severity Index (PDSI), NCAR Climate Data Guide, https://climatedataguide.ucar.edu/climate-data/palmer-drought-severity-index-pdsi, (last accessed July 25, 2023).*

[71] *Explanation, National Weather Service Climate Prediction Center, https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/cdus/palmer_drought/wpdanote.shtml, last accessed July 25, 2023).*

Palmer Drought Severity Index	
-4.0 OR LESS	Extreme Drought
-3.0 or -3.9	Severe Drought
-2.0 or -2.9	Moderate Drought
-1.9 to +1.9	Near Normal
+2.0 or +2.9	Unusual Moist Spell
+3.0 or +3.9	Very Moist Spell
+4.0 or above	Extremely Moist

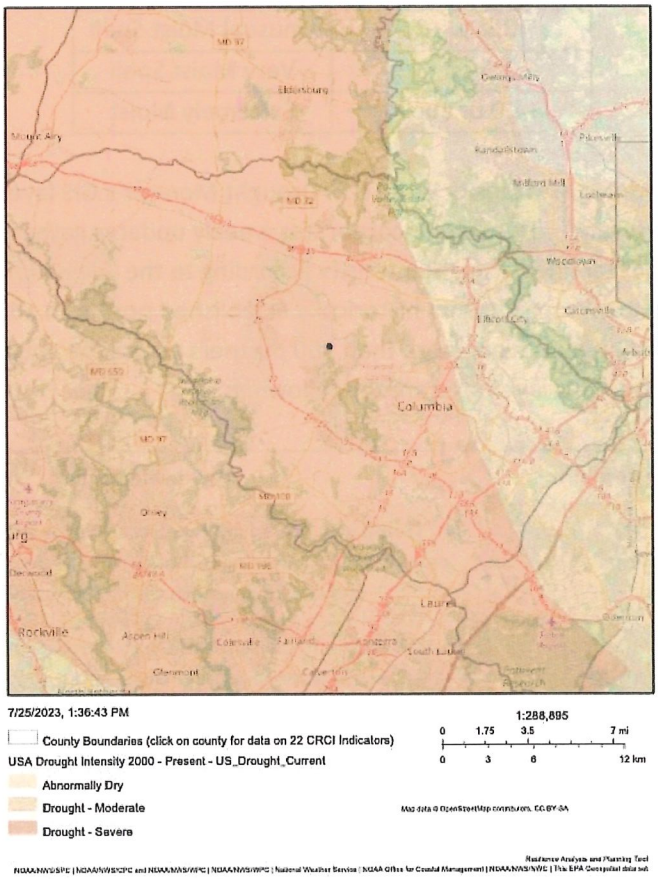
Another tool to measure drought intensity is the U.S. Drought Monitor's GIS layer managed by Esri "USA Drought Intensity 2000-Present". This layer incorporates weekly updates gathered since the year 2000 on drought conditions and classifies drought intensity according to the "deviation of precipitation, stream flow, and soil moisture content from historically established norms, in addition to subjective observations and reported impacts from more than 350 partners across the country[72]. The Drought Classification Categories that this layer uses are the following:

Class	Description	Possible Impacts
D0	Abnormally Dry	Going into drought: short-term dryness slows growth of crops/pastures. Coming out of drought: some lingering water deficits; drops/pastures not fully recovered.
D1	Moderate Drought	Some damage to crops/pastures; streams, reservoirs, or wells are low with some water shortages developing or imminent; voluntary water-use restrictions requested.
D2	Severe Drought	Crop/pasture losses are likely; water shortages are common and water retrictions are imposed.
D3	Extreme Drought	Major crop/pasture losses; widespread water shortages or restrictions.
D4	Exceptional Drought	Exceptional and widespread crop/pasture losses; shortages of water in reservoirs, streams, and wells creating water emergencies.

[72] *USA Drought Intensity 2000-Present, Esri, https://fema.maps.arcgis.com/home/item.html?id=9731f9062afd45f2be7b3bf2e050fbfa, (last accessed July 24, 2023).*

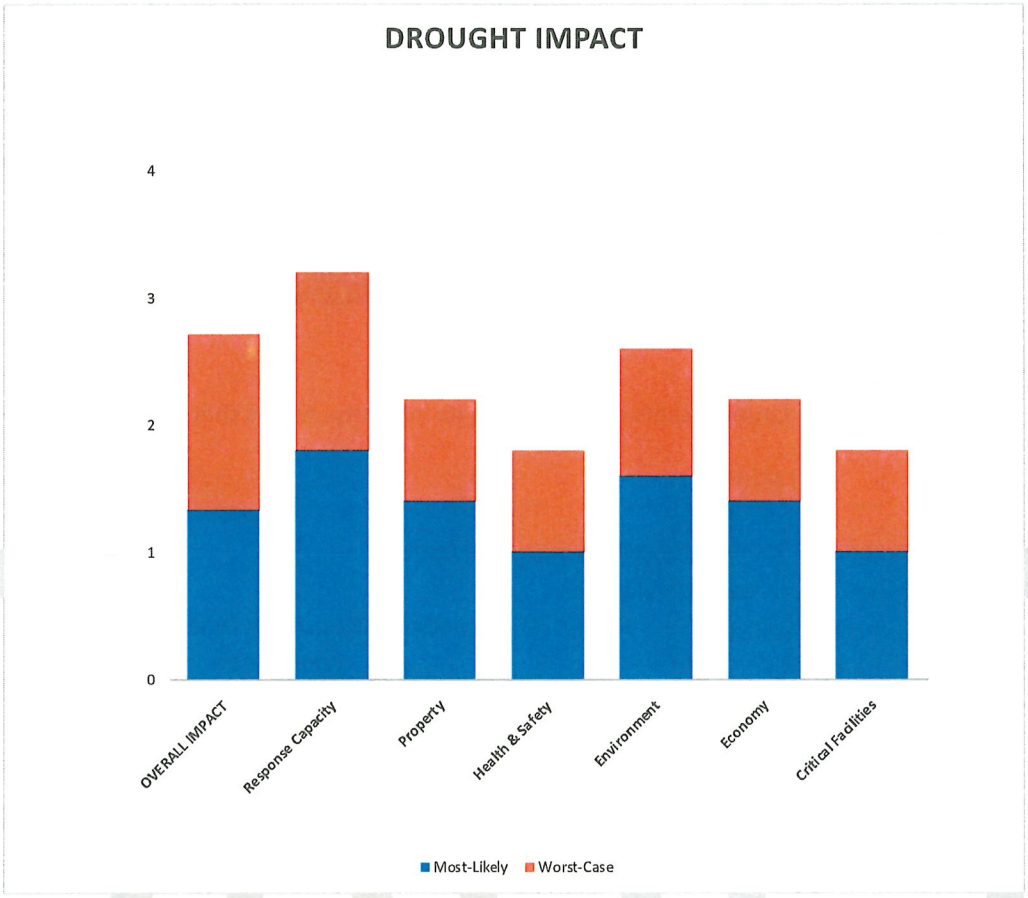
The map below depicts this layer for Howard County. Most of Howard County falls into the "D2: Severe Drought" red shaded area, whereas a small portion of the eastern part of the County falls into "D1: Moderate Drought". This means that when drought occurs in the eastern portion of the County, it tends to be severe, and when it occurs in the western portion, it tends to be moderate.

FIGURE 46: DROUGHT INTENSITY 2000-PRESENT (2023)



Hazard Impacts

The figure and table below characterize drought impacts to property, health and safety, critical facilities, response capacity, the environment, and the economy.



Drought - Consequence Analysis Likely		
CATEGORY	**RANKING**	**DESCRIPTION**
PROPERTY DAMAGE	*Limited-Significant*	▪ 0% of critical and non-critical infrastructure damage if water service is uninterrupted. ▪ Damaged landscaping is expected and farmers experience crop pasture loss.
HEALTH AND SAFETY	*Limited*	▪ Zero to five injuries are expected. Dehydration, heat exhaustion, and heat stroke are the most common causes of injuries.
CRITICAL FACILITIES	*Limited*	▪ *Utilities* – No facility shut down or out of service is expected. Voluntary restrictions may be imposed. ▪ *Information/Communications* – No shutdown. No major impact on information or communications infrastructure. ▪ *Transportation* – No delays or shutdowns expected.
RESPONSE CAPACITY	*Limited-Significant*	▪ *Police* – Local resources adequate. Minimal impact to response capability by law enforcement. ▪ *Fire and Rescue* – Local resources adequate. Limited impact on the response capability, primarily to allow rehabilitation for crews working extended operations. Some stress on fire suppression operations, particularly in western end of the County where drafting is required for water access. ▪ *Health* – Local resources adequate. HD operations will not be affected and will monitor the extreme heat incident from the Health Department Operations Center (HDOC).

ENVIRONMENTAL IMPACT	*Limited-Significant*	▪ Temporary spike in air pollution. ▪ There may be slightly higher levels of water pollution as decreased water levels lead to increased concentrations of contaminants.		
ECONOMIC IMPACT	*Limited-Significant*	▪ Limited economic consequences. Probable shift in hours of construction projects and other outdoor projects. ▪ Farmers within the County experience crop pasture loss which may result in higher prices for produce.		
TOTAL IMPACT	***Limited-Significant***	▪ **Total Impact Score: 1.3 on a scale of 1 (Limited) to 4 (Catastrophic).**		
Limited		*Significant*	*Critical*	*Catastrophic*

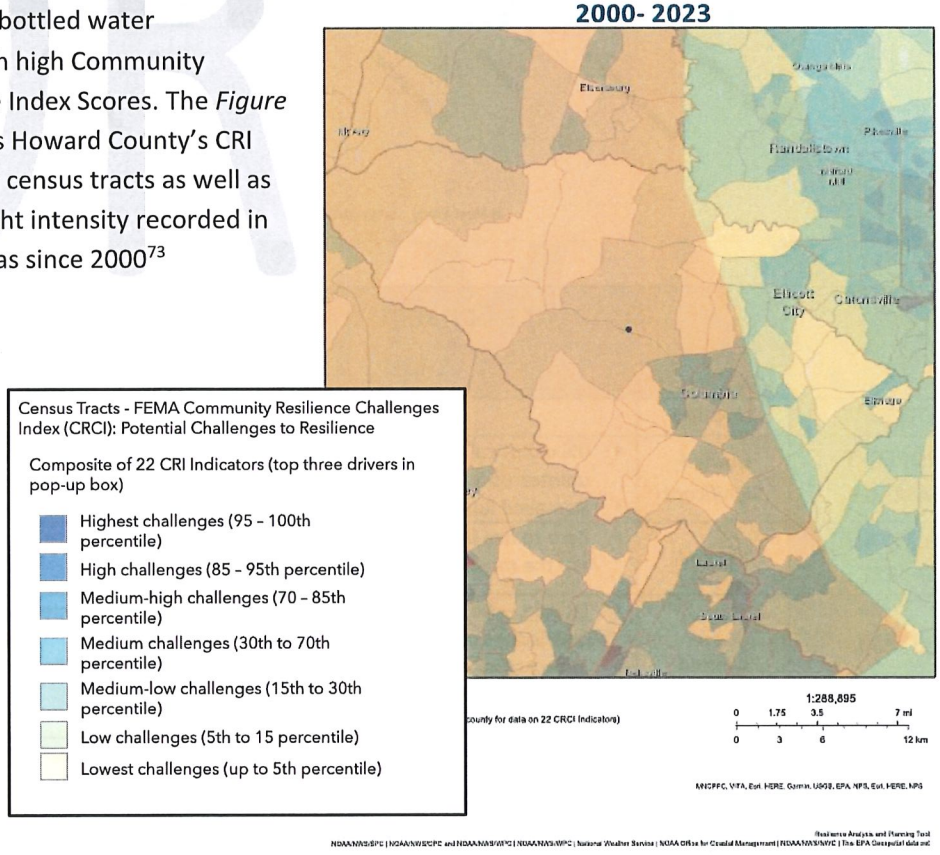
Vulnerability of County Assets

Drought can impact multiple County assets depending on its intensity. Assets that are vulnerable are the following:

People

- Farmers (most farms located in western Howard County)
- People with agriculture-based livelihoods
- Households without vehicles to access bottled water
- Areas with high Community Resilience Index Scores. The *Figure 47* depicts Howard County's CRI scores for census tracts as well as the drought intensity recorded in these areas since 2000[73]

FIGURE 47: COMMUNITY RESILIENCE INDEX & DROUGHT INTENSITY 2000- 2023



[73] *USA Drought Intensity 2000-Present, Esri, https://fema.maps.arcgis.com/home/item.html?id=9731f9062afd45f2be7b3bf2e050fbfa, (last accessed July 24, 2023).*

Structures

- All residential and commercial buildings are affected by drought.
- Water supply (Washington Suburban Sanitary Commission in Laurel and Baltimore City)
- Water treatment (Little Patuxent Water Reclamation Plant).

Systems

- Firefighting capabilities in areas where water must be shuttled to the location.
- Economic capabilities (reduced crop productivity).

Natural, Historic, and Cultural Resources

- Outdoor cultural activities could be hindered or canceled due to weather conditions as droughts are associated with increased temperatures and heat-related illness.

Activities that Have Value to the Community

- Lakes for recreation, such as Lake Kittamaqundi, Centennial Lake, Lake Elkhorn, Scott's Cove Recreation Area, Triadelphia Reservoir, and Wilde Lake (lower water depth, damage to fish habitat, damage to wildlife).
- Camping activities in Patapsco State Park (damage to wildlife, closed off camping areas, higher risk for fires).

Effects of Population Change and Development in Hazard-Prone Areas

As Howard County, Maryland, anticipates changes in future population density, particularly with noticeable growth projected in central and south-eastern regions, it's important to assess how these demographic shifts could influence the County's vulnerability to drought. Population density can significantly impact water demand, supply, and management, affecting the severity and consequences of drought events. The higher population densities, especially around Columbia and Ellicott City, can stress local water sources, including rivers, reservoirs, and groundwater aquifers. As more water is withdrawn to meet the needs of a growing population, these sources may become more vulnerable to depletion during droughts, impacting both water availability and quality. Higher population density areas require robust water infrastructure to ensure equitable and reliable water distribution. During droughts, increased demand can stress distribution systems, potentially leading to water shortages, pressure fluctuations, and challenges in providing adequate water to all residents. Vulnerable communities, such as low-income households or those with chronic health conditions, may face challenges in accessing clean water resources during droughts.

Future development can alter natural hydrological processes by increasing impervious surfaces such as roads, buildings, and parking lots. This reduces the ability of the land to absorb rainwater, leading to increased runoff and reduced groundwater recharge. These changes can exacerbate drought conditions by disrupting the natural water cycle. Developments in drought-prone areas require resilient water infrastructure to ensure consistent water supply. During droughts, higher water demand from newly developed areas can stress distribution systems, leading to pressure fluctuations, potential water shortages, and challenges in providing adequate water to residents. Population growth, density, and upcoming development are most noticeable in the central and southeastern parts of Howard County. To locate the specific areas of current and projected population density, as well as anticipated future

development, please refer to Chapter 2 of the Plan. This chapter covers the Growth and Development, with a subsection dedicated to Future Development. These sections help identify where existing high population densities are located and where future developmental activities are anticipated.

Hazard Occurrences

According to the NCDC database, Howard County experienced 12 drought events from 1997 to 2022. All 13 events occurred before 2007. The database does not show any drought events occurring in Howard County since 2007.[74] The U.S. Drought Monitor lists an additional 11 events since 2007 where some part of Howard County was in a D1 drought stage. For nine of those events since 2007, more than 50% of the County was in at least a D1 drought stage.[75]

The graph below depicts occurrences of drought in Maryland from 2000 to 2022. The graph also shows the severity of the droughts using the U.S. Drought Monitor's[76] drought ratings:

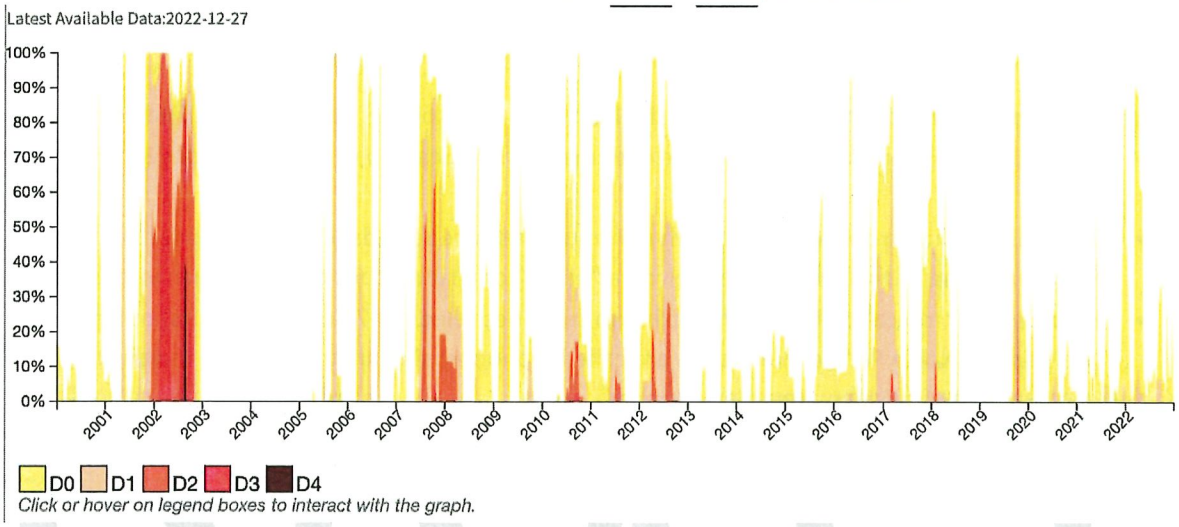
D0 - Abnormally Dry	• Short-term dryness slowing planting, growth of crops • Some lingering water deficits • Pastures or crops not fully recovered
D1 – Moderate Drought	• Some damage to crops, pastures • Some water shortages developing • Voluntary water-use restrictions requested
D2 – Severe Drought	• Crop or pasture loss likely • Water shortages common • Water restrictions imposed
D3 – Extreme Drought	• Major crop/pasture losses • Widespread water shortages or restrictions
D4 – Exceptional Drought	• Exceptional and widespread crop/pasture losses • Shortages of water creating water emergencies

[74] *Storm Events Database*, NOAA NAT'L CTRS. FOR ENV'T INFO., https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+Drought&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1997&endDate_mm=12&endDate_dd=31&endDate_yyyy=2022&county=ALL&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=24%2CMARYLAND# (last visited Apr. 3, 2023).

[75] *Data & Maps -- Historical Data and Conditions*, NAT'L INTEGRATED DROUGHT INFO. SYS., https://www.drought.gov/historical-information?state=maryland&countyFips=24027&dataset=0&selectedDateUSDM=20191015&selectedDateSpi=19581201 (last visited Apr. 3, 2023).

[76] *What is the USDM*, U.S. DROUGHT MONITOR, https://droughtmonitor.unl.edu/About/WhatistheUSDM.aspx (last visited Apr. 3, 2023).

FIGURE 48: HISTORICAL DROUGHT IN MARYLAND, 2000-2022[77]



Hazard Future Likelihood – Medium

Given the increased variability and intensity of precipitation due to climate change, there is some uncertainty about the future probability of drought in Howard County. Some mitigating factors include the development of drought-resistant crops and Howard County utilizing water from a variety of external jurisdictions. The future annual probability of a drought is given a 1-30% chance of annual occurrence, or one event every 3-99 years. The following table anticipates the future occurrence rate of the hazard based on historical likelihood and future trends.

Future Likelihood of a Drought in Howard County	
Historical Average (time period)	23 events (1997-2022)
Historical Annual Probability	30+% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes
Future Annual Probability	1-30% chance of annual occurrence
Future Likelihood Score	2.4 (Infrequent-Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

Hurricane/Tropical Cyclone (Risk Score 1.8)

Hazard Description

Hurricanes, tropical storms, tropical depressions, and typhoons are classifications of Tropical Cyclones. For the purposes of this document, the hazard will be referred to as "Hurricane/Tropical Cyclone" as hurricane is the more commonly associated name with this hazard. NOAA defines a tropical cyclone as a "warm-core non-frontal synoptic-scale cyclone, originating over tropical or subtropical waters, with

[77] *Current U.S. Drought Monitor Conditions for Maryland,* NAT'L INTEGRATED DROUGHT INFO. SYS., https://www.drought.gov/drought/states/maryland?places=Howard+County,+MD,+USA (last visited Apr. 3, 2023).

organized deep convection and a closed surface wind circulation about a well-defined center. Once formed, a tropical cyclone is maintained by the extraction of heat energy from the ocean at high temperature and heat export at the low temperatures of the upper troposphere."[78]

"Tropical cyclones rotate counterclockwise in the Northern Hemisphere. They are classified as follows:

- Tropical Depression: A tropical cyclone with maximum sustained winds of 38 mph (33 knots) or less.
- Tropical Storm: A tropical cyclone with maximum sustained winds of 39 to 73 mph (34 to 63 knots). A storm of this magnitude is given a "name" once it reaches tropical storm intensity.
- Hurricane: A tropical cyclone with maximum sustained winds of 74 mph (64 knots) or higher. In the western North Pacific, hurricanes are called typhoons; similar storms in the Indian Ocean and South Pacific Ocean are called cyclones.
    - A hurricane can be described as a well-defined low-pressure system with circulation around the "eye" or center of the storm.[79]
- Major Hurricane: A tropical cyclone with maximum sustained winds of 111 mph (96 knots) or higher, corresponding to a Category 3, 4 or 5 on the Saffir-Simpson Hurricane Wind Scale.

Tropical cyclones forming between five- and 30-degrees North latitude typically move toward the west. Sometimes the winds in the middle and upper levels of the atmosphere change and steer the cyclone toward the north and northwest. When tropical cyclones reach latitudes near 30 degrees North, they often move northeast." [80] The table below provides a concise explanation of each tropical cyclone category.[81]

Tropical Cyclone - Wind Speeds Categories

(Source: NOAA)

Category	Wind Speed	Definition
Tropical Depression	< 38 mph	An organized system of strong thunderstorms with a defined surface circulation and maximum sustained winds of 38 mph or less.
Tropical Storm	39 -73 mph	An organized system of strong thunderstorms with a defined surface circulation and a wind speed range from 39 to 73 mph.
Hurricane	74+ mph	An intense tropical low-pressure system of strong thunderstorms with a well-defined surface circulation and a sustained wind speed of 74 mph or more. The term hurricane is used for Northern Hemisphere tropical cyclones east of the International Dateline to the Greenwich Meridian.

[78] *Glossary of National Hurricane Center Terms*, NAT'L HURRICANE CTR. & CENT. PACIFIC HURRICANE CTR., http://www.nhc.noaa.gov/aboutgloss.shtml#TROPCYC (last visited Apr. 3, 2023).

[79] *Hurricane FAQs,* NOAA, https://www.aoml.noaa.gov/hrd/tcfaq/A11.html (last visited Apr. 3, 2023).

[80] *Glossary of National Hurricane Center Terms*, NAT'L HURRICANE CTR. & CENT. PACIFIC HURRICANE CTR., http://www.nhc.noaa.gov/aboutgloss.shtml#TROPCYC (last visited Apr. 3, 2023).

[81] *See* NAT'L HURRICANE CTR. & CENT. PACIFIC HURRICANE CTR., http://www.nhc.noaa.gov/ (last visited Apr. 3, 2023).

Category	Wind Speed	Definition
Major Hurricane	111+ mph	Category 3, 4, and 5 hurricanes are considered major hurricanes. See the Saffir-Simpson Scale definitions below for more information about these hurricanes.

The following table presents the Risk Score for Hurricane/Tropical Cyclone in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Hurricane/Tropical Cyclone Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	3 Likely		50%
CONSEQUENCE	**Impact**	1.1 Limited-Significant	3.1 Critical-Catastrophic	40%
CONSEQUENCE	**Warning Time**	1 Very Long	1 Very Long	5%
CONSEQUENCE	**Duration**	2 Moderate	3 Long	5%
TOTAL RISK SCORE		**2.1**	**3.07**	

Hazard Location

Tropical cyclone risk in the United States extends along the entire East Coast (from Florida to Maine), the Gulf Coast, and Hawaii. Historical storm tracks show that the southern Atlantic Coast and the Gulf Coast are at the greatest risk. As one moves further inland and/or north along the Atlantic Coast where colder ocean waters persist, the threat of powerful hurricanes diminishes. However, the threat of tropical storms and remnants of hurricanes is still prevalent. The greatest threat for the occurrence of a tropical cyclone in Howard County is during the Atlantic Hurricane season, which runs from June 1st to November 30th each year. The hurricane/tropical cyclone hazard has the potential to affect the entire County.

While there is potential for hurricane force winds to occur in Howard County, its inland location removes it from the Atlantic coastline and places it north of the warm Carolina waters. Instead, its location makes the County more vulnerable to tropical storms and tropical depressions.

Hazard Extent

The severity of hurricanes and tropical cyclones is measured primarily by wind velocity, surface pressure, and storm surge. Hurricane severity is measured by the Saffir-Simpson Scale, which classifies hurricanes on a number scale of one to five, based on factors, such as wind speed, storm surge height, and

potential damage. The higher the number, the more severe the storm. The table belo depicts the potential effects of wind damage during a hurricane event.

Saffir-Simpson Hurricane Wind Scale[82]

(Source: NHC and NOAA)

Category	Sustained Winds	Damage Level	Types of Damage Due to Hurricane Winds
1	74-95 mph 64-82 kt 119-153 km/h	Minimal	Very dangerous winds will produce some damage: Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap, and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110 mph 83-95 kt 154-177 km/h	Moderate	Extremely dangerous winds will cause extensive damage: Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks
3 (Major)	111-129 mph 96-112 kt 178-208 km/h	Extensive	Devastating damage will occur: Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4 (Major)	130-156 mph 113-136 kt 209-251 km/h	Extreme	Catastrophic damage will occur: Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted, and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5 (Major)	157 mph or higher 137 kt or higher 252 km/h or higher	Catastrophic	Catastrophic damage will occur: A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Since 1950, there has not been a hurricane that has passed directly over Howard County, due to most storms downgrading to either tropical cyclone or tropical depressions by the time they reach the region.

[82] *Saffir-Simpson Hurricane WInd Scale*, NAT'L HURRICANE CTR. & CENT. PACIFIC HURRICANE CTR., https://www.nhc.noaa.gov/aboutsshws.php (last visited Apr. 3, 2023).

However, hurricanes or tropical cyclones/depressions do pass close enough to bring heavy rain and increased high winds to the County. In the "Hazard Occurrences" section below for this hazard, a map depicts all storm tracks that occurred within 100 miles of Howard County from 1950-2021.

Hazard Impacts

Tropical cyclones are among the most financially devastating naturally occurring hazards in the United States. Hurricanes, the strongest type of the tropical cyclones in the United States, generate hazards that can cause extensive damage such as high winds, heavy rainfall, tornadoes, and storm surge. Below, you can see evidence of the damage left behind by different storms in Howard County.

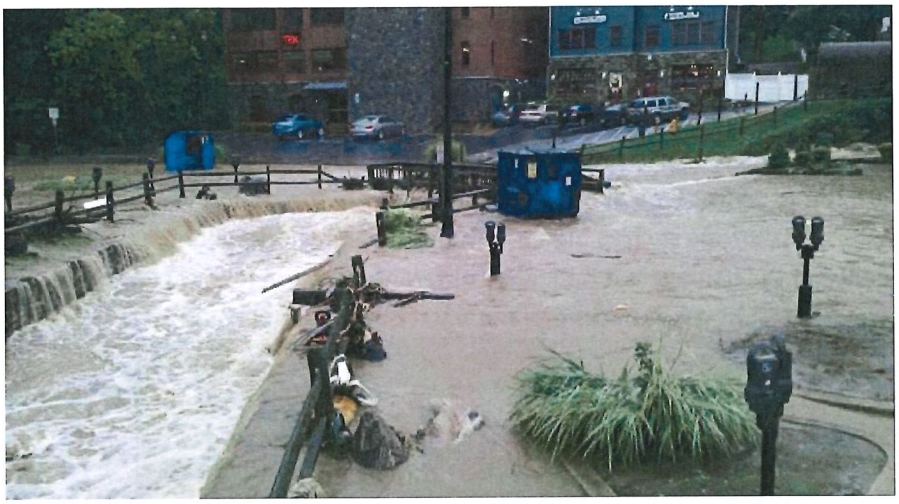
FIGURE 49: FLOODING IN THE VALLEY MEDE SUBDIVISION

*Source: Howard County Office of Emergency Management

FIGURE 50: TROPICAL STORM LEE: FLOODING ALONG MAIN STREET ELLICOTT CITY

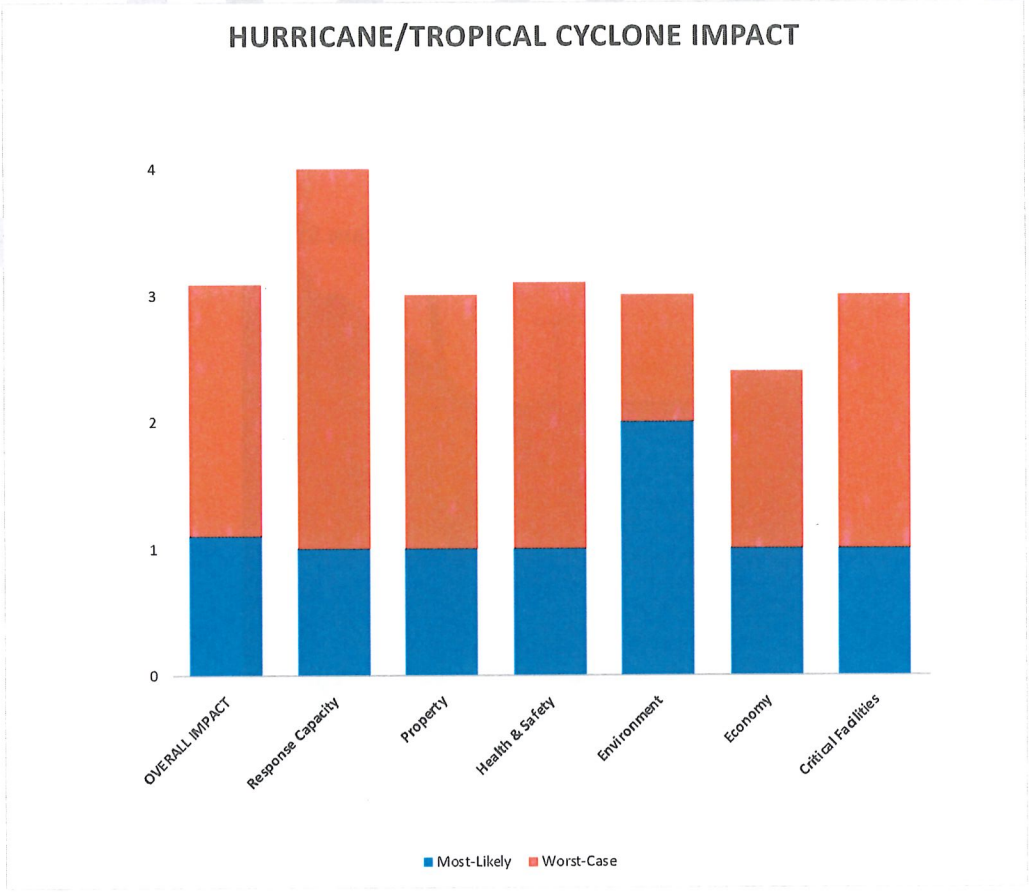
*Source: Elkridge Patch

FIGURE 51: TROPICAL STORM LEE: FLOODING AT A MUNICIPAL PARKING LOT IN HISTORIC ELLICOTT CITY



*Source: Baltimore Sun

The figure and table below characterize hurricane/tropical cyclone impacts to property, health and safety, critical facilities, response capacity, the environment, and the economy.



Hurricanes / Tropical Cyclone - Consequence Analysis Likely				
CATEGORY	**RANKING**	**DESCRIPTION**		
PROPERTY DAMAGE	*Limited*	▪ Critical and non-critical infrastructure will be damaged. ▪ Ellicott City, Elkridge, and other low-lying areas affected and downed trees and wires with minimal structural damage expected. ▪ Few downed trees and power lines and some flooding across roadways that usually flooded was expected. ▪ Erosion and minor roadbed damage at undersized culverts are expected. ▪ Some structural damage to occupancies and minor flooding is expected.		
HEALTH AND SAFETY	*Limited*	▪ Zero deaths expected. Heavy rain and flooding are the most common causes of death. ▪ Zero to five injuries expected. Scrapes and cuts from debris are the most common causes of injuries.		
CRITICAL FACILITIES	*Limited*	▪ *Utilities* – Hours of critical facilities will be shut down. Trees and branches could cause downed power lines. ▪ *Information/Communication* – Hours-weeks-months of shutdown depending on intensity of damage. ▪ *Transportation* – Road crews shelter in place at height of wind speed will be out of service.		
RESPONSE CAPACITY	*Limited*	▪ *Police* – Local resources adequate. No impact to response capability and continuity of operations. ▪ *Fire and Rescue* – Local resources adequate. Limited impact to response capability. Additional personnel may be required to assist with increased call volume, damage assessment, and swift water team. ▪ *Health* – Local resources adequate. HD operations will not be affected and maintain contact with the EOC. ▪ *Public Works* – Local resources adequate. No impact on response capability and continuity of operations.		
ENVIRONMENTAL IMPACT	*Significant*	▪ Short-term spike in water pollution due to flooding.		
ECONOMIC IMPACT	*Limited*	▪ Limited amount loss in dollar value. ▪ Some infrastructure impact on economic consequences. ▪ Limited economic impact.		
TOTAL IMPACT	***Limited - Significant***	▪ **Total Impact Score: 1.1 on a scale of 1 (Limited) to 4 (Catastrophic).**		
Limited		*Significant*	*Critical*	*Catastrophic*

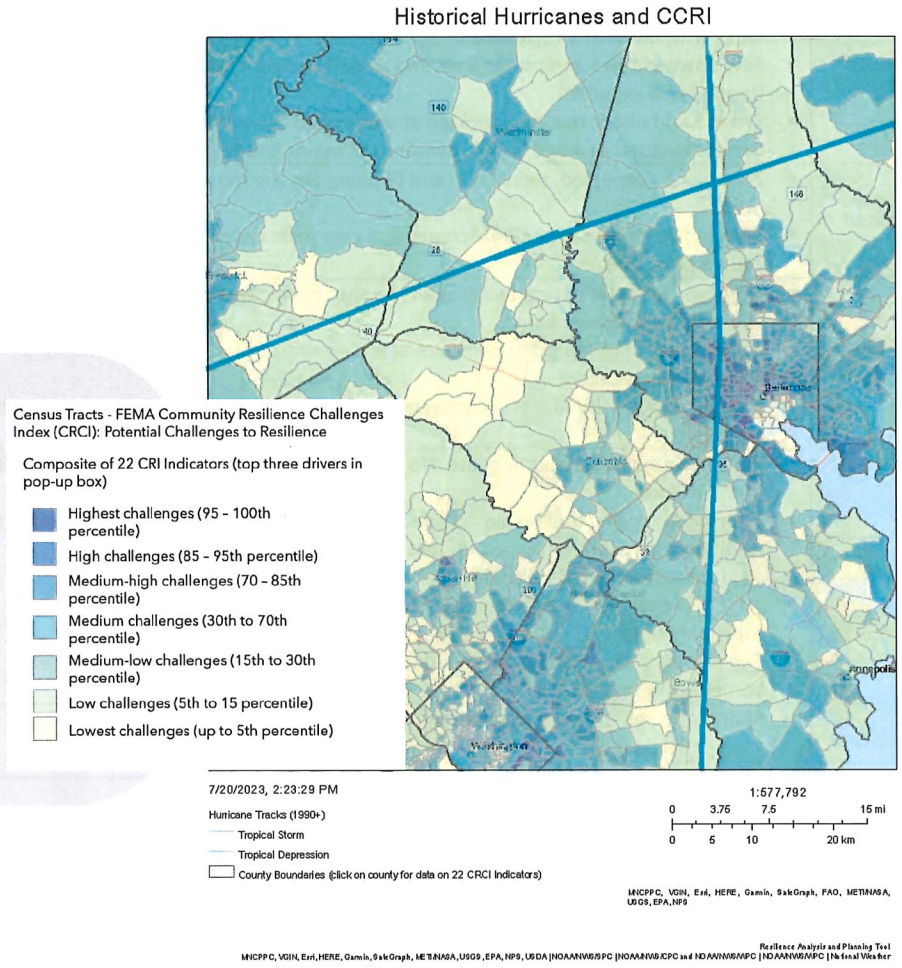
Vulnerability of County Assets

Historically, a hurricane or tropical cyclone has never tracked directly through Howard County; however, tropical cyclones have passed in close proximity after making landfall further south in the United States. As evidenced in Figure 35 and the map below from FEMA's RAPT, storms passing in close proximity would bring significant rainfall to Howard County, as well as the potential for high winds, severe thunderstorms. Given the concentration of population centers in the eastern portion of Howard County, there would be significant concerns were a hurricane to impact the County directly, particularly around Columbia. Assets that are vulnerable are the following:

People

- FEMA's CRI indicates slightly higher challenges to resilience in population centers in the eastern portion of the County. The map below depicts CRI with historical hurricane tracks.

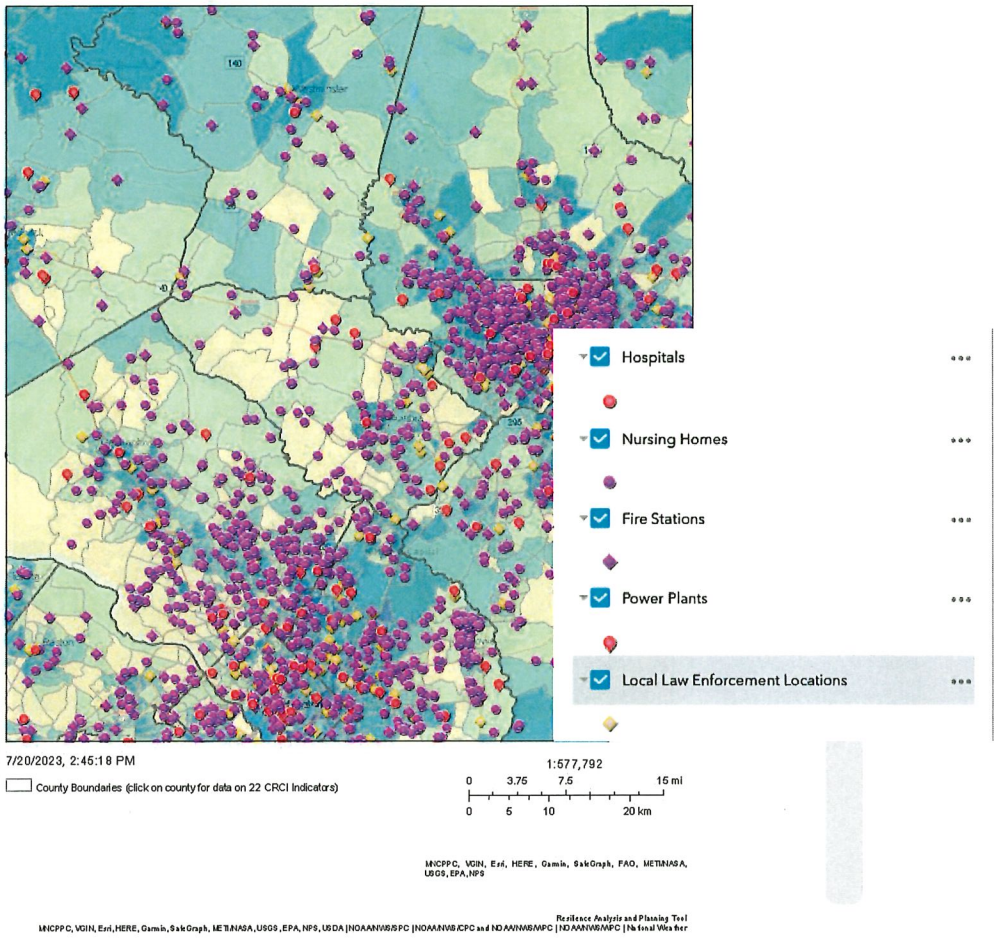
FIGURE 52: HISTORICAL HURRICANES & CCRI



Structures

- All residential and commercial buildings are vulnerable to strong wind
- Most nursing homes, hospitals, fire stations, power plants, law enforcement, universities, public and private schools, and utilities fall in the eastern portion of the County near population centers. The map below shows the clustering of these buildings as well as how these buildings are also largely located where populations with challenges to resilience reside.

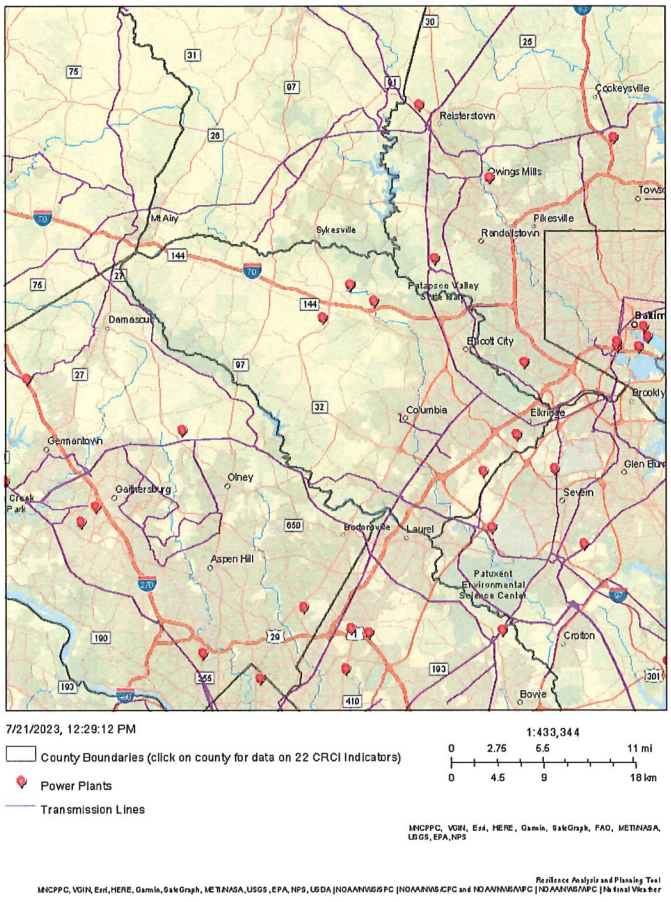
FIGURE 53: STRUCTURAL ASSETS & CCRI



- Historical Ellicott City Economy (due to its vulnerability to flooding, storms that bring heavy rains impact this area and the business's ability to operate).
- Electric/Gas Utilities (strong winds could knock out utilities for large areas of the County).
    - For example, Hurricane Irene, with windspeeds up to 50 mph in the area, caused widespread power outages throughout the County. According to the Baltimore Sun (2011), the storm left around 850,000 businesses and households without power[83].
    - The map below depicts power plants and electrical transmission lines that could be affected by high wind speeds.

[83] *Irene's Greatest Aggravation: Power Outages, 2011, Baltimore Sun, https://www.baltimoresun.com/maryland/bs-md-irene-power-20110828-story.html, (last accessed July 26, 2023).*

FIGURE 54: ELECTRICAL INFRASTRUCTURE



Systems

- Communications Systems (strong windspeeds could affect cell towers and ham radio antennae).
- Emergency Services (strong windspeeds could hinder large emergency vehicles, such as ambulances and fire engines).

Natural, Historic, and Cultural Resources

- Tree Canopy (strong wind speeds could knock down old or unhealthy trees).

Activities that Have Value to the Community

- Cultural activities that are held outdoors, such as festivals or concerts would be cancelled or postponed.

Effects of Population Change and Development in Hazard-Prone Areas

As Howard County, Maryland, anticipates changes in future population density, it's important to assess how these demographic shifts could influence the County's vulnerability to Hurricanes/Tropical Cyclones. While Howard County may not be directly affected by Hurricanes/Tropical Cyclones due to its distance from the coast, it still faces risks from the storms' residual effects of localized flooding, damaging winds, etc. Therefore, the "Hazard-Prone Areas" are those low-lying areas in the County as well as Historical Ellicott City and the Lawyer's Hill Historical District. Population density in these areas

can significantly impact the vulnerabilities and consequences of these weather events. Greater population density can strain existing drainage systems and stormwater infrastructure. As more land is developed, the capacity of drainage systems to handle runoff may be exceeded during intense rainfall events, potentially causing flooding in susceptible areas. As population density rises, there is an increased concentration of buildings, including residential and commercial structures, in limited geographic areas. Strong damaging winds can cause damage to structures and infrastructure, impacting densely populated areas more significantly. Higher population density often leads to increased urbanization and the expansion of impervious surfaces, such as roads, buildings, and parking lots. This can result in reduced natural absorption of rainwater, leading to increased surface runoff during heavy rainfall and a higher risk of localized flooding.

Future development in areas prone to flooding caused by hurricanes and tropical cyclones can lead to increased exposure of people and assets to the impacts of these storms. As more development occurs, a larger population and more infrastructure could be at risk from strong winds, heavy rainfall, flooding, and other associated hazards. While not directly coastal, parts of Howard County could still experience significant rainfall and flooding from the remnants of hurricanes and tropical cyclones.

Future development in flood-prone areas may also exacerbate the risk of inundation, particularly if stormwater management and drainage systems are not adequately designed to handle increased runoff. Densely populated areas with increased development are likely to have more critical infrastructure, such as buildings, roads, and utility systems. Hurricanes and tropical cyclones can cause widespread damage to these assets, disrupting services and potentially impeding emergency response and recovery efforts.

Population growth, density, and upcoming development are most noticeable in the central and southeastern parts of Howard County. To locate the specific areas of current and projected population density, as well as anticipated future development, please refer to Chapter 2 of the Plan. This chapter covers the Growth and Development, with a subsection dedicated to Future Development. These sections help identify where existing high population densities are located and where future developmental activities are anticipated.

Hurricanes / Tropical Cyclone - Consequence Analysis Likely		
CATEGORY	**RANKING**	**DESCRIPTION**
PROPERTY DAMAGE	*Limited*	▪ Critical and non-critical infrastructure will be damaged. ▪ Ellicott City, Elkridge, and other low-lying areas affected and downed trees and wires with minimal structural damage expected. ▪ Few downed trees and power lines and some flooding across roadways that usually flooded was expected. ▪ Erosion and minor roadbed damage at undersized culverts are expected. ▪ Some structural damage to occupancies and minor flooding is expected.
HEALTH AND SAFETY	*Limited*	▪ Zero deaths expected. Heavy rain and flooding are the most common causes of death. ▪ Zero to five injuries expected. Scrapes and cuts from debris are the most common causes of injuries.

CRITICAL FACILITIES	*Limited*	▪ *Utilities* – Hours of critical facilities will be shut down. Trees and branches could cause downed power lines. ▪ *Information/Communication* – Hours-weeks-months of shutdown depending on intensity of damage. ▪ *Transportation* – Road crews shelter in place at height of wind speed will be out of service.
RESPONSE CAPACITY	*Limited*	▪ *Police* – Local resources adequate. No impact to response capability and continuity of operations. ▪ *Fire and Rescue* – Local resources adequate. Limited impact to response capability. Additional personnel may be required to assist with increased call volume, damage assessment, and swift water team. ▪ *Health* – Local resources adequate. HD operations will not be affected and maintain contact with the EOC. ▪ *Public Works* – Local resources adequate. No impact on response capability and continuity of operations.
ENVIRONMENTAL IMPACT	*Significant*	▪ Short-term spike in water pollution due to flooding.
ECONOMIC IMPACT	*Limited*	▪ Limited amount loss in dollar value. ▪ Some infrastructure impact on economic consequences. ▪ Limited economic impact.
TOTAL IMPACT	***Limited - Significant***	▪ **Total Impact Score: 1.1 on a scale of 1 (Limited) to 4 (Catastrophic).**
Limited		*Significant* / *Critical* / *Catastrophic*

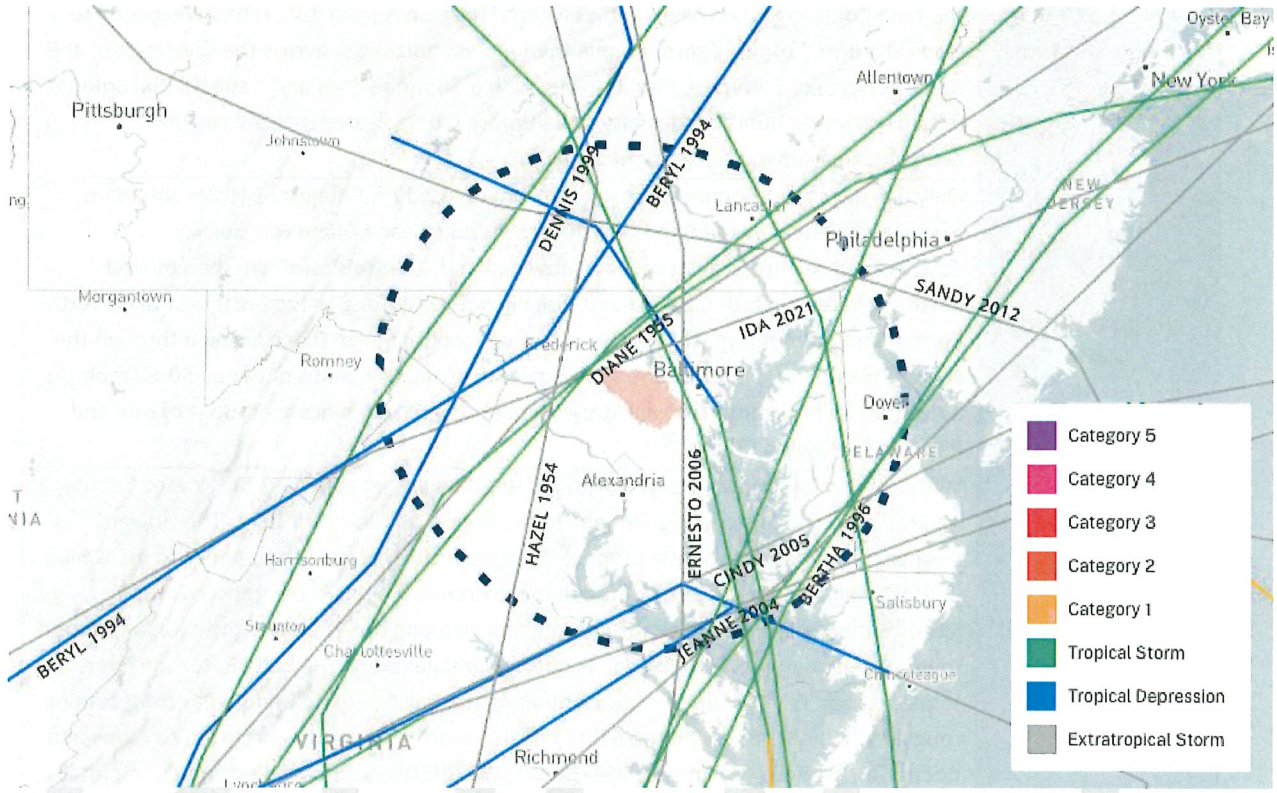
Hazard Occurrences

According to the NCDC database, there has not been a Hurricane in Howard County, Maryland since 2000 (categorized by passage of the eye directly over the County). Despite the eyes of storms not directly passing over Howard County, the County has felt the effects of nearby hurricanes across the years. The database does list one tropical storm event that has impacted Howard County from 1950 to 2022.[84] Other storms were downgraded to either tropical storms or tropical depressions by the time they reached the Mid-Atlantic region, which is typical for this region. Although not all of these storms brought significant damage, most brought heavy rain and increased high winds across Howard County. The map below depicts all storm tracks that occurred within 100 miles of Howard County from 1950-2021.

[84] *Storm Events Database*, NOAA NAT'L CTRS. FOR ENV'T INFO., https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+Hurricane+%28Typhoon%29&eventType=%28Z%29+Tropical+Depression&eventType=%28Z%29+Tropical+Storm&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=2000&endDate_mm=12&endDate_dd=31&endDate_yyyy=2022&county=HOWARD%3A27&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=24%2CMARYLAND (last visited Apr. 3, 2023).

FIGURE 55: HOWARD COUNTY: STORM TRACKS, 1950-2021

(Source: NOAA[85])



Notable Hurricane/Tropical Cyclone Incidents in Howard County

**The damage figures have been adjusted for inflation and are detailed in 2022-dollar values

September 1952 Tropical Storm Able	On the night of August 30th, 1952, Hurricane Able made landfall over Beaufort, South Carolina. As the storm moved northward across South Carolina, North Carolina, and Virginia, Able was downgraded to a tropical storm. On September 1st, the center of Tropical Storm Able had moved over the western portion of Howard County. Able brought winds of 35 to 40 mph and gusts up to 50 mph. The peak wind gust at the Washington National Airport was 60 mph. The rain associated with the storm caused isolated flooding, while the wind brought down trees and branches and caused power outages to the region.[86]
October 1954 Hurricane Hazel	On October 15th, 1954, Hurricane Hazel made landfall 250 miles south of Wilmington, North Carolina as a Category 3 hurricane. Hazel maintained its hurricane force winds as it rapidly progressed north. From Southern Virginia to Central Pennsylvania, Hazel produced Category 1 hurricane force winds. The eye of the storm passed to the west of Washington, D.C. and then near Hagerstown, Maryland. There were reports of peak gusts in an excess of 100 mph in Howard County.

[85] *Historical Hurricane Tracks*, NOAA, https://coast.noaa.gov/hurricanes/#map=4/32/-80 (last visited Apr. 3, 2023).

[86] Harry F. Hawkins, Jr., *The Weather and Circulation of August 1952*, 80 MONTHLY WEATHER REV. 134 (Aug. 1, 1952), https://journals.ametsoc.org/view/journals/mwre/80/8/1520-0493_1952_080_0134_twacoa_2_0_co_2.xml.

August 1955 Tropical Storm Connie	On August 12th, Connie made landfall over the Outer Banks of North Carolina as a Category 1 hurricane. Hurricane Connie then moved northward across North Carolina. By the time Connie reached Maryland's Eastern Shore on August 13th, it had weakened to a tropical storm. Tropical Storm Connie then moved northwest across the Chesapeake and towards north of Baltimore City, bringing with it 50 mph winds and a substantial amount of rain. Howard County's proximity to Baltimore City indicates that the region experienced a substantial amount of rainfall.
August 1955 Tropical Storm Diane	Only five days after Connie made landfall, on August 17th, Category 1 Hurricane Diane made landfall near Wilmington, North Carolina. Hurricane Diane was quickly downgraded to a tropical storm as it moved inland. The tropical storm then moved northwest across North Carolina and Virginia before shifting to the northeast over North-Central Virginia. On August 18th, the center of Tropical Storm Diane tracked through the eastern portion of Frederick County, Maryland, producing winds between 50-60 mph. As a result of its proximity, Tropical Storm Diane brought a significant amount of rain and flooding to Howard County.
June 1972 Tropical Storm Agnes	While the eye of Tropical Storm Agnes did not pass within 100 miles of Howard County, Agnes did cause considerable damage to the region on June 21st, 1972. The Howard County FIS estimates the total property damage from Tropical Storm Agnes to be as high as $55.4 million. The majority of the damage occurred along the Patapsco River in Ellicott City and Elkridge areas. The total damage along the Patapsco River was estimated to be approximately $48.4 million. Property damages along the Little Patuxent River totaled about $3.2 million and damages along the Patuxent and Middle Patuxent totaled roughly $689,581. An estimated $1.373 million worth of damages occurred to roads and bridges throughout the County. Meanwhile, the SHEDLUS database estimates the total property damage from Tropical Storm Agnes to be roughly $14.9 million.
September 1975 Hurricane Eloise	The remnants of Hurricane Eloise on September 22nd, 1975, coupled with snow from a previous storm, resulted in over 12 inches of rain in four days and caused both the Patuxent and Patapsco Rivers to overflow up to 24 feet above normal. Much of Ellicott City and Elkridge were again flooded, as some businesses had just reopened after recovering from the extensive damage caused by Tropical Storm Agnes. Mud and debris covered the landscape, and homes and businesses were declared unsafe.
September 1999 Tropical Storm Dennis	The remnants of Hurricane Dennis tracked across Western Maryland on September 7th. 1990, bringing heavy rain and flooding throughout the County. Strong winds also caused power outages throughout the region.
September 1999 Hurricane Floyd	The remnants of Hurricane Floyd produced high winds and heavy rains which closed 200 roads and streets Countywide on September 16th, 1999. Businesses were threatened by the raging waters of the Patapsco River as its banks overflowed in Ellicott City. Rainfall measurements of two to five inches were reported throughout the day. County officials reported 17 homes damaged, 350 basements flooded, two people rescued, and the Howard Country Fair was shut down for the first time in its 47-year history.
September 2003 Hurricane Isabel	Hurricane Isabel made landfall on September 18th, 2003m as a Category 2 hurricane. As the storm moved across Southern Virginia, it weakened to tropical storm status. The rain associated with Hurricane Isabel caused isolated flooding, while strong wind brought

	down power lines and left more than 65,000 homes without power. At one point, 80-90 roads were deemed impassable due to fallen trees.[87]
September 2006 Tropical Storm Ernesto	Tropical Storm Ernesto made landfall on September 1st, 2006, in North Carolina. The storm maintained its strength as it tracked northward from North Carolina to Virginia, and then into Southern Maryland. Ernesto's center passed just east of Howard County, bringing upwards of five inches of rain and wind guests over 50 mph. Ernesto's winds caused over 44,000 residents in the region to lose power.[88]
September 2008 Hurricane Hanna	On September 6th, 2008, Hurricane Hanna made landfall in Myrtle Beach, South Carolina. Hanna became an extratropical cyclone as it moved up the Eastern Seaboard towards Canada,[89] staying "east of the Baltimore-Washington metropolitan area. Maximum sustained winds generally averaged between 20-35 mph through the afternoon of the 6th."[90] There were 537 deaths reported, mostly as a result of flooding in Haiti, and seven deaths were reported on the east coast of the United States.[91]
August 2011 Tropical Storm Irene	In late August and early September 2011, Howard County was impacted by a downgraded Hurricane Irene, which became a tropical storm by the time it reached Central Maryland. Hurricane Irene originally made landfall on August 27th, 2011, as a Category 1 hurricane near Cape Lookout, North Carolina, with maximum sustained winds of 85 mph. The storm followed the Atlantic coastline as a Category 1 hurricane, which then made a second landfall near Little Egg Inlet, New Jersey the following morning. In Howard County, tens of thousands were left without power. Specifically, on August 27th, 2011, Howard County experienced 30,000 outages as Hurricane Irene advanced[92]. Initial estimates indicated damage of about $2.5 million in Howard County, where the storm severely damaged two homes and caused significant damage to four others in the Ellicott City area. The highest rainfall totals in Howard County were around four to five inches along the eastern part of the County. The path of the storm is shown in the figure below. In Maryland, Hurricane Irene caused tropical storm force winds and torrential rains. More than 700,000 people were left without power across the State. Total damage in Maryland was estimated at approximately $20.8 million, with the most severe damages occurring in the Eastern and Southern portions of the State. A Presidential Disaster Declaration (FEMA-DR-4034) was declared for 13 of the 24 counties in Southern and Eastern Maryland as a result of this storm.

[87] Jack Beven & Hugh Cobb, *Tropical Cyclone Report: Hurricane Isabel*, NAT'L HURRICANE CTR. (July 1, 2004) https://www.nhc.noaa.gov/data/tcr/AL132003_Isabel.pdf.

[88] Stephanie Desmon & Gadi Dechte, *Ernesto's Wind Gusts Punched Away at Maryland*, BALTIMORE SUN (Sept. 3, 2006), http://articles.baltimoresun.com/2006-09-03/news/0609030063_1_arundel-county-rain-anne-arundel.

[89] *Hurricane Hanna - September 6, 2008*, NOAA NAT'L WEATHER SERV., https://www.weather.gov/mhx/Sep062008EventReview (last visited Apr. 3, 2023).

[90] *Id.*

[91] *Id.*

[92] Brian M. Rosenthal, Cecilia Kang, & Clarence F. Williams, *More than 1 million without power, phone service as Hurricane Irene advances*, THE WASHINGTON POST (Aug. 27, 2011), https://www.washingtonpost.com/blogs/post_now/post/thousands-without-power-as-hurricane-irene-advances/2011/08/27/gIQAI2X1iJ_blog.html.

	The first two figures below show the total rainfall and wind speeds for Hurricane Irene. The rainfall figure shows rainfall totals in Howard County were around two inches in the western part of the County, with the rainfall total increasing to the east. The highest rainfall totals in Howard County were between four to five inches along the eastern part of the County. Hurricane Irene also caused widespread power outages throughout the impacted area. The figure below provides a Baltimore Gas and Electric (BGE) report showing the number of power outages on August 30th by Zone Improvement Plan (ZIP) code.
September 2011 Tropical Storm Lee	Tropical Storm Lee made landfall on September 4th, 2011, along the Gulf Coast near South-Central Louisiana as a slow-moving storm with heavy rains and winds of 45 mph. The storm slowly moved inland, bringing torrential rain and flooding to the Gulf Coast region. The storm continued inland, tracking towards the Mid-Atlantic and Northeast. On September 7th, 2011, the remnants of the storm reached the Maryland area. That afternoon, the combination of a warm front moving across the area and the moisture from the remnants of Tropical Storm Lee produced heavy storms and flooding. With two to three inches of rain falling on already saturated soils, the heavy rains caused flash flooding throughout Maryland. Specific to Howard County, flash flood warnings were issued after heavy rains caused numerous rivers and creeks to rise. According to the NWS, the Little Patuxent River near Savage rose to 13.6 feet on September 7th, its highest level in the previous five years. [93] [94] The storms and flooding also resulted in numerous road closures. More than 40 road closures were reported in Howard County, including portions of Route 1 and Route 29. South Entrance Road in Columbia, which connects Little Patuxent Parkway to Route 29 Southbound, was closed in the early afternoon of September 7th. The most significant flooding from Tropical Storm Lee occurred along Main Street in Historic Ellicott City, an area prone to flooding. The swollen Patapsco River and Tiber Creek River flooded parts of Main Street. Portions of the road on Main Street were covered in rushing water, causing pockets of water that were several feet deep. Several businesses closest to the river and creek flooded, with up to six feet of floodwater in their basements.[95] As a result of the flooding, the DFRS evacuated the area from the County line to Cocoa Lane (the 8200 through 8500 blocks). The figures below show flooding along Main Street, as well as behind a municipal parking lot adjacent to Main Street. As a result of the flooding, a Presidential Disaster Declaration (FEMA DR-4038) was declared on October 5th, 2011, for Howard County and several other Maryland counties.

[93] Lindsey McPherson, *Heavy Rains Batter County; Flood Warning Extended to Thursday Morning*, BALTIMORE SUN (Sept. 7, 2001), https://www.baltimoresun.com/ph-ho-cf-flooding-0915-20110907-story.html.

[94] The highest level ever recorded there previously was 18.38 feet in June 1972 after Hurricane Agnes.

[95] Travis Crouse, *Ellicott City Flooding Tropical Storm Lee*, MD HISTORIC DISTRICT (Sept. 7, 2011), http://www.mdhistoricdistrict.com/ellicott-city-flooding-from-tropical-storm-lee/.

October 2012 Hurricane Sandy	Hurricane Sandy impacted the United States, Caribbean, and Canada. According to the Tropical Cyclone Report, "The cyclone made landfall as a category 1 hurricane (on the Saffir-Simpson Hurricane Wind Scale) in Jamaica, and as a 100-kt category 3 hurricane in eastern Cuba before quickly weakening to a category 1 hurricane while moving through the central and northwestern Bahamas [...] The system strengthened into a hurricane while it moved northeastward, parallel to the coast of the southeastern United States, and reached a secondary peak intensity of 85 kts while it turned northwestward toward the mid-Atlantic states."[96] On October 29th, 2012, Hurricane Sandy made landfall to the north of Maryland, along the coast of Southern New Jersey as a post-tropical cyclone with 70 kt maximum sustained winds.[97] Sandy was responsible for a total of 147 deaths. Within the United States, there were 72 deaths "making Sandy the deadliest U.S. cyclone outside of the southern states since Agnes (1972)."[98] 48 of those deaths occurred in New York, though none occurred in Howard County. 54 deaths occurred in Haiti, 11 in Cuba, three in the Dominican Republic, two in the Bahamas, two offshore within the Atlantic Ocean, one in Canada, one in Jamaica, and one in Puerto Rico.[99] Additionally, within the United States, at least 650,000 houses were damaged or destroyed and 8.5 million lost power.[100] The size and intensity of the storm brought heavy rain and high winds to Howard County. A water reclamation plant in Savage experienced a power outage. This caused "20 – 25 million gallons of untreated but rain-diluted human waste to spill into the Little Patuxent River, a branch of one of the Chesapeake Bay's most degraded tributaries."[101] Water contamination became a significant threat to the health and environment of those downstream from the plant. Water mains feeding Howard County from the City of Baltimore failed, and the drinking water supply was limited for a period of one to two weeks.
August 2020 Hurricane Isais	In late July of 2020, the National Hurricane Center began tracking a tropical wave that developed off the coast of Africa. This tropical wave would gradually move west towards the Caribbean, while gradually strengthening. This tropical wave was given the name Isaias when it was designated as a tropical storm at 11 PM on Wednesday July 29th. Isaias then took a northwest turn towards the Bahamas, while remaining just off of the east coast of Florida. There, it reached its peak intensity as a Category 1 hurricane, with maximum sustained winds of 85 mph, and a minimum central pressure of 987 mb. Weakening occurred as Isaias moved through the Bahamas, dropping back down to a strong tropical storm. Isaias then re-strengthened as it began to turn northward and move towards the North Carolina coastline, eventually reaching Category 1 hurricane

[96] Eric S. Blake, Todd B. Kimberlain, Robert J. Berg, John P. Cangialosi, and John L. Beven II, *Tropical Cyclone Report: Hurricane Sandy*, NOAA NAT'L HURRICANE CTR. (Feb. 12, 2013), https://www.nhc.noaa.gov/data/tcr/AL182012_Sandy.pdf.

[97] *Id.*

[98] *Id.*

[99] *Id.*

[100] *Id.*

[101] Timothy B. Wheeler, *Storm triggers Big Howard Sewage Spill*, BALTIMORE SUN (Oct. 30, 2012), https://www.baltimoresun.com/news/environment/bs-gr-howard-sewer-leak-20121030-story.html.

	status once again, with winds of 85 mph and a minimum central pressure of 988 mb. Isaias made landfall at Ocean Isle Beach, North Carolina at 11:10 PM EDT on Monday August 3rd."[102] In Howard County, the 911 Call center received about a dozen calls for trees, branches, and wires down. There were no deaths or injuries reported.

Hazard Future Likelihood - Medium

The historical probability is based on the eye of a storm passing directly over Howard County. However, this does not account for the numerous hurricanes and tropical storms that have passed in close proximity and have had impacts on Howard County. The future annual probability of this event is 1-30% chance of annual occurrence, or one event every 3-99 years. An expected increase in rainfall levels and extreme storms may result in a slight increase in the likelihood of flooding.[103] The National Climate Assessment also states that "there has been a substantial increase in most measures of Atlantic hurricane activity since the early 1980s [including] measures of intensity, frequency, and duration as well as the number of strongest (Category 4 and 5) storms."[104] Other considerations include Howard County's proximity to the Chesapeake Bay and its location on the East Coast.

The following table anticipates the future occurrence rate of the hazard based on historical likelihood and future trends.

Future Likelihood of a Hurricane/Tropical Cyclone Hazard in Howard County	
Historical Average (time period)	1 event (2002-2022)
Historical Annual Probability	1-10% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes
Future Annual Probability	1-30% chance of annual occurrence
Future Likelihood Score	2.4 (Infrequent-Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

Wildfires (Risk Score 1.7)

Hazard Description

Wildfires are uncontrolled forest fires, grassland fires, rangeland, or urban-interface fires which consume natural fuels and spread in response to the environment.[105] Wildfires can be either a natural phenomenon or human-caused. The frequency and severity of wildfires depends on both weather and

[102] *Tropical Storm Isaias Impacts: August 4th, 2020*, NOAA Nat'l Weather Serv., https://www.weather.gov/lwx/TropicalStormIsaias (last visited Apr. 6, 2023).
[103] *Fourth National Climate Assessment, Volume II: Impacts, Risks, & Adaptation in the United States*, U.S. Global Change Research Program, https://nca2018.globalchange.gov (last visited Apr. 3, 2023).
[104] *Id.*
[105] *NWCG Glossary of Wildland Fire Terminology*, Nat'l Wildfire Coordinating Group, https://www.nwcg.gov/publications/pms205 (last visited Apr. 6, 2023).

human activity. Wildfires can occur any month in Maryland but peak in the spring and fall. During these seasons, deciduous trees are bare, allowing sunlight and wind to reach the ground and dry any available fuels. The relative humidity of the air is also lower and, combined with a breeze, creates the conditions for wildfires to spread rapidly. Wildfires can also occur in late fall. Depending on weather conditions, the month of November also generally has a high rate of wildfires.[106] The following table presents the Risk Score for drought in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Wildfire Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	2.2 Infrequent-Likely		50%
CONSEQUENCE	**Impact**	1 Limited	1.7 Limited-Significant	40%
	Warning Time	4 Short	4 Short	5%
	Duration	1 Short	2 Moderate	5%
	TOTAL RISK SCORE	**1.9**	**2.1**	

Hazard Location

Although urban interface fires have the greatest possibility to cause property damage, the potential for wildfires exists throughout the entire County. The greatest risk for significant wildfires to occur would be in large, forested areas such as the Patapsco State Park and the Hugh Thomas Wildlife Management Area to the north. The Patapsco River Valley, where Patapsco State Park is located, is characterized by steep slopes exceeding 20% grade. In addition, dense vegetation and hardwoods provide ample fuel for fire. In the southern portion of the County, the Rocky Gorge Reservoir Park and the Patuxent Wildland Area are also areas at risk for potential wildfires. The Patuxent Wildland Area is a State-designated wildland, which restricts the ability to reduce fuels or create ingress routes. In addition, the characteristics of the Patuxent Wildland Area are similar to the Patapsco State Park, where dense vegetation and hardwoods provide high fuel loads.

Hazard Extent

The frequency and severity of wildfires depends on many factors. The three that control wildfire behavior the most are the availability of fuels, the weather, and the areas topography. In addition, vegetation left over after a dry winter can provide more fuel. The speed and intensity of a fire will usually increase as the slope and wind increases, and the humidity decreases. The severity in Howard

[106] For additional information on wildfires, *see Wildland Fire in Maryland*, MARYLAND DEP'T OF NAT. RES., https://dnr.maryland.gov/forests/Pages/wfm.aspx (last visited Apr. 3, 2023).

County has been historically low, and the duration of wildfires has ranged from a matter of hours to several days.

A measure to predict daily wildfire and a forecast for future conditions for the County is the National Fire Danger Rating System (NFDRS)[107]. It rates fire potential using five color-coded levels, which are described below.

Fire Danger Level	Description
Low	Fuels do not ignite easily from small embers, but a more intense heat source, such as lightning, may start fires in duff or dry rotten wood. Fires in open, dry grasslands may burn easily a few hours after a rain, but most wood fires will spread slowly, creeping or smoldering. Control of fires is generally easy.
Moderate	Fires can start from most accidental causes, but the number of fire starts is usually pretty low. If a fire does start in an open, dry grassland, it will burn and spread quickly on windy days. Most wood fires will spread slowly to moderately. Average fire intensity will be moderate except in heavy concentrations of fuel, which may burn hot. Fires are still not likely to become serious and are often easy to control.
High	Fires can start easily from most causes and small fuels (such as grasses and needles) will ignite readily. Unattended campfires and brush fires are likely to escape. Fires will spread easily, with some areas of high intensity burning on slopes or concentrated fuels. Fires can become serious and difficult to control unless they are put out while they are still small.
Very High	Fires will start easily from most causes. The fires will spread rapidly and have a quick increase in intensity, right after ignition. Small fires can quickly become large fires and exhibit extreme fire intensity, such as long-distance spotting and fire whirls. These fires can be difficult to control and will often become much larger and longer-lasting fires.
Extreme	Fires of all types start quickly and burn intensely. All fires are potentially serious and can spread very quickly with intense burning. Small fires become big fires much faster than at the "very high" level. Spot fires are probable, with long-distance spotting likely. These fires are very difficult to fight and may become very dangerous and often last for several days.

Notably, Howard County has a wealth of fire response assets, both internally and in neighboring jurisdictions, as evidenced in the map below, that would allow for rapid suppression, even in the more rural parts of Howard County.

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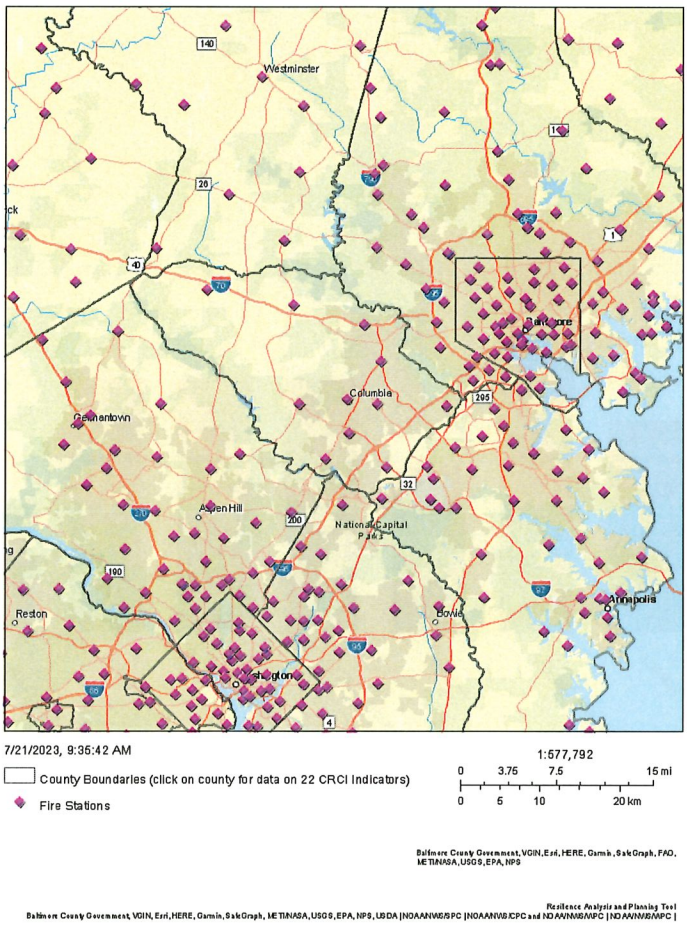
[107] *National Fire Danger Rating System, US Forest Service, https://www.fs.usda.gov/detail/cibola/landmanagement/resourcemanagement/?cid=stelprdb5368839, (last accessed July 26, 2023).*

FIGURE 56: HOWARD COUNTY FIRE STATIONS

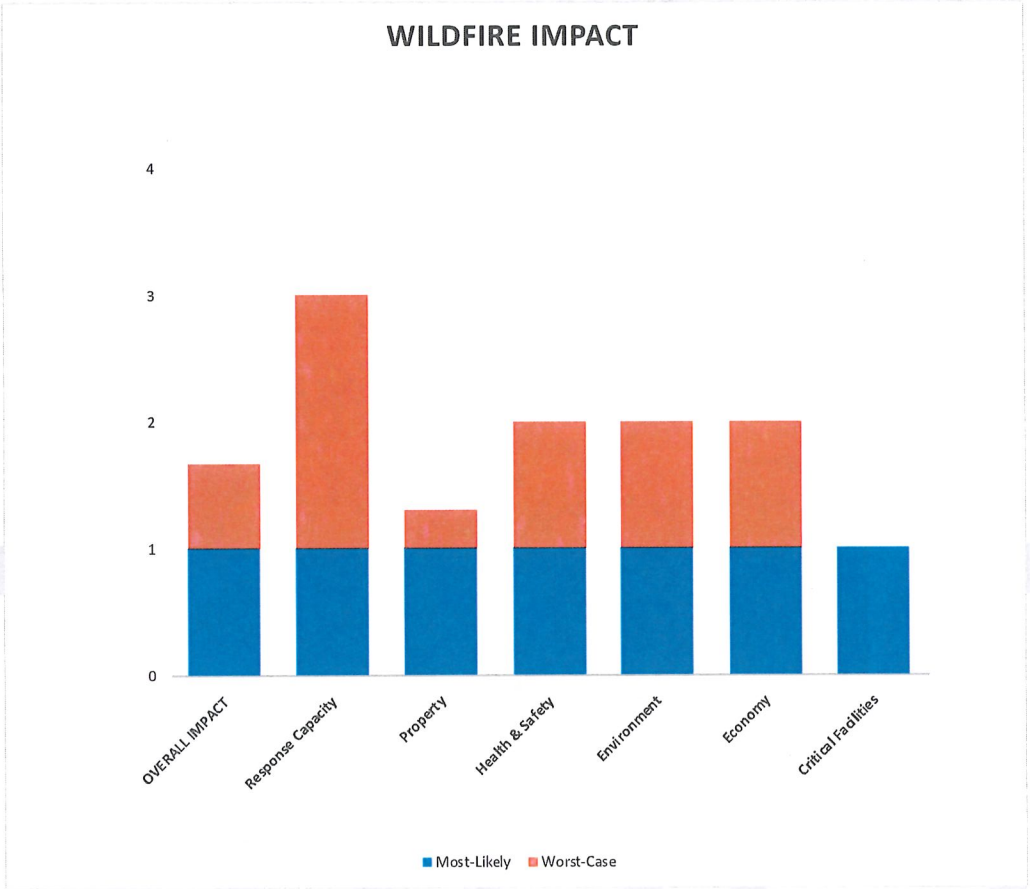


Hazard Impacts

The severity in Howard County has been historically very low, and the duration of wildfires has ranged from a matter of hours to several days. Wildland urban interface fires[108] are becoming increasingly problematic in Maryland. As people continue to live and work near wildland areas, the threat to private property from wildfires increases. This phenomenon is growing in Howard County as suburbanization and population growth continues in the County.

The figure and table below characterize wildfire impacts to property, health and safety, critical facilities, response capacity, the environment, and the economy.

[108] *What is the WUI?*, U.S. FIRE ADMIN., https://www.usfa.fema.gov/wui/what-is-the-wui.html (last visited Apr. 6, 2023) (defining the wildland urban interface as "the zone of transition between unoccupied land and human development").



Vulnerability of County Assets

Data on occurrences of wildfires within Howard County is not available, but the areas at greater risk are the more rural, western portions of Howard County, which is largely agricultural and has a low population density. Assets that are vulnerable to wildfires are the following:

People

- People with challenges to resilience according to FEMA's Community Resilience Index. Please refer to Chapter 2, Section FEMA Community Resilience Index to review this map and indicators for the County.
- People living in the rural, western portions of Howard County (Patapsco State Park, Hugh Thomas Wildlife Management Area).

Structures

- All residential and commercial buildings are vulnerable to wildfires

Systems

- Economy (most area farms are located in the western portion of the County where wildfires are more likely to occur).

Natural, Historic, and Cultural Resources

- Tree Canopy (trees can be damaged or destroyed by wildfires)

- Historic wooden buildings located in or near the State parks.

Activities that Have Value to the Community

- Camping and hiking areas

Effects of Population Change and Development in Hazard-Prone Areas

Increased population density can lead to urban expansion into wildland areas, creating what is known as the urban-wildland interface. This interface is particularly vulnerable to wildfires, as homes and infrastructure are in close proximity to natural vegetation and forested areas. Higher population density can contribute to an increase in human activities that could spark wildfires, such as campfires, discarded cigarette butts, outdoor equipment use, and electrical malfunctions. Densely populated areas have more infrastructure and utilities, including power lines and gas pipelines, which can be vulnerable to wildfire-related damage. Wildfires can disrupt essential services and pose additional risks to residents.

The interaction between population growth, land use, and fire risk is crucial in determining the potential impacts on wildfire vulnerability. The proximity of structures to natural fuels like trees and grasslands can expedite fire spread. Urbanization can create localized microclimates that influence fire behavior. Wind patterns, heat retention in urban areas, and altered fuel characteristics can contribute to more intense and unpredictable fire behavior, making firefighting efforts more challenging. Development can influence the level of community awareness and preparedness for wildfires.

Future population growth, density, and upcoming development are most noticeable in the central and southeastern parts of Howard County. To locate the specific areas of current and projected population density, as well as anticipated future development, please refer to Chapter 2 of the Plan. This chapter covers the Growth and Development, with a subsection dedicated to Future Development. These sections help identify where existing high population densities are located and where future developmental activities are anticipated.

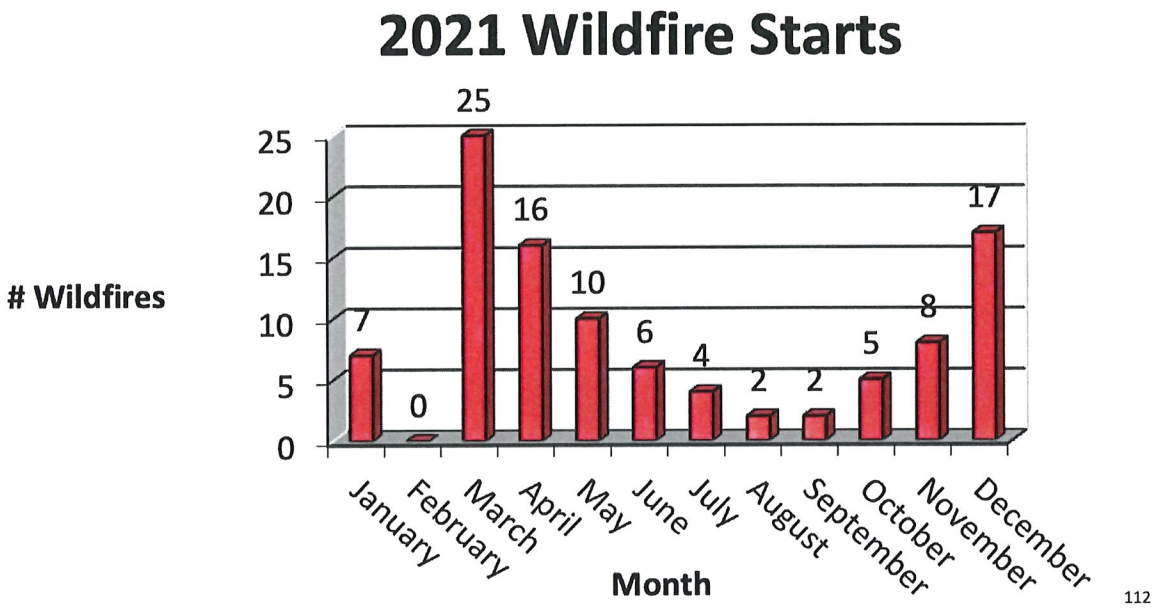
Wildfire - Consequence Analysis **Likely**		
CATEGORY	**RANKING**	**DESCRIPTION**
PROPERTY DAMAGE	*Limited*	▪ 0% of critical and non-critical infrastructure will be damaged. ▪ Scorched earth and destroyed landscaping expected.
HEALTH AND SAFETY	*Limited*	▪ Zero deaths are expected. Smoke and toxic gas is the most common causes of death. ▪ Zero to two injuries are expected. Smoke inhalation and toxic gases are the most common causes of injuries.
CRITICAL FACILITIES	*Limited*	▪ *Utilities* - Shutdown or out of service is unlikely. ▪ *Information/Communications* - Shutdown or out of service is unlikely. ▪ *Transportation* – Traffic is shut down for twenty (20) minutes.
RESPONSE CAPACITY	*Limited*	▪ *Police*- Local resources adequate. No impact to response capability or continuity of operations. ▪ *Fire and Rescue* -Local resources adequate. Traffic issues and increased response times may be impacted. ▪ *Health*- Local resources adequate. HD operations will not be affected and will be communicating with the EOC.

		▪ *Public Works* - Local resource adequate with minimal to no impact on response capability and continuity of operations. ▪ *DPW-* Mutual aid needed (Fire and Rescue, possibly SHA). Some response calls will be rerouted.
ENVIRONMENTAL IMPACT	*Limited*	▪ Minimal impact with a loss to plant and animal life in the immediate area. ▪ Limited environmental impact is expected.
ECONOMIC IMPACT	*Limited*	▪ Limited loss in dollar value. ▪ Limited economic consequences.
TOTAL IMPACT	***Limited***	▪ **Total Impact Score: 1 on a scale of 1 (Limited) to 4 (Catastrophic).**

Limited	*Significant*	*Critical*	*Catastrophic*

Hazard Occurrences

Wildfires incident data shows fires in Maryland occur relatively frequently. In an average year, "the Maryland Forest Service responds to an average of 325 wildfires that burn more than 3,200 acres of forest, brush, and grasses. Fire departments respond to over 5,000 wildfire incidents per year."[109] In 2018, Maryland experienced a total of 77 wildfires.[110] In 2021, that number had jumped to 102.[111]



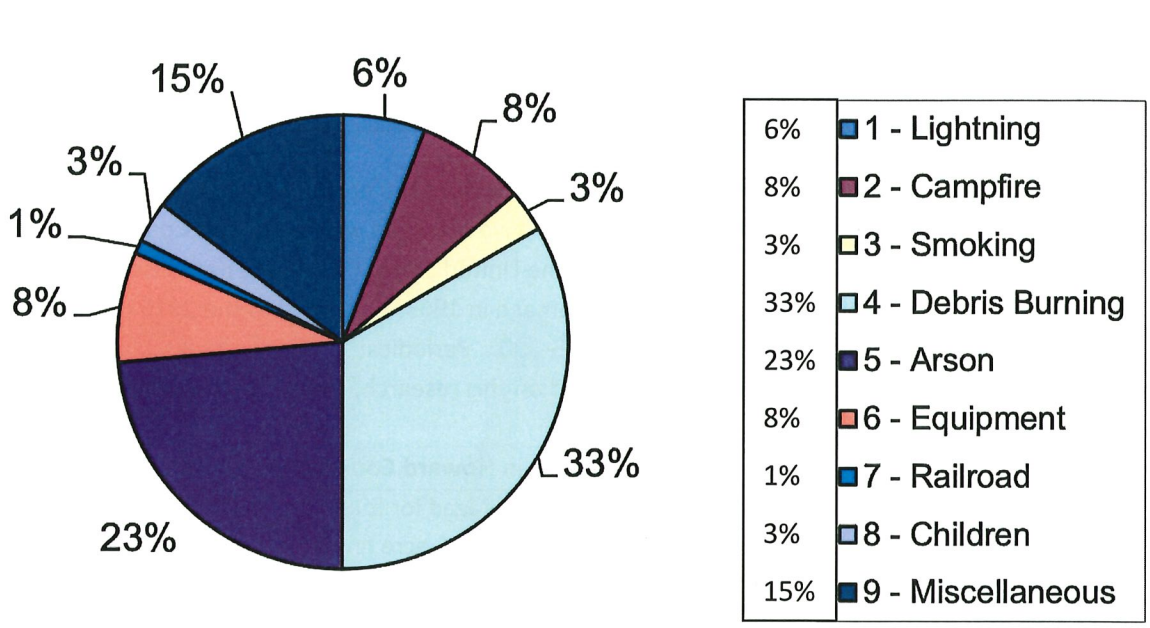
[112]

[109] *Wildland Fire in Maryland*, MARYLAND DEP'T OF NAT. RES., https://dnr.maryland.gov/forests/Pages/wfm.aspx (last visited Apr. 3, 2023).

[110] *Maryland Forest Service Wildland Fire Program 2018 Annual Wildland Fire Report*, MARYLAND DEP'T OF NAT. RES. (2018) https://dnr.maryland.gov/forests/Documents/fire/2018AnnualWildfireReport.pdf.

[111] *Maryland Forest Service Wildland Fire Program 2021 Annual Wildland Fire Report*, MARYLAND DEP'T OF NAT. RES. (2021) https://dnr.maryland.gov/forests/Documents/fire/2021AnnualWildfireReport.pdf.

[112] *Id.*



[113]

The table below summarizes the total number of fires and acres for the State of Maryland between 2004 and 2021.

Fires and Acres Burned in Maryland from 2004 - 2021[114]

(Source: Maryland Department of Natural Resources)

Year	Total Number of Fires	Total Acres Burned
2004	253	3,149
2005	441	4,344
2006	753	6,074
2007	622	5,102
2008	583	2,339
2009	408	4,853
2010	170	1,503
2011	125	8,310
2012	159	837
2013	122	161
2014	118	1,721
2015	158	1,078
2016	121	242
2017	107	2,175

[113] *Id.*

[114] *Id.*

Year	Total Number of Fires	Total Acres Burned
2018	77	359
2019	138	1,493
2020	76	1,421
2021	102	1,363

The NCDC[115] indicated there were no wildfire incidents between 1950 and 2022 within Howard County. However, additional research does reflect that wildfires have occurred within Howard County. According to the Spatial Hazard Events and Losses Database for the United States (SHELDUS) database,[116] two wildfires caused several thousand dollars' worth of damage in 1963. According to the 2015 HIRA, there were 6,919 wildfire hazard events recorded from 1995-2001. Periodical sources were also consulted to identify past wildfire events for Howard County. Based on this research, some recent wildfire events are described below.

Notable Wildfire Incidents in Howard County

March 1999	On March 30th, 1999, a 10-acre brushfire raged for four hours in the Patapsco Valley State Park. Firefighters were then called to a 5-acre brushfire within an hour after extinguishing the park fire. Firefighters responded to four other fires within eight miles of one another. The high number of fires was due to drought-like conditions.
March 2004	On March 23rd, 2004, a brushfire on County land near Oakland Mills High School in Columbia burned 10 acres of land. Fueled by dead corn stalks and trees, the fire raced across an open field before firefighters contained it an hour later.[117]
February 2011	On February 19th, 2011, high winds with gusts up to 45 mph, high temperatures, and low humidity contributed to the start of eight brushfires, which eventually burned down 20 acres. One of the largest fires occurred near the 3800 block of Manor Lane in Ellicott City. A wildfire was also located on Interstate 95 in the Laurel area between MD-198 and the Capital Beltway closing both northbound and southbound lanes until the fire was brought under control.

Additionally, current wildfire data from DFRS reflects the following data relating to the number of wildfires within Howard County:

2016	2017	2018	2019
116	135	112	57

[115] *Storm Events Database*, NOAA NAT'L CTRS. FOR ENV'T INFO., https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+Wildfire&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=9999&endDate_mm=12&endDate_dd=31&endDate_yyyy=9999&county=HOWARD%3A27&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=24%2CMARYLAND (last visited Apr. 6, 2023).

[116] *Spatial Hazard Events and Losses Database for the United States,* AZ. STATE UNIV. CTR. FOR EMERGENCY MGMT. AND HOMELAND SECURITY, https://cemhs.asu.edu/sheldus (last visited Apr. 6, 2023).

[117] Gus Sentementes, *Brush Fire Scorches About 10 Acres*, BALTIMORE SUN (Mar. 24, 2004), http://articles.baltimoresun.com/2004-03-24/news/0403240194_1_firefighters-oakland-mills-corn-stalks.

Due to conflicting data, a definitive total number of wildfires occurring within Howard County from 1995-2022 cannot be determined. However, based on all the data provided above, there is an estimated number of over 7,300 wildfire hazard events that have occurred in Howard County in the reviewed time period of 1997-2022.

Hazard Future Likelihood - Medium

The future annual probability of this hazard is 1-30% chance of annual occurrence, or one event every 9-99 years. As noted above, wildfire incidents are directly related to weather patterns and antecedent conditions, and thus its probability of occurrences are dynamic. Other considerations include the prevalence of native pine trees within the County and lesser maintenance of fallen trees.

The following table anticipates the future occurrence rate of the hazard based on historical likelihood and future trends.

Future Likelihood of a Wildfire in Howard County	
Historical Average (time period)	Estimated over 7,300 events (1997-2022)
Historical Annual Probability	30%+ chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No
Future Annual Probability	1-30% chance of annual occurrence
Future Likelihood Score	2.2 (Infrequent/Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

While climate change is increasingly a driver of fire behavior and wildfire occurrence, especially in cases of the intense fire behavior seen in the Western United States, Canada, and Australia, the local context of Howard County is quite different. Subject matter experts identified high population density, ease of access to water, and a robust response system as factors that currently mitigate any increase in likelihood due to the myriad effects of climate change.[118] Additionally, challenges in data collection do not distinguish between emergency-level wildfires and smaller occurrences. As such, there is not an expected increase in future likelihood, but Howard County continues to observe these instances and refine data collection to ensure continued accurate analysis.

Earthquake (Risk Score 1.7)

Hazard Description

An Earthquake is a sudden release of energy from the earth's crust that creates seismic waves. Stress is created in the earth's crust from thermal variations, tectonic changes, and other forms of pressure. Weaknesses in the earth crust yield when the stresses exceed the friction along these crustal weaknesses, and an earthquake happens. At the earth's surface, earthquakes may manifest themselves

[118] Howard County HIRA Subject Matter Expert Workshops, Consequence Analysis. Fall 2022

by a shaking or displacement of the ground. This may lead to loss of life and destruction of property. The size of an earthquake is expressed quantitatively as magnitude[119], while local strength of shaking is expressed as intensity. The following table presents the Risk Score for earthquakes in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Earthquake Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	2 Infrequent		50%
CONSEQUENCE	**Impact**	1 Limited	3.5 Critical-Catastrophic	40%
	Warning Time	4 Short	4 Short	5%
	Duration	1 Short	4 Very Long	5%
	TOTAL RISK SCORE	**1.6**	**2.6**	

Hazard Location

The entire County is susceptible to the effects of earthquakes. The map shown below was produced by the 2018 U.S. Geological Survey National Seismic Hazard Mapping Project. "The 2018 Update of the U.S. National Seismic Hazard Model defines the potential for earthquake ground shaking for various probability levels across the conterminous United States and is applied in seismic provisions of building codes, insurance rate structures, risk assessments, and other public policy."[120]

[119] The inherent size of an earthquake is commonly expressed using a magnitude.

[120] Earthquake Hazards Program, *2018 United States (Lower 48) Seismic Hazard Long-term Model*, USGS (Oct. 24, 2019), https://www.usgs.gov/programs/earthquake-hazards/science/2018-united-states-lower-48-seismic-hazard-long-term-model (last visited Apr. 3, 2023).

FIGURE 57: UNITED STATES EARTHQUAKE HAZARD MAP

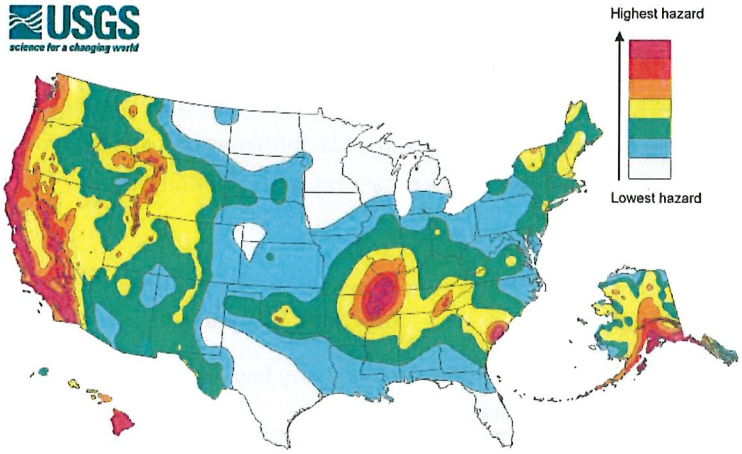
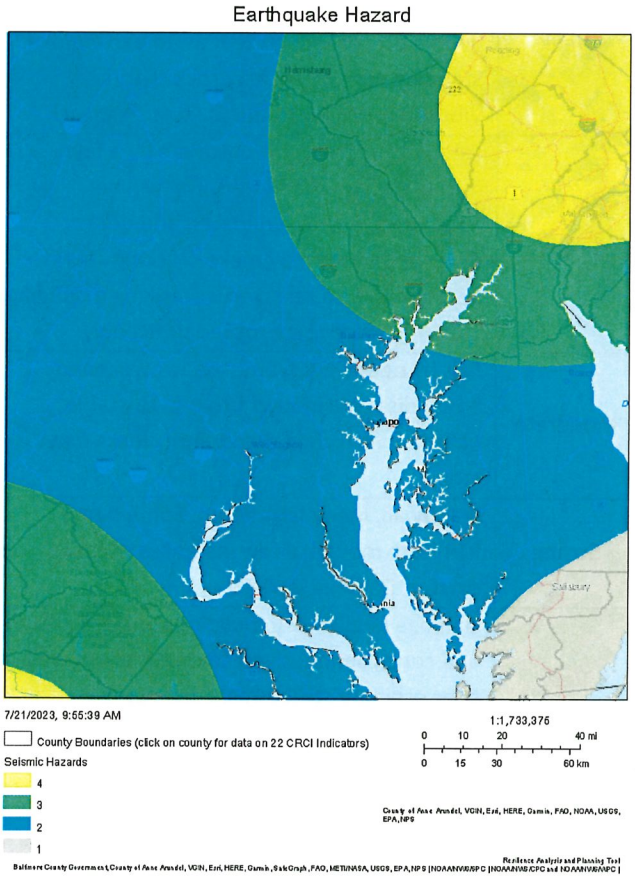


FIGURE 58: HOWARD COUNTY EARTHQUAKE HAZARD



Hazard Extent

Earthquakes are measured by their Mercalli magnitude and their intensity. The Modified Mercalli Intensity Scale describes the severity of earthquake effects. It is a ranking based on observed effects that people will experience and find relatable. The lower numbers of the intensity scale generally deal with the way the earthquake is felt by people. The higher numbers of the scale are based on observed structural damage. Structural engineers usually contribute information for assigning intensity values of VIII or above[121]. The table below describes these measurements. Definitions sourced from U.S. Geological Survey (USGS).

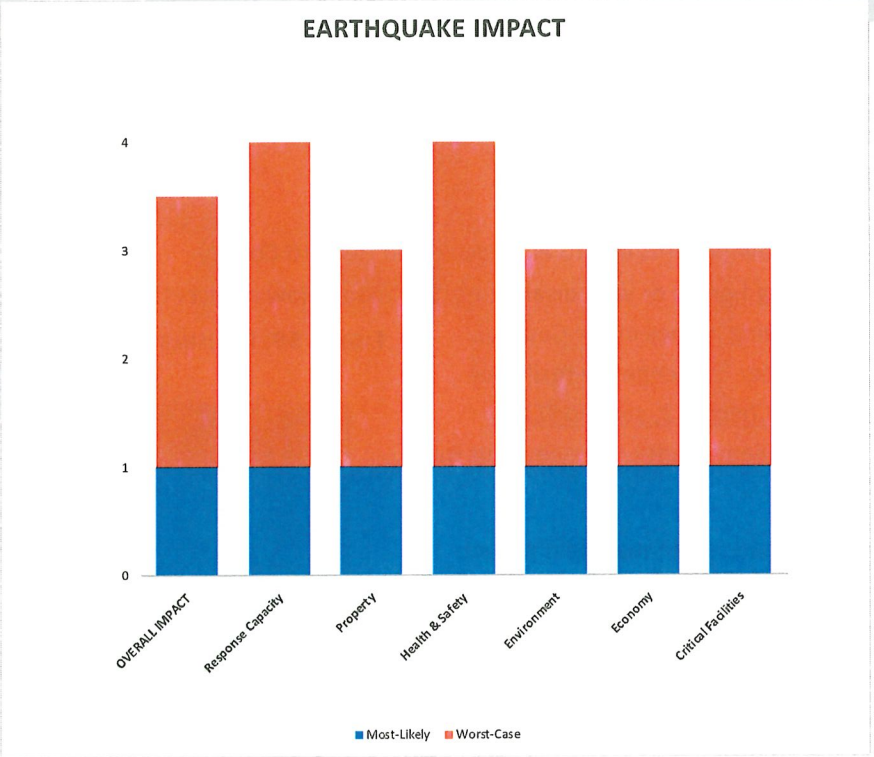
Intensity	Richter Magnitude	Shaking	Description/Damage	Average Estimated Annual Frequency
I	<2.0-2.9	Not Felt	Not felt except by a very few under especially favorable conditions.	Continual/several million per year
II		Weak	Felt only by a few persons at rest, especially on upper floors of buildings.	Over one million per year
III	3.0-3.9	Weak	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck.	Over 100,000 per year
IV		Light	Felt indoors by many, outdoors by a few during the day. At night, some will be awakened. Dishes, windows, and doors disturbed; walls may make cracking sound. Sensation like a heavy truck striking a building. Standing motor cars rocked noticeably.	
V	4.0-4.9	Moderate	Felt by nearly everyone; many awakened. Some dishes/windows broken. Unstable objects overturned. Pendulum clocks may stop.	10,000 to 15,000 per year
VI		Strong	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage is slight.	
VII	5.0-6.9	Very Strong	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken	1,000 to 1,500 per year
VIII		Severe	Damage slight in specially designed structures; considerable damage in ordinary substantial	

[121] *Draft City of Annapolis Hazard Mitigation Plan, 2023, Office of Emergency Management, https://www.annapolishazards.org/_files/ugd/636565_9caaa9bd07c746dbb8a27472dc7d5aca.pdf, (last accessed July 28, 2023).*

			buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.	
IX		Violent	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.	100-150 per year
X	7.0-9.0 and greater	Extreme	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.	One per year

Hazard Impacts

The figure and table below characterize earthquake impacts to property, health and safety, critical facilities, response capacity, the environment, and the economy.



Earthquake - Consequence Analysis Likely		
CATEGORY	**RANKING**	**DESCRIPTION**
PROPERTY DAMAGE	*Limited*	▪ Critical and non-critical infrastructure are not damaged. ▪ No structural damage expected.
HEALTH AND SAFETY	*Limited*	▪ *Health*- Zero deaths are expected. Being crushed by structural damage is the most common cause of death.

		▪ *Health*- Zero to five injuries are expected. Broken or fractured bones and internal bleeding are the most common causes of injuries.
CRITICAL FACILITIES	*Limited*	▪ Utilities – Water lines would be the only essential functions that will be out of service. Other outages unlikely. ▪ *Information/Communications* – No shutdown. No major impact on information or communications infrastructure. ▪ *Transportation* –Impacts if any to transportation will be minor and short-term.
RESPONSE CAPACITY	*Limited*	▪ *Police* – Local resources adequate. ▪ *Fire and Rescue* – Local resources adequate. Should not impact operations. May require damage assessment teams. ▪ *Health* – Local resources adequate. HD operations will not be affected after building has been cleared to be safe by emergency/ facility personnel. ▪ *Public Works* – Local resources adequate with no impact response capability and continuity of operations.
ENVIRONMENTAL IMPACT	*Limited*	▪ Minimal environmental impact on air, water, and land is expected. ▪ Limited environmental impact is expected.
ECONOMIC IMPACT	*Limited*	▪ Limited economic impact.
TOTAL IMPACT	***Limited***	▪ **Total Impact Score: 1 on a scale of 1 (Limited) to 4 (Catastrophic).**
Limited		*Significant* / *Critical* / *Catastrophic*

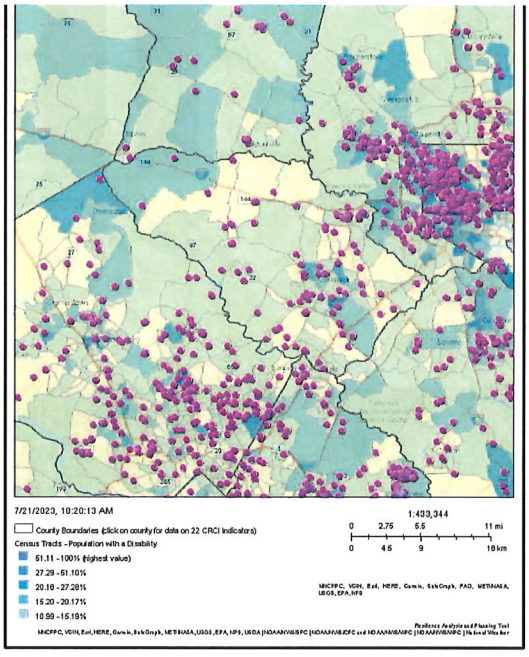
Vulnerability of County Assets

Earthquakes can impact multiple County assets depending on its intensity. Assets that are vulnerable are the following:

People

- There are no known deaths due to earthquakes in Howard County.
- People in nursing homes or with disabilities (The map below depicts these populations and locations of nursing homes in the County).
- People with higher challenges to resilience (Please refer to Chapter 2, section FEMA Community Resilience Index to review this map).

FIGURE 59: NURSING HOMES & PERCENTAGE WITH A DISABILITY



Structures

- All commercial and residential buildings are vulnerable to earthquakes.
- Historic buildings (made of unreinforced masonry) and concentrations of these buildings are in Historic Ellicott City and Lawyer's Hill Historic District.
- Water treatment plant damage (Little Patuxent Water Reclamation Plant).

Systems

- Communications Infrastructure (Cell Towers/Radio Operations).
- Water Infrastructure (water pipes).

- Transportation (roads could be blocked by fallen debris or if roads are damaged).
- Emergency Services (closed roads and damaged equipment could hinder services).
- Economy (rebuilding costs and businesses closed).

Natural, Historic, and Cultural Resources

- Environment (contamination due to broken pipes/gas lines).

Activities that Have Value to the Community

- Damage to houses of worship, community centers, places where people gather.

Effects of Population Change and Development in Hazard-Prone Areas

As Howard County anticipates potential changes in population density, it's crucial to understand how these trends may influence the County's vulnerability to earthquakes. Although not located near a tectonic plate boundary, understanding earthquake vulnerability is important due to the potential for distant earthquakes to impact the area. Increased population density often leads to more extensive development, with a higher concentration of buildings, roads, and critical infrastructure. In the event of an earthquake, densely populated areas may experience a greater impact on buildings and infrastructure, resulting in higher risks of structural damage, collapse, and potential casualties. While Howard County is not located on a major fault line, increased development may extend into nearby regions with greater seismic activity potential. In the event of a surface rupture or ground shaking, densely developed areas could experience more significant ground displacement, contributing to structural damage.

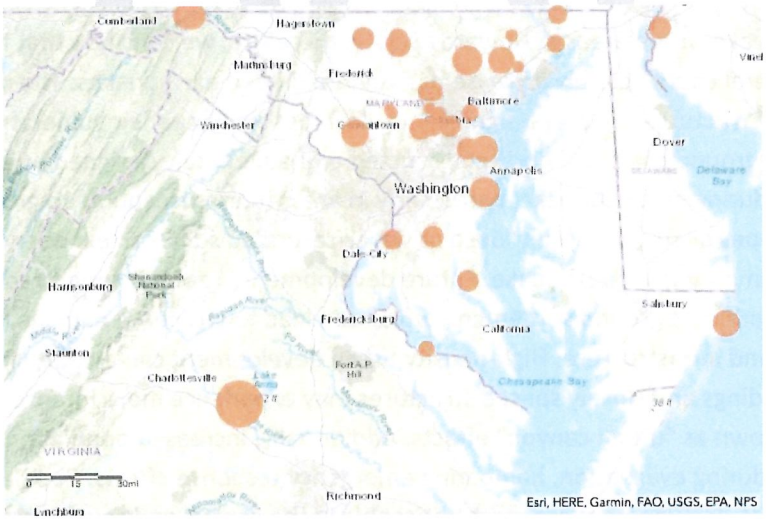
There are no earthquake-prone areas in Howard County, therefore, we conclude that future development in general could possibly increase our vulnerability to earthquakes. The design and construction of new structures will play a significant role in determining their vulnerability to earthquake-induced ground shaking. Poorly constructed or inadequately designed buildings could suffer damage or collapse during an earthquake, particularly in areas more susceptible to ground shaking. Areas with certain types of soil, especially loose or water-saturated soils, can experience a phenomenon known as liquefaction during an earthquake. Future development in zones prone to soil liquefaction could be at risk of significant ground settlement, which can lead to structural damage, tilting, or even sinking of buildings and infrastructure. High-density urban development can amplify the impacts of an earthquake. Tall buildings and closely spaced structures may experience more intense shaking due to the phenomenon known as "urban canyon" effects. Additionally, increased population density can lead to more congestion during evacuation, hampering emergency response efforts. Population growth, density, and upcoming development are most noticeable in the central and southeastern parts of Howard County. To locate the specific areas of current and projected population density, as well as anticipated future development, please refer to Chapter 2 of the Plan. This chapter covers the Growth and Development, with a subsection dedicated to Future Development. This will help you identify where existing high population densities are located and where future developmental activities are anticipated.

Hazard Occurrences

Data from the Maryland Geological Survey (MGS) indicates there have been 70 earthquakes with epicenters in Maryland between 1758-2017.[122] The USGS shows the earliest recorded earthquake with its epicenter in Maryland occurred in Annapolis on April 24th, 1758. The shock lasted 30 seconds and could be felt as far away as Pennsylvania. In recent years, moderate-sized earthquakes which occurred in nearby states have been felt in Maryland with only minimal effects. On November 19th, 1969, a 4.3 magnitude earthquake near Elgood, West Virginia was felt in Central Maryland, including Howard County. On February 28th, 1973, residents throughout the Mid-Atlantic region were jolted awake by shock waves from a minor earthquake near the Delaware/New Jersey/Pennsylvania border. Numerous points in northeastern Maryland reported this earthquake.[123]

Maryland's USGS earthquake history was reviewed to identify past earthquake occurrences that have impacted Howard County. According to the USGS, there were 18 notable earthquake incidents in Howard County, Maryland since 1991.[124] The strongest magnitude event was a magnitude 2.7 event that occurred near Columbia, MD in 1993. More recently Howard County has experienced a magnitude 2.1 event in August of 2021 and a magnitude 2.0 event in October of 2022. The likelihood of significant earthquake damage in Howard County is low since the probability of the area being stricken by an earthquake is relatively low as compared to other parts of the country. Even though earthquakes do occur occasionally, the County is in an area of very low seismic activity.

FIGURE 60: APPROXIMATE EPICENTER OF MARYLAND EARTHQUAKES SINCE 1758[125]



[122] James P. Reger, *Earthquakes and Maryland*, MD GEOLOGICAL SURVEY, http://www.mgs.md.gov/geology/geohazards/earthquakes_and_maryland.html (last visited Apr. 3, 2023) (These numbers reflect the most up to date data according to the Maryland Geological Survey. Events that may have occurred since 2017 are not listed).

[123] *Id.*

[124] *USGS Earthquake Catalog*, USGS, shorturl.at/noPS0 (last visited Apr. 3, 2023).

[125] James P. Reger, *Earthquakes and Maryland*, MD GEOLOGICAL SURVEY, http://www.mgs.md.gov/geology/geohazards/earthquakes_and_maryland.html (last visited Apr. 3, 2023).

Notable Earthquake Incidents in Howard County

November 1969	On November 19th, 1969, a 4.3 magnitude earthquake near Elgood, West Virginia was felt in central Maryland, including Howard County.[126]
March – December 1993	From March through December 1993, data indicated that a series of two-dozen small tremors occurred near Columbia, Maryland, ranging in magnitude from >1 to 2.7 on the Richter Scale.[127]
August 2011	On August 23rd, 2011, Maryland experienced the effects of a nearby earthquake when a 5.8 magnitude quake centered in Virginia impacted much of the East Coast. Tremors were felt as far south as North Carolina, as far north as Buffalo and Boston, and as far west as Detroit. The epicenter of the earthquake was about 3.5 miles beneath Mineral, Virginia, which is 35 miles northwest of Richmond. The USGS indicated the earthquake was one of the strongest ever to occur in Virginia and the strongest felt in Maryland. After the ground shook for several seconds, buildings were evacuated, and some businesses and agencies shut down for the afternoon. Rail travel was interrupted, and many commuters faced an early, congested rush hour.[128] Damage inspections after the earthquake found structural damage was limited, although in some areas there were significant localized damages. In Howard County, many residents were startled by the earthquake but there was no significant damage or injuries reported. The figure below is a USGS "shake map" that shows the intensity of shaking from the Mineral, Virginia earthquake. Note that the area west of Baltimore, where Howard County is located, experienced weak to low shaking intensity and no expected damages.
October 2017	October 30th, 2017, an earthquake with a magnitude of 1.52 occurred in Glenelg.
November 2017	November 11th, 2017, an earthquake with a magnitude of 1.5 occurred in Roxbury.
August 2021	August 4th, 2021, an earthquake with a magnitude of 2.1 occurred in Clarksville.
October 2022	October 10th, 2022, an earthquake with a magnitude of 2.0 occurred in Sykesville.

[126] *Maryland*, THE GREAT SOUTHEAST SHAKEOUT, https://www.shakeout.org/southeast/maryland/ (last visited Apr. 7, 2023).

[127] James P. Reger, *Earthquakes and Maryland*, MD GEOLOGICAL SURVEY, http://www.mgs.md.gov/geology/geohazards/earthquakes_and_maryland.html (last visited Apr. 3, 2023).

[128] Scott Calvert & Childs Walker, *Earthquake in Virginia Rattles Baltimore and the East Coast*, BALTIMORE SUN (August 23, 2011, 12:00am), https://www.baltimoresun.com/maryland/bs-xpm-2011-08-23-bs-md-earthquake-20110823-story.html.

Hazard Future Likelihood – Low

While there is a very likely chance (30%+) of *any* earthquake occurring annually based on historical data, most earthquakes would be low enough in intensity that most community members would not feel them. The historical number of earthquakes is therefore higher than the future likelihood of the hazard occurring. The future annual probability of an earthquake is 1-10% chance of annual occurrence, or one event every 10-99 years. One consideration that could impact the future likelihood of the hazard occurring is if there is an increase in fracking[129] within the County.The following table anticipates the future occurrence rate of the hazard based on historical likelihood and future trends.

Future Likelihood of an Earthquake in Howard County	
Historical Average (time period)	18 events (1992-2022)
Historical Annual Probability	30% + chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes
Future Annual Probability	1-10% chance of annual occurrence
Future Likelihood Score	2 (Infrequent)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

Space Weather (Risk Score 1.3)

Hazard Description

Solar storms are a type of space weather. Space weather generally comprises four components: solar flares, coronal mass ejections (CMEs), high speed solar wind, and solar energetic particles.[130] The type of space weather that is most relevant to Howard County is the threat of geomagnetic storms which fall under coronal mass ejections. A geomagnetic storm is "a major disturbance of Earth's magnetosphere that occurs when there is a very efficient exchange of energy from the solar wind into the space environment surrounding Earth."[131] These storms result from variations in the solar wind that produces major changes in the currents, plasmas, and fields in Earth's magnetosphere.[132] The largest storms that result from these conditions are associated with solar CMEs "where a billion tons or so of plasma from the sun, with its embedded magnetic field, arrives at Earth. CMEs typically take several days to arrive at Earth, but have been observed, for some of the most intense storms, to arrive in as short as 18 hours."[133] These storms could cause disturbances in the electric power grid, which could negatively impact homes and businesses in Howard County.

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[129] Water Res. Mission Area, *Hydraulic Fracturing*, USGS, https://www.usgs.gov/mission-areas/water-resources/science/hydraulic-fracturing?qt-science_center_objects=0#qt-science_center_objects (last visited Apr. 3, 2023) (defining fracking as "a process that typically involves injecting water, sand, and chemicals under high pressure into a bedrock formation via a well. This process is intended to create new fractures in the rock as well as increase the size, extent, and connectivity of existing fractures in order to extract trapped oil and gas.").

[130] *Space Weather FAQ*, NOAA Space Weather Prediction Ctr., https://www.swpc.noaa.gov/content/space-weather-faq-frequently-asked-questions (last visited Apr. 7, 2023).

[131] *Geomagnetic Storms*, NOAA Space Weather Prediction Ctr., https://www.swpc.noaa.gov/phenomena/geomagnetic-storms (last visited Apr. 7, 2023).

[132] *Id.*

[133] *Id.*

The following table presents the Risk Score for space weather in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Space Weather Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	1.0 Unlikely		50%
CONSEQUENCE	**Impact**	1.6 Limited-Significant	3.2 Critical-Catastrophic	40%
	Warning Time	1 Very Long	1 Very Long	5%
	Duration	3 Long	4 Very Long	5%
TOTAL RISK SCORE		**1.3**	**2.0**	

Hazard Location

Geomagnetic storms are the highest space weather concern for Howard County, and all parts of the County are at the same risk.

Hazard Extent

Geomagnetic storms are measured by "ground-based instruments that observe how much the horizontal component of Earth's magnetic field varies. Based on this measurement, the storms are categorized from G1 (minor) to G5 (extreme). In the most extreme cases, transformers in power grids may be damaged, spacecraft operation and satellite tracking can be hindered, high frequency radio propagation and satellite navigation systems can be blocked, and auroras may appear much further south than normal[134]. The table below is the scale that NOAA uses to measure classify geomagnetic storms[135].

[134] *Storms from the Sun, NASA, https://www.nasa.gov/mission_pages/sunearth/news/storms-on-sun.html#:~:text=To%20measure%20the%20strength%20of,goes%20from%201%20to%209., (last accessed July 31, 2023).*

[135] *NOAA Space Weather Scales, NOAA, https://www.swpc.noaa.gov/sites/default/files/images/NOAAscales.pdf, (last accessed July 31, 2023).*

Category		Effect	Physical measure	Average Frequency (1 cycle = 11 years)
Scale	Descriptor	Duration of event will influence severity of effects		
Geomagnetic Storms			Kp values* determined every 3 hours	Number of storm events when Kp level was met; (number of storm days)
G 5	Extreme	Power systems: widespread voltage control problems and protective system problems can occur, some grid systems may experience complete collapse or blackouts. Transformers may experience damage. Spacecraft operations: may experience extensive surface charging, problems with orientation, uplink/downlink and tracking satellites. Other systems: pipeline currents can reach hundreds of amps, HF (high frequency) radio propagation may be impossible in many areas for one to two days, satellite navigation may be degraded for days, low-frequency radio navigation can be out for hours, and aurora has been seen as low as Florida and southern Texas (typically 40° geomagnetic lat.).**	Kp=9	4 per cycle (4 days per cycle)
G 4	Severe	Power systems: possible widespread voltage control problems and some protective systems will mistakenly trip out key assets from the grid. Spacecraft operations: may experience surface charging and tracking problems, corrections may be needed for orientation problems. Other systems: induced pipeline currents affect preventive measures, HF radio propagation sporadic, satellite navigation degraded for hours, low-frequency radio navigation disrupted, and aurora has been seen as low as Alabama and northern California (typically 45° geomagnetic lat.).**	Kp=8	100 per cycle (60 days per cycle)
G 3	Strong	Power systems: voltage corrections may be required, false alarms triggered on some protection devices. Spacecraft operations: surface charging may occur on satellite components, drag may increase on low-Earth-orbit satellites, and corrections may be needed for orientation problems. Other systems: intermittent satellite navigation and low-frequency radio navigation problems may occur, HF radio may be intermittent, and aurora has been seen as low as Illinois and Oregon (typically 50° geomagnetic lat.).**	Kp=7	200 per cycle (130 days per cycle)
G 2	Moderate	Power systems: high-latitude power systems may experience voltage alarms, long-duration storms may cause transformer damage. Spacecraft operations: corrective actions to orientation may be required by ground control; possible changes in drag affect orbit predictions. Other systems: HF radio propagation can fade at higher latitudes, and aurora has been seen as low as New York and Idaho (typically 55° geomagnetic lat.).**	Kp=6	600 per cycle (360 days per cycle)
G 1	Minor	Power systems: weak power grid fluctuations can occur. Spacecraft operations: minor impact on satellite operations possible. Other systems: migratory animals are affected at this and higher levels; aurora is commonly visible at high latitudes (northern Michigan and Maine).**	Kp=5	1700 per cycle (900 days per cycle)

* Based on this measure, but other physical measures are also considered.
** For specific locations around the globe, use geomagnetic latitude to determine likely sightings (see www.swpc.noaa.gov/Aurora)

Hazard Impacts

In a severe or extreme geomagnetic storm, electric power grid systems could suffer from widespread voltage control problems and possible transformer damage. In a worst-case scenario, such storms could result in complete power grid collapse or blackouts. When magnetic fields move about in the vicinity of a conductor, such as a wire, an electric current is induced into the conductor. This happens on a grand scale during geomagnetic storms. By receiving geomagnetic storm alerts and warnings, power companies can minimize damage and power outages.[136]

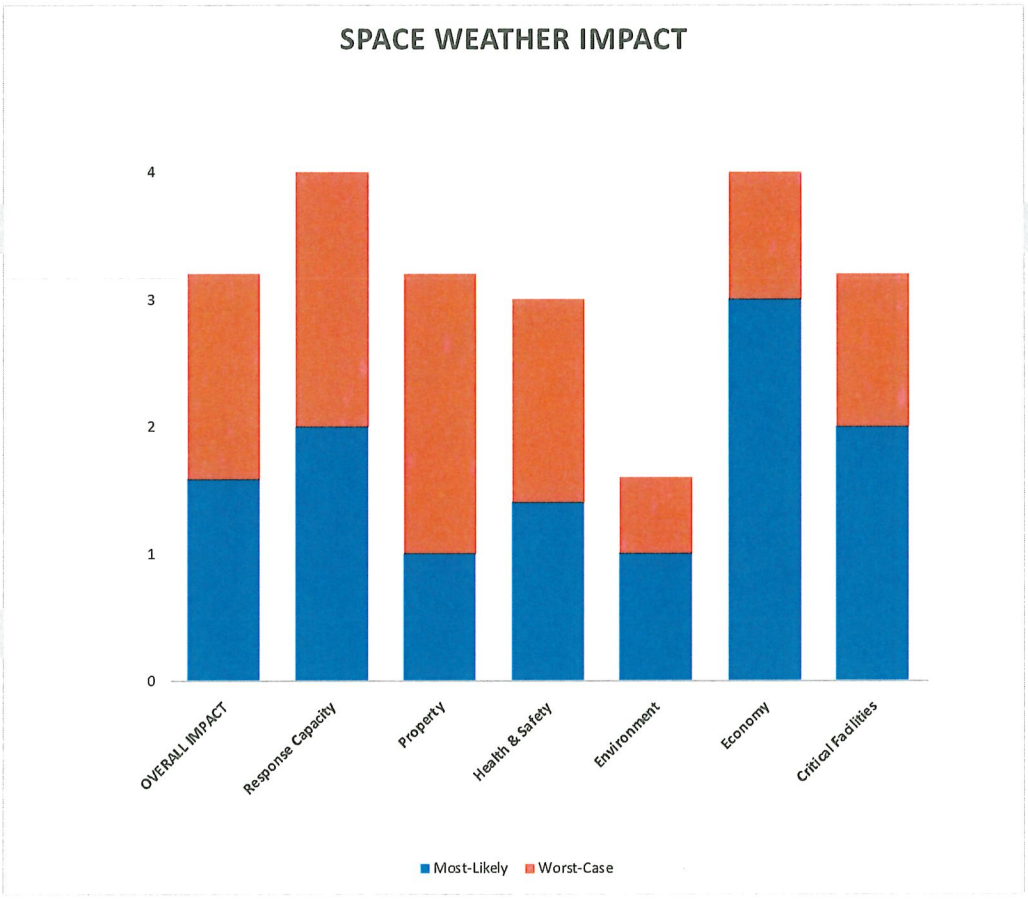
Besides the risk to the electric power grid, space weather could have other potential impacts on the ability to conduct timely and uninterrupted emergency response related communication for or among the people of Howard County. Examples include: solar radiation storms that could cause disruption of satellite communication which could disrupt a wide variety of communication methods or Global Navigation Satellite System (GNSS) (i.e. Global Positioning System (GPS)) location precision; or Radio Blackouts of High-Frequency (HF) communication due to an energetic solar flare during the daylight hours could result in inability to communicate via HF radio emergency bands, commercial terrestrial radio, or Amateur Radio networks aiding in emergency response.[137]

[136] *A Profile of Space Weather*, NOAA SPACE WEATHER PREDICTION CTR., http://www.swpc.noaa.gov/sites/default/files/images/u33/primer_2010_new.pdf (last visited Apr. 7, 2023).

[137] All the data from this section of the HIRA was provided by the NOAA.

Geomagnetic storms are the highest space weather concern for Howard County. These storms are categorized by the NOAA Space Weather Scales rating from G-1 (minor) to G-5 (extreme).[138] The risk of hazard intensifies when coupled with extreme weather that has already stressed the power grid, inclining heat waves, blizzards, winter storms, tropical systems, and tornadoes.

The figure and table below characterize space weather impacts to property, health and safety, critical facilities, response capacity, the environment, and the economy.



Vulnerability of County Assets

Across Howard County, the primary impact of a space weather event will be born out on the electrical infrastructure grid, which will then have a host of cascading effects, depending on the magnitude of the event. Assets in the County that are vulnerable are the following:

People

- Underserved communities, such as those communities with higher challenges to resilience (please refer to Chapter 2, Section FEMA Community Resilience Index to view the map), would be disproportionately impacted by a geomagnetic storm event that takes out the electrical grid

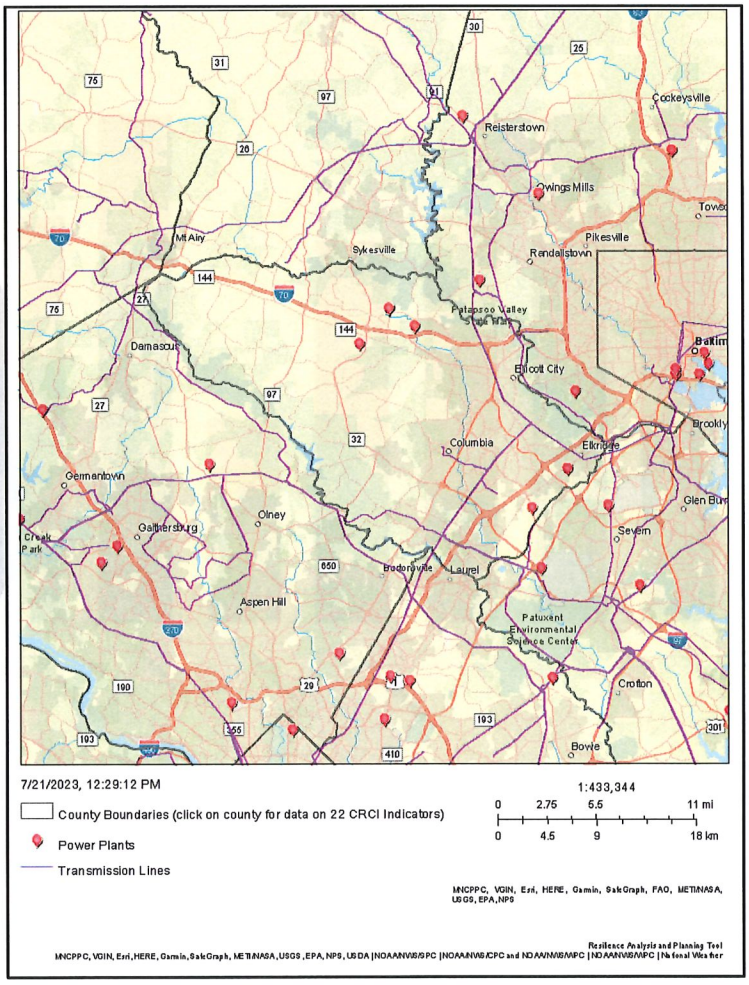
[138] *NOAA Space Weather Scales*, NOAA SPACE WEATHER PREDICTION CTR., https://www.swpc.noaa.gov/noaa-scales-explanation (last visited Apr. 3, 2023).

due to its cascading effects. These communities will be less likely to have access to alternate power sources like generators.

Structures

- The Energy community lifeline (electricity blackouts or complete loss; unable to pump fuel for vehicles).
- The map below shows power plants and main transmission lines that would be vulnerable to a geomagnetic storm.

FIGURE 61: HOWARD COUNTY ELECTRICAL INFRASTRUCTURE



Systems

- Economy (due to loss of power, businesses do not have access to ecommerce or cannot open businesses).
- Communications (radios and internet are taken out).
- Supervisory Control And Data Acquisition (SCADA) systems (fuel pipelines and other critical infrastructure would be vulnerable).
- Food (loss of storage capabilities).

- Emergency Services (no electricity, fuel, radios, or internet would hinder communications, medical services, and affect equipment).

Natural, Historic, and Cultural Resources

- Environment (migratory animals).
- Historic and cultural artifacts that need environment control for preservation.
- Animal care facilities, such as zoos, veterinary hospitals, and rescues.

Activities that Have Value to the Community

  - Many large entertainment venues and events, like concerts at Merriweather Post Pavilion, would be canceled due to loss of electricity.

Effects of Population Change and Development in Hazard-Prone Areas

Increased population density often corresponds with higher technology reliance. In densely populated areas, there could be a greater dependence on electronic devices, communication networks, and critical infrastructure that are susceptible to disruption from space weather events. Densely populated regions may have a more extensive and interconnected communication network, which could be vulnerable to disturbances caused by space weather phenomena like geomagnetic storms. These disruptions can affect both local and long-distance communication systems. The widespread use of GPS navigation systems in densely populated areas increases the potential impact of space weather on navigation accuracy and reliability. Disruptions in GPS signals due to ionospheric disturbances can affect transportation systems and location-based services. Regardless of population density, critical infrastructure sectors such as power grids, transportation, and emergency services can be affected by space weather. Ensuring the resilience of these systems is essential to minimizing vulnerability. Space weather events have the potential to affect global communication and navigation systems, which can impact regions with varying population densities, especially in the context of a technologically interconnected world.

As Howard County, Maryland, envisions future development and urbanization, it's crucial to assess how these changes may impact the county's vulnerability to space weather events. As development expands, so does the complexity and interconnectivity of the power grid. A more intricate power distribution system can be more susceptible to geomagnetically induced currents (GICs) during space weather events, potentially leading to transformer damage and power outages. Densely developed areas are likely to have extensive communication networks, making them more susceptible to disruptions caused by space weather. High-frequency radio signals used for communication, navigation, and emergency services can be affected by ionospheric disturbances during geomagnetic storms. Development can lead to greater interconnectivity between various infrastructure systems. While this can improve efficiency, it can also amplify the cascading effects of space weather-induced disruptions, potentially affecting multiple sectors simultaneously.

Population growth, density, and upcoming development are most noticeable in the central and southeastern parts of Howard County. To locate the specific areas of current and projected population density, as well as anticipated future development, please refer to Chapter 2 of the Plan. This chapter covers the Growth and Development, with a subsection dedicated to Future Development. This will help you identify where existing high population densities are located and where future developmental activities are anticipated.

Space Weather - Consequence Analysis Likely		
CATEGORY	**RANKING**	**DESCRIPTION**
PROPERTY DAMAGE	*Limited*	▪ Critical and non-critical infrastructure will be damaged. ▪ Possibility of critical and high voltage switch gear being destroyed, and back-up generators may be worn out. ▪ Possible issues to communication and potential concerns with traffic signals are expected.
HEALTH AND SAFETY	*Limited-Significant*	▪ Unknown deaths are expected. Lightning and electrocution are the most common causes of death. Complications due to extreme heat are the most common causes of death. Community members requiring power use for life sustaining interventions would be impacted. For those individuals, underlying medical conditions are the most common causes of death. ▪ Unknown injuries likely.
CRITICAL FACILITIES	*Significant*	▪ *Utilities* – minor disruption due to brownouts. ▪ *Information/Communication* – minor disruption due to brownouts. ▪ *Transportation* – minor disruption due to brownouts.
RESPONSE CAPACITY	*Significant*	▪ *Police* – Local resources adequate. Low impact to response capability or continuity of operations. May cause law enforcement to lose radio, computer communication for a limited period of time. Land lines will be required for communication. ▪ *Fire and Rescue* – Local resources adequate. Communication issues will be the most impacted. ▪ *Health* – Mutual aid needed. Administrative duties will be on hold until communication can be restored. Clinical services can continue to provide services and maintain mutual charts of their patients. ▪ *Public Works* – Local resources adequate. Any responses that have potential failure nodes due to electronic communications are impacted.
ENVIRONMENTAL IMPACT	*Limited*	▪ Minimal impact on air, water, and land is expected. ▪ Limited environmental impact is expected.
ECONOMIC IMPACT	*Critical*	▪ Business disruption, closure, and extended period of electrical, and telecommunications and IT infrastructure damage assessment and repair in economic consequences. ▪ Critical economic impact.
TOTAL IMPACT	***Limited-Significant***	▪ **Total Impact Score: 1.6 on a scale of 1 (Limited) to 4 (Catastrophic).**
Limited	*Significant*	*Critical*	*Catastrophic*

Hazard Occurrences

There have been no notable occurrences of space weather having an impact in Howard County within the reviewed period.

Hazard Future Likelihood - Low

The future annual probability of the hazard occurring is zero-10% chance of annual occurrence, or one event every 10-100 years. A space weather hazard has occurred historically in other jurisdictions, specifically, geomagnetic storms have caused power grid blackouts in the past. This coupled with population density and the high use of electronics within the County may impact the future likelihood of the hazard occurring. The following table anticipates the future occurrence rate of the hazard based on historical likelihood and future trends.

Future Likelihood of Space Weather in Howard County	
Historical Average (time period)	No notable occurrences (1972-2022)
Historical Annual Probability	0% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No
Future Annual Probability	0-10% chance of annual occurrence
Future Likelihood Score	1.25 (Unlikely- Infrequent)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

Pest Infestation/Zoonotic Infection (1.2)

Hazard Description

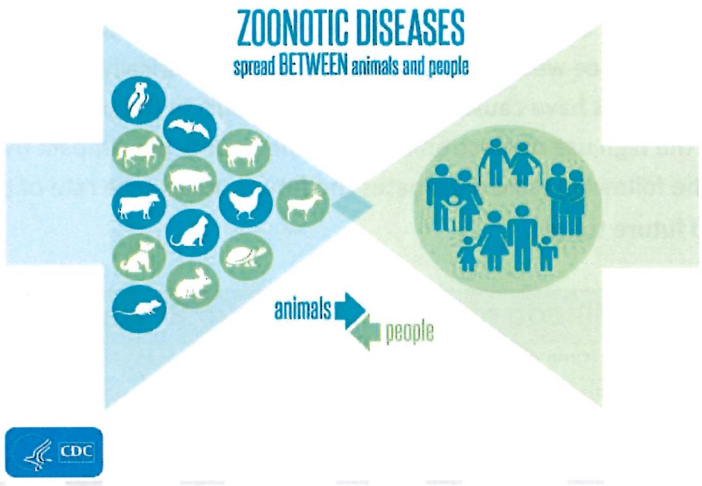
Pest Infestation is the occurrence of one or more pest species in an area or location where their numbers and impact are currently or potentially at intolerable levels. Zoonotic Diseases (also known as zoonoses) "are caused by infections that spread between animals and people"[139]. Additionally, "scientists estimate that more than six out of every ten known infectious diseases in people are spread from animals, and three out of every four new or emerging infectious diseases in people are spread from animals. Every year, tens of thousands of Americans will get sick from harmful germs spread between animals and people"[247].

Pest infestations include vectors such as insects, birds, and rodents. Two species of bedbugs feed on humans: the common bedbug (*Cimex lectularius*), which occurs in most parts of the world, and the tropical bedbug (*Cimex hemipterus*), which occurs mainly in tropical countries. They are a severe nuisance when they occur in large densities, being commonest in places with poor housing conditions. They are not important in the transmission of diseases, although they possibly play a role as vectors of Hepatitis B virus. For infants living in heavily infested houses, where they may receive 100 or more bites a night, it is possible that the blood loss could cause mild anemia. Zoonotic diseases spread between

[139] *Zoonotic Diseases*, CTRS. FOR DISEASE CONTROL & PREVENTION, https://www.cdc.gov/onehealth/basics/zoonotic-diseases.html (last visited Apr. 3, 2023).

animals and people. Some examples of zoonotic diseases / infections include, but are not limited to, animal influenza, avian influenza, and Lyme disease.[140]

FIGURE 62: ZOONOTIC DISEASE SPREAD[141]



Zika is a viral disease transmitted to humans by infected mosquitoes. It causes fever and severe joint pain. Other symptoms include muscle pain, headache, nausea, fatigue, and rash. After the bite of an infected mosquito, onset of illness occurs usually between four to eight days but can range from two to 12 days. The Zika virus was first identified in 1947 in Uganda. This virus produced a rare and mild disease until suddenly re-emerged in Brazil in 2015 and spread explosively through South America, Central America, and the Caribbean. The first importation in the United States may have occurred between March and mid-April of 2016, however, it was not detected until July 2016.[142] The Zika virus is associated with a birth defect known as microcephaly. In addition, the Zika virus can cause a neurologic condition, known as Guillain-Barre Syndrome, in adults which results in muscle weakness or paralysis, in extreme cases.

These viruses are transmitted from human-to-human by the bites of infected female mosquitoes. Most commonly, the mosquitoes involved are *Aedes aegypti* and *Aedes albopictus*, two species which can also transmit other mosquito-borne viruses, including West Nile Virus and dengue. These mosquitoes can be found biting throughout daylight hours, though there may be peaks of activity in the early morning and late afternoon. Both species are found biting outdoors, but *Aedes aegypti* will also readily feed indoors.

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[140] *Id.*

[141] *Id.*

[142] Giovanni Marini, Giorgio Guzzetta, Roberto Rosa, & Stefano Merler, *First outbreak of Zika virus in the continental United States: a modelling analysis*, 22 EURO SURVEILL. 37, https://doi.org/10.2807/1560-7917.ES.2017.22.37.30612.

The following table presents the Risk Score for pest infestation/zoonotic diseases in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Pest Infestation/Zoonotic Infection Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	1.0 Unlikely		50%
CONSEQUENCE	**Impact**	1.2 Limited-Significant	1.3 Limited-Significant	40%
	Warning Time	1 Very Long	1 Very Long	5%
	Duration	4 Very Long	4 Very Long	5%
	TOTAL RISK SCORE	**1.2**	**1.3**	

Hazard Location

Low, but persistent levels of West Nile Virus and more recently (to a lesser extent), Zika Virus, are examples of mosquito related pest infestations that have been documented throughout Maryland, including Howard County. There is frequent travel within the County and many bed bug cases occur in hotels. The County is also near many metropolitan areas/airports/and interstates which increases the likelihood of diseases being spread across the County. Lyme disease, a tickborne related disease, is also well documented in Howard County.

Hazard Extent

Measuring the severity of pest infestations and/or zoonotic infection will depend largely on the nature of the infestation or infection. For **zoonotic infections**, such as Zika, diagnostic testing or antibody testing is used to determine the level of infection in the population. One limiting factor of antibody testing is that it cannot distinguish between a recent infection and a prior infection, so it is difficult to estimate local infection levels based on antibody testing alone[143]. Surveys of the disease vector, in the case of Zika, mosquitoes, also provide insights about the potential for spread of the infection. Once a zoonoses is detected, it can be classified, like other diseases, as an epidemic, a pandemic, an outbreak, or eventually endemic. The definitions for each classification are below:

- Epidemic— "a disease that affects a large number of people within a community, population, or region"[144].

[143] Centers for Disease Control and Prevention. *Testing for Zika*. https://www.cdc.gov/zika/symptoms/diagnosis.html. (Last accessed August 1, 2023).

[144] *What's the Difference Between a Pandemic, an Epidemic, Endemic, and an Outbreak? 2020, Intermountain Health, https://intermountainhealthcare.org/blogs/topics/live-well/2020/04/whats-the-difference-between-a-pandemic-an-epidemic-endemic-and-an-outbreak/, (last accessed August 1, 2023).*

- Pandemic— "an epidemic that's spread over multiple countries or continents"[145].
- Endemic—a disease that "belongs to a particular people or country"[146].
- Outbreak— "a greater than anticipated increase in the number of endemic cases. It can also be a single case in a new area. If it's not quickly controlled, an outbreak can become an epidemic"[147].

In addition, the World Health Organization (WHO) also created the six Pandemic Phases to help countries around the world prepare and respond to diseases. These phases might not always proceed in numerical order. The phases along with their descriptions and actions that the WHO recommends for affected and not-yet-affected countries can be seen in the table below[148]:

	ESTIMATED PROBABILITY OF PANDEMIC	DESCRIPTION	MAIN ACTIONS IN AFFECTED COUNTRIES	MAIN ACTIONS IN NOT-YET-AFFECTED COUNTRIES
PHASE 1	Uncertain	No animal influenza virus circulating among animals has been reported to cause infection in humans.	Producing, implementing, exercising, and harmonizing national pandemic influenza preparedness and response plans with national emergency preparedness and response plans.	
PHASE 2		An animal influenza virus circulating in domesticated or wild animals is known to have caused infection in humans and is therefore considered a specific potential pandemic threat.		
PHASE 3		An animal or human-animal influenza reassortant virus has caused sporadic cases or small clusters of disease in people, but has not resulted in human-to-human transmission sufficient to sustain community-level outbreaks.		
PHASE 4	Medium to high	Human-to-human transmission of an animal or human-animal influenza reassortant virus able to sustain community-level outbreaks has been verified.	Rapid containment.	Readiness for pandemic response.
PHASE 5	High to certain	The same identified virus has caused sustained community-level outbreaks in at least two countries in one WHO region.	Pandemic response: each country to implement actions as called for in their national plans.	Readiness for imminent response.
PHASE 6	Pandemic in progress	In addition to the criteria defined in Phase 5, the same virus has caused sustained community-level outbreaks in at least one other country in another WHO region.		
POST-PEAK PERIOD		Levels of pandemic influenza in most countries with adequate surveillance have dropped below peak levels.	Evaluation of response; recovery; preparation for possible second wave.	
POSSIBLE NEW WAVE		Level of pandemic influenza activity in most countries with adequate surveillance is rising again.	Response	-
POST-PANDEMIC PERIOD		Levels of influenza have returned to the levels seen for seasonal influenza in most countries with adequate surveillance.	Evaluation of response; revision of plans; recovery.	

[145] *Ibid.*

[146] *Ibid.*

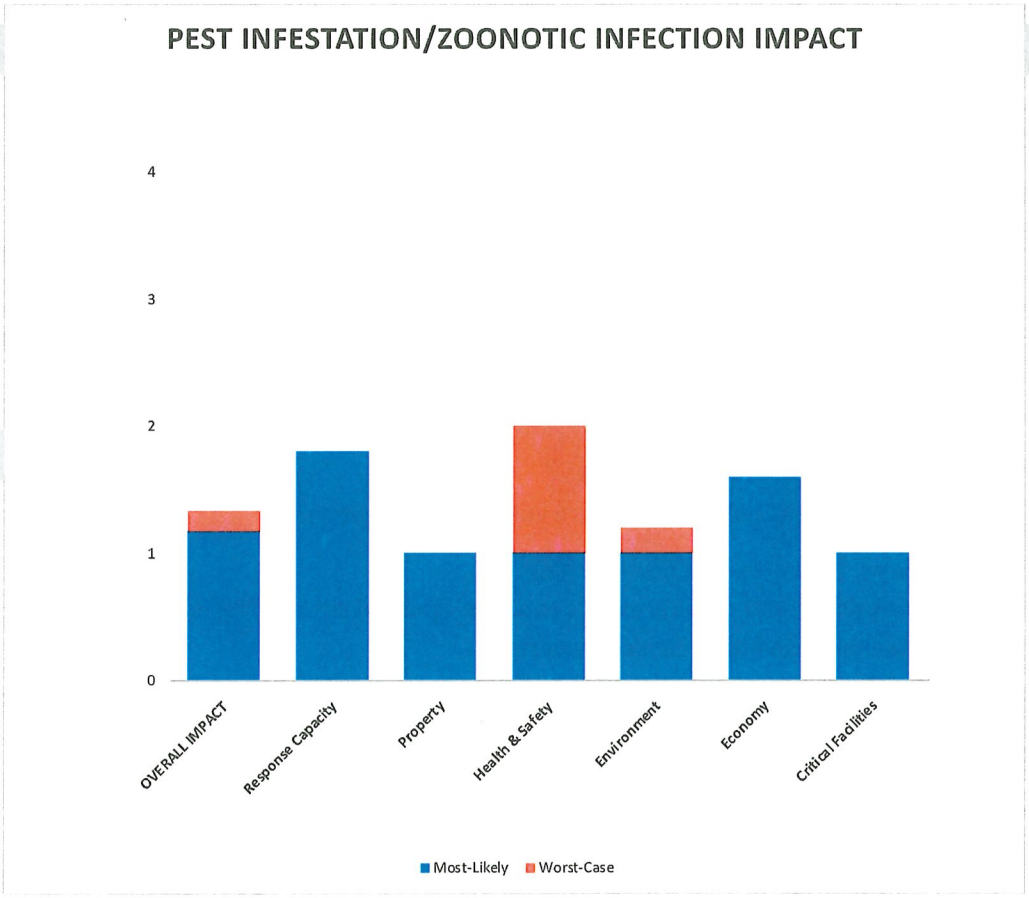
[147] *Ibid.*

[148] *The WHO Pandemic Phases, National Library of Medicine, https://www.ncbi.nlm.nih.gov/books/NBK143061/, (last accessed August 1, 2023).*

For **pest infestations**, such as bed bugs or lice, the magnitude will largely be determined by households affected, as this is the greatest indicator of spread occurring between community members. Pest infestations that are agricultural in nature may rely on a Disease Severity Index that determines the percentage of a crop/herd affected[149].

Hazard Impacts

Like West Nile Virus, Zika has the potential to affect community members and visitors to Howard County who have spent time in areas with an infected mosquito population. Pregnant women may be the most vulnerable as cases of microcephaly have been linked with fetuses exposed in utero to the Zika virus. The figure and table below characterize pest infestation/zoonotic infection impacts to property, health and safety, critical facilities, response capacity, the environment, and the economy.



[149] US Department of Agriculture. Chiang, K., Liu, H., Bock, C.H. 2017. A discussion on disease severity index values: warning on inherent errors and suggestions to maximize accuracy. Annals of Applied Biology. 171:139-154. https://www.ars.usda.gov/research/publications/publication/?seqNo115=338027

Vulnerability of County Assets

While specific impacts on Howard County would depend on the nature of the hazard, there are likely to be health and human safety impacts for whatever pest infestation or zoonotic infection. The following assets would be vulnerable in Howard County:

People

- People who live in western Howard County (more rural areas provide ample habitat for some pests).
- People who live in densely populated areas, which is eastern Howard County (high population density can lead to easier vector transmission).
- People unable to clean and maintain their homes to prevent pest infestation or transmission of zoonoses (this could include older adults or people with access and functional needs).
- People in consistent contact with livestock or those who work on farms.
- More vulnerable populations in eastern Howard County, as indicated in the Community Resilience Index map in Chapter 2 may experience disparate effects based on being less likely to implement mitigation measures that could prevent transmission.

Structures

- Wooden structures, both residential and commercial, are vulnerable to insects like termites

Systems

- Economy (zoonoses, such as avian flu, threaten large swathes of livestock and can negatively impact production; also, pest infestations can cause the shutdown of businesses).
- Food safety (people could eat contaminated animal products).

Natural, Historic, and Cultural Resources

- Historic homes made of wood are vulnerable to termites.

Activities that Have Value to the Community

- Entertainment or cultural events could be canceled if a building is closed due to unsanitary conditions caused by pests.

Effects of Population Change and Development in Hazard-Prone Areas

Continued development will increase population density, thereby expanding opportunities for vector transmission. As Howard County is in close proximity to a major international airport, two major metropolitan areas, an international shipping port, and a major interstate, it experiences a constant flow of people through Howard County from across the world, expanding the possibility for unknowing transmission of a zoonotic infection or introduction of a pest.

As Howard County, Maryland, anticipates potential changes in population density and undergoes future development, it's crucial to understand how these trends could influence the County's vulnerability to pest infestation and zoonotic infections. Higher population density often leads to increased urbanization, which can alter natural habitats and provide new environments for pests and disease vectors to thrive. This can include increased waste production and poorly managed urban areas that attract pests like rodents and insects. Crowded living conditions can increase the potential for zoonotic

disease transmission from animals to humans. Increased contact between humans and animals, including pets and wildlife, can facilitate the spread of diseases like rabies, Lyme disease, and West Nile virus. Both high and low population density areas could be affected by changing climate patterns, influencing the distribution of pests and diseases. Warmer temperatures can extend the range of disease vectors and increase the rate of pest reproduction. Regardless of population density, modern travel and globalization can introduce pests and diseases to new areas. Air travel, trade, and tourism can contribute to the spread of pests and zoonotic infections.

Population growth, density, and upcoming development are most noticeable in the central and southeastern parts of Howard County. To locate the specific areas of current and projected population density, as well as anticipated future development, please refer to Chapter 2 of the Plan. This chapter covers the Growth and Development, with a subsection dedicated to Future Development. This will help you identify where existing high population densities are located and where future developmental activities are anticipated.

Pest Infestation / Zoonotic Infection - Consequence Analysis **Likely**		
CATEGORY	**RANKING**	**DESCRIPTION**
PROPERTY DAMAGE	*Limited*	▪ No structural damage but significant loss in furniture and carpeting is expected.
HEALTH AND SAFETY	*Limited*	▪ Zero deaths are expected. Most deaths would be unlikely but when they do occur, it is due to an occurrence in conjunction with other comorbidities. ▪ Zero to five injuries are expected. Allergy, anxiety, and sleepiness are the most common causes of injuries.
CRITICAL FACILITIES	*Limited*	▪ *Utilities* – No critical facilities will be shut down and no outage is expected. ▪ *Information/Communications* – Shutdown unlikely. No major impact on information or communications infrastructure. ▪ *Transportation* – Shutdown unlikely. Impacts to transportation will be minor and short-term.
RESPONSE CAPACITY	*Limited-Significant*	▪ *Police* – Local resources adequate. No impact to response capability or continuity of operations. ▪ *Fire and Rescue* –Local resources adequate. No impact to response capability and continuity of operations. ▪ *Health* – Local resources adequate. HD operations will not be affected severely. The HDOC will be monitoring and recording infestations throughout the county with the assistance of environmental health. Informing the public and steps needed to ensure to maintain a healthy living environment will occur. ▪ *Public Works* – Local resources adequate. No impact on response capability and COOP.
ENVIRONMENTAL IMPACT	*Limited*	▪ Limited environmental impact is expected. Minimal impact on air, water, and land resources.
ECONOMIC IMPACT	*Limited-Significant*	▪ Negative impact on retail and County reputation in economic consequences.

TOTAL IMPACT	*Limited-Significant*	▪ **Total Impact Score: 1.2 on a scale of 1 (Limited) to 4 (Catastrophic).**		
Limited		*Significant*	*Critical*	*Catastrophic*

Hazard Occurrences

There have been no notable incidents in Howard County during the review period of 1972-2022.

Hazard Future Likelihood - Low

While there may be continued instances of zoonotic infections or pest reports, there is no evidence that these would rise to the level of an infestation or a widespread infectious event. The future annual probability for this hazard is a 1% chance of annual occurrence, or one event every 99 years. The following table anticipates the future occurrence rate of the hazard based on historical likelihood and future trends.

Future Likelihood of a Pest Infestation/Zoonotic Infection in Howard County	
Historical Average (time period)	Zero events (1972-2022)
Historical Annual Probability	0% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No
Future Annual Probability	0-1% chance of annual occurrence
Future Likelihood Score	1.0 (Infrequent- Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

Emerging Hazard Trends

Howard County recognizes that hazards and the risks they present are likely to change from year to year, and that the emerging issue of global climate change will likely affect how hazards will impact the County in the future. Although there is no way to accurately anticipate these future developments, the County continually monitors trends in terms of probability and potential impacts as a way to develop and calibrate mitigation activities.

Climate Change

In the Baltimore Metropolitan region, annual temperature, annual precipitation, and sea levels are all rising slowly and steadily, and have been doing so for many decades.[150] Future projections anticipate continued increases in temperature, precipitation, and sea levels, increasing the likelihood and consequences of a variety of hazards, such as extreme heat, flooding, thunderstorms, windstorms, hurricanes, and severe winter weather.[151] These changes will put additional strain on underserved

[150] *Planning, Designing, Operating, and Maintaining Local Infrastructure in a Changing Climate*, BALTIMORE METRO. COUNCIL, https://www.baltometro.org/sites/default/files/bmc_documents/general/transportation/climate-change/Climate%20Change%20Resource%20Guide.pdf (last visited Apr. 3, 2023).

[151] *Id.* at 9-17.

populations who do not have the same resources to withstand and recover from natural hazards as the general population, as well as those who may be more vulnerable to the impacts of natural hazards because of health conditions or age.

Additionally, climate change will strain local infrastructure and lifelines with heavy precipitation, flooding, sea level rise, extreme heat, and other extreme weather conditions. For example, transportation, stormwater, water, wastewater, facilities, and solid waste infrastructure will be subjected to heightened challenges that will threaten their continuity of operations and increase maintenance costs.[152]

Food Insecurity

Natural hazards threaten food security by posing risks at every step of the food supply chain: production, transportation, storage, and distribution. For example, droughts can reduce crop yields, lowering the amount of food in the supply chain; tornadoes can destroy major roads relied upon by food transporters; and storms may knock out power, causing refrigerated food to spoil.

Climate change has exacerbated these supply chain vulnerabilities, revealing the need for local emergency managers to increase their situational awareness of the issue and identify the communities at greatest risk of food insecurity. This requires mapping local food distribution points, warehouses, roads prone to flooding and high traffic, public schools, and areas of higher food insecurity, as well as building relationships with pantries, the Maryland Food System Council, and private food businesses. It also requires building up the resilience of the infrastructure that underlies the food supply chain, such as transportation and power.

[152] *Id.* at 20-35.

Chapter 5: Capability Assessment

CFR Requirements for Plan Integration

44 CFR § 201.6(c)(4): The plan must include [a] plan maintenance process that includes:

> (i) A section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.
> (ii) A process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.
> (iii) Discussion on how the community will continue public participation in the plan maintenance process.

44 CFR § 201.6(b)(3): [T]he planning process must include [the] review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.

Introduction

Through the dedication and hard work of multiple County departments and agencies, Howard County continues to maintain a high level of preparedness through the application of hazard mitigation principles. For example, the County maintains strong flood-control practices, including rigorous permitting procedures which aim to ensure flooding is kept to a minimum in the region. The County is constantly looking for opportunities to implement, update, and cross-pollinate hazard mitigation principles into various plans, ordinances, regulations, and programs across the County. This approach ensures that all documents are well-coordinated, complementary, and that effective hazard mitigation principles are applied in all applicable aspects of County management.

The sections below include a review of select planning documents and ordinances used by the County in the areas of building standards, stormwater management, comprehensive planning, emergency operations, and capital improvements programming. Areas where hazard mitigation principles are addressed or should be addressed are indicated. Options to incorporate hazard mitigation considerations into these documents have been included to facilitate the seamless application of mitigation principles to the plans and documents. The rest of the section includes a brief overview of County organization followed by a Capabilities Assessment table describing specific capabilities across County government related to hazard mitigation.

Plan Integration

This document review is comprised of an inventory of the County's existing planning and regulatory tools and a review and incorporation of existing plans and other technical information as appropriate.

The purpose of a plan/ordinance review is trifold:

- To identify existing County standards and mandates;

- To provide an inventory and review of sample plans and ordinances and identify sections in these documents that address hazard mitigation-related issues; and,
- To provide a platform to integrate plans and other documents to reconcile any inconsistencies among different documents.

The sections below include a review of relevant Howard County plans and ordinances, including:

- PlanHoward 2030[153]
- Office of Emergency Management Strategic Plan 2020-2025[154]
- County Ordinances related to Subdivision and Land Development, Floodplains, and Stormwater Management

Planning Integration Practices

Internal Process for Integrating this Plan into Other Planning Mechanisms

Howard County departments and offices consistently work together when developing plans to integrate each other's plan data, information, goals, and actions. It is standard practice to reach out and engage with relevant partners in other departments and offices when writing a new plan or updating an old one. In addition, OEM employees are members of several different working groups (both within and external to the County) that meet once a month or more where news of new plans, expertise that is needed, or missing information is shared with the group. One of these groups is called the Emergency Management Operations Group (EMOG). These meetings occur monthly and are hosted by OEM and representatives from County departments that could be asked to work in the Emergency Operations Center during an incident attend these meetings. This provides OEM with the chance to make sure that not only is hazard mitigation planning incorporated into all other plans in the County, but that we include other plan strategies in this Plan as well.

External Process for Integrating this Plan into Other Planning Mechanisms

Howard County departments and offices often work with external agencies and neighboring jurisdictions during the planning process to integrate each other's plan data, information, goals, and actions. All OEM employees sit on at least one Baltimore Urban Area Security Initiative (UASI) committee where regional partners come together once a month to discuss jurisdictional plans that are being developed, regional plans, resources, and available trainings. This ensures that data, best practices, and expertise can be shared. Some of these groups under the UASI include the Public Information and Outreach Committee, the Recovery/Emergency Management/Training and Exercise Committee, the Regional Catastrophic Preparedness Grant Program Taskforce, the Special Operations Committee, the Disaster Debris Committee, the Regional Evacuation Working Group, and the Grants and Fiscal Representatives Committee.

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[153] *PlanHoward 2030*, HOWARD CNTY. DPET. OF PLANNING AND ZONING (amended Feb. 9, 2021), https://www.howardcountymd.gov/sites/default/files/2021-03/PlanHoward2030Amended.pdf.

[154] *Strategic Plan 2020-2025*, HOWARD CNTY. OFFICE OF EMERGENCY MGMT. (June 2020), https://live-hoco-d9.pantheonsite.io/sites/default/files/2021-05/Signed%20Final%202020-2025%20OEM%20Strategic%20Plan.pdf.

Howard County General Plan (PlanHoward2030)

The following policies and implementing actions in the County General Plan, developed by the Howard County Department of Planning and Zoning (DPZ) in 2012 and amended in 2021, were developed to be in harmony with relevant County plan actions. Howard County OEM participated as part of the DFRS in the contributing to this plan. We have listed the clauses below that relate to hazard mitigation.

PLANHOWARD 2030 REVIEW			
PLAN TOPIC	**PAGE NUMBER**	**ITEM TYPE**	**CURRENT CLAUSE**
Environmental Protection	19	Water Resources Element (WRE)	The Water Resources Element (WRE), an amendment to General Plan 2000, was adopted in April 2010. The WRE is intended to ensure the County has a safe and adequate supply of drinking water, and adequate land and water capacity for the treatment of wastewater and stormwater, to support future growth. The WRE contains policies and actions to help the County manage water resources more sustainably to ensure that, as the County continues to grow, water resources will be conserved, protected, and restored to health. **The WRE is included in PlanHoward 2030 by reference** and may be updated in the future to reflect evolving water and sewer demand and pollution reduction requirements.
	19	Policy 3.1	Ensure the adequacy of wastewater treatment capacity.
	19	Policy 3.2	Reduce pollution loads to surface and groundwater.
	19	Implementing Action	**Stormwater Utility**. Institute a dedicated fund to ensure increased and sustained funding for stormwater and watershed management programs.
	20	Policy 3.3	Use watershed management plans to guide the protection and restoration of water resources.
	20	Implementing Action	**Watershed Management Plans**. Prepare comprehensive watershed management plans for all watersheds, to set priorities and guide efforts to protect, restore, and improve the County's water resources. Complete and update all watershed management plans on a regular cycle.
	20	Implementing Action	**Forest Cover and Riparian Forest Buffers**. Establish and achieve measurable goals for forest cover and riparian forest buffers in all County watersheds.
	20	Implementing Action	**Wetlands**. Develop a wetlands program to inventory, map, protect, and enhance wetland resources.
	20	Policy 3.4	Coordinate regional protection of water resources.
	20	Implementing Action	**Patuxent and Patapsco Rivers**. Coordinate and cooperate with other local, regional, and State agencies and organizations on joint watershed planning and management for the Patuxent and the Patapsco Rivers.
	20	Implementing Action	**Patapsco Heritage Area Management Plan.** Work with the Patapsco Heritage Greenway, Inc. and Baltimore County to

PLANHOWARD 2030 REVIEW			
PLAN TOPIC	**PAGE NUMBER**	**ITEM TYPE**	**CURRENT CLAUSE**
			assist in implementing the management plan, certified by the Maryland Heritage Area Authority, for those portions that apply to Howard County. **The adopted plan is included in PlanHoward2030 by reference.**
	22	Implementing Action	**Best Management Practices**. Expand current outreach and education efforts to promote and assist private property owners with the implementation of BMP.
	24	Implementing Action	**Streams, Wetlands, and Floodplains**. Evaluate the effectiveness of current regulations in protecting streams, wetlands, and floodplains.
	25	Policy 3.8	Improve stormwater management practices throughout the County to help restore and protect water resources.
	25	Implementing Action	**Redevelopment.** Ensure redevelopment is designed and implemented to reduce stormwater runoff rate, volume, and pollution to the maximum extent practicable.
	Recommendation: There are no additional recommendations at this time.		
Resource Conservation	**Recommendation**: Include an additional implementing action to protect historic resources from the impacts of natural hazards through preservation-based hazard mitigation solutions.		
Economic Development	**Recommendation**: Develop a new policy and implementing actions that encourages economic resilience and encourages business owners to have a business continuity plan for flood and other hazard events.		
Public Facilities and Services	105	Policy 8.4	**Policy 9.4** – Ensure the adequacy of water and sewer services.
	105	Implementing Action	**Wastewater Treatment Plant Capacity**. Monitor flows to the Little Patuxent Water Reclamation Plant to ensure sufficient capacity for projected growth in the Planned Service Area.
	108	Policy 8.7	**POLICY 8.7** – Identify and fund the most cost-effective strategies for Watershed Implementation Plan execution.
	108	Implementing Action	**Best Management Practices**. Monitor and evaluate the cost-effectiveness of diverse BMP to maximize nutrient reduction from the funds expended.
	119	Policy 8.16	**POLICY 8.16** – Minimize loss of life, loss of property, and injury due to fire or medical emergencies.
	119	Implementing Action	**Fire Stations**. Construct and staff the new and replacement fire stations in the current Capital Improvement Program (Waterloo, Elkridge, and Banneker). Renovate and rehabilitate existing fire stations as appropriate to ensure the continued provision of efficient service.
	120	Implementing Action	**Underground Cisterns**. Continue to construct underground cisterns to support fire suppression in the Rural West.
	120	Implementing Action	**Fire and Rescue Vehicles**. Provide funding to replace fire and rescue vehicles when needed.

PLANHOWARD 2030 REVIEW			
PLAN TOPIC	**PAGE NUMBER**	**ITEM TYPE**	**CURRENT CLAUSE**
	120	Implementing Action	**Adequate Resources**. Ensure the Police Department has adequate staff and equipment based on levels of crime and demand for services.
	Recommendation: There are no additional recommendations at this time.		
Community Design	138	Implementing Action	**Infrastructure Gaps**. Expand existing infrastructure for older communities that were constructed under prior regulations, so these communities could benefit from additional improvements such as storm drains and sidewalks.
	138	Implementing Action	**Environmental Enhancement**. Expand environmental remediation to address storm water management, stream bank erosion, and buffer conservation.
	Recommendations: There are no additional recommendations at this time.		
General Plan Amendment	**Ellicott City Watershed Master Plan (2020)** is a comprehensive, long-range document created by a community-driven vision for historic Ellicott City and the Tiber Branch Watershed and was adopted as a general plan amendment and **included in PlanHoward2030 by reference**.		

Howard County Code of Ordinances – Subdivision and Land Development, Floodplain, and Stormwater Management (2022)

The following sections of the Howard County Subdivision and Land Development, Floodplain, and Stormwater Management Ordinances relate to mitigation and are echoed in this document.

HOWARD COUNTY CODE OF ORDINANCES REVIEW – SUBDIVISION AND LAND DEVELOPMENT, FLOODPLAIN, AND STORMWATER MANAGEMENT ORDINANCES	
TITLE 16 – SUBTITLE 1 – SUBDIVISION AND LAND DEVELOPMENT	
PLAN TOPIC & CITATION(S)	**CURRENT CLAUSE**
§ 16.104 Waivers § 16.104(d)(2-6)	(d) *No Waivers of Floodplain, Wetland, Stream, or Steep Slope Regulations in the Tiber Branch Watershed*. The Department may not grant waivers of any requirement of section 16.115 or section 16.116 of this title for any property located in the Tiber Branch Watershed unless the waiver: (2) Is necessary for the reconstruction of existing structures or infrastructure damaged by flood, fire, or other disaster; (3) Is necessary for the construction of a stormwater management or flood control facility as part of a redevelopment project; (4) Is necessary for the retrofit of existing facilities or installation of new facilities intended solely to improve stormwater management or flood control for existing development[.] (5) Is requested as part of a development proposal and the Director of the Department of Public Works, or his designee serving as Floodplain Administrator, finds that upon completion of construction of the development, which may include off-site improvements within the Tiber Branch Watershed, there will be improvement to flood control in the

	Tiber Branch Watershed at least ten percent more than what would otherwise be required by law; or (6) Is necessary for the construction of an addition, garage, driveway or other accessory use improvement of an existing residential structure on property located within the Tiber Branch Watershed that increases the square footage of the impervious surfaces on the property by no more than 25 percent over the square footage of impervious surfaces that existed on the property prior to the effective date of this bill [Dec. 9, 2016].
§ 16.115 Floodplain Preservation § 16.115(a)(1-3) § 16.115(b)(1-2) § 16.115(c)(1-2)	(a) *Development Restricted in 100-Year Floodplain (Base Flood Elevation).* Development within the boundaries of the 100-year floodplain (base flood elevation) shall be pursuant to title 16, subtitle 7 of this Code. Most land within base flood elevation is considered a protection area (i.e., a stream valley or valuable ecological area or scenic resource) which is shown: (1) In the General Plan of Howard County for conservation status; or (2) In the master plan of parks for acquisition as a conservation area; or (3) In the capital improvement program for acquisition as a conservation area. (b) *Floodplain Protection*. In subdivisions and site development plans containing a 100-year floodplain (base flood elevation), the floodplain land shall be protected in accordance with one of the following alternatives. Prior to the recordation of the final plat and final acceptance of the construction drawings, a deed description of the floodplain will be provided when requested. (1) Deed the floodplain land to the County. Developers are encouraged to dedicate and deed the land in the 100-year floodplain (base flood elevation) to Howard County as permanent open space. (2) Grant a floodplain easement to Howard County. If the floodplain is not dedicated to the County, the developer shall grant the County right of entry through a perpetual easement, and shall: (i) Dedicate and deed the land area within the 100-year floodplain (base flood elevation) in fee simple to a legally constituted property owners association. The property owners association may use the area in any manner consistent with the maintenance and preservation of the area as a floodplain; or (ii) Include the 100-year floodplain (base flood elevation) within the boundary of the lots in accordance with section 16.120 of this subtitle. The property owner whose lot includes floodplain area may use the area in any manner consistent with the maintenance and preservation of the area as a floodplain. (c) *Prohibitions on Use of Floodplain Land*: (1) A person shall not store materials of any kind in a floodplain either temporarily or permanently. Accordingly, building materials and other debris shall not be stored or discarded in floodplains. (2) No clearing, excavating, filling, altering drainage, or impervious paving, may occur on land located in a floodplain unless required or authorized by the Department of Planning and Zoning upon the advice of the Department of Inspections, Licenses and Permits, the Department of Public Works, the Department of Recreation and Parks, the Soil Conservation District, or the Maryland Department of the Environment. Any proposed construction of a structure located within a floodplain shall be subject to the requirements of the Howard County Building Code.

§ 16.116 Protection of Wetlands, Streams, and Steep Slopes § 16.116(a)(1-4) § 16.116(b)(1-2)	(a) *Streams and Wetlands*: (1) Grading, removal of vegetative cover and trees, paving, and new structures shall not be permitted within 25 feet of a wetland in any zoning district. (2) Grading, removal of vegetative cover and trees, paving, and new structures shall not be permitted within: (i) Fifty feet of an intermittent stream bank; (ii) Seventy-five feet of a perennial stream bank for Use I streams as classified by the Maryland Department of the Environment in residential zoning districts and residential and open space land uses in the NT, PGCC, and MXD districts; (iii) One hundred feet of a perennial stream bank for Use III and IV streams; and (iv) Fifty feet of a perennial stream bank in nonresidential zoning districts. (3) In residential subdivisions, wetlands, streams, and their buffers shall be located in required open space or a non-buildable preservation parcel rather than on residential lots except as permitted by section 16.120 of this subtitle. (4) Wetlands and the required buffers for wetland and streams shall be delineated on final plats and site development plans with a clear notation of use restrictions. Wetland limits shall be identified with surveyed bearings and distances. Wetlands need not be delineated for agricultural preservation subdivisions or rural cluster subdivisions if a qualified professional certifies that wetlands and buffers will not be impacted by the proposed lots or potential development. (b) *Steep Slopes.* Steep slopes are slopes that average 25 percent or greater over ten vertical feet. (1) Grading, removal of vegetative cover and trees, new structures, and paving shall not be permitted on land with existing steep slopes, except when: (i) The on-site and off-site contiguous area of steep slopes is less than 20,000 square feet; and (ii) There is sufficient area, a minimum ten feet, outside of stream and wetland buffers for required sediment and erosion control measures. (2) In residential subdivisions steep slopes existing at the time of subdivision shall be located in required open space or a preservation parcel, except as permitted by section 16.120 of this subtitle.
§ 16.131 Sewage Disposal and Water Supply § 16.131(b)	(b) *Sewage Disposal and Water Supply Required Pursuant to Regulations*. Subdivision and site development plans shall provide for sewage disposal and for an appropriate supply of potable water in accord with the provisions of the Howard County master plan for water and sewerage, the regulations of the Maryland Department of Environment and the regulations of the Howard County Health Department. Community water systems and community sewer systems may be constructed and operated only in the metropolitan district. No waiver may be granted to these requirements. Provision shall be made for an adequate supply of water for fire protection.
§ 16.133 Storm Drainage § 16.133(a-f)	(a) *Requirement to Construct Storm Drainage*. Where deemed necessary by the Director of Planning and Zoning, after consultation with the Director of Public Works: (1) The developer shall construct storm drains to handle on-site runoff; and

	(2) The developer shall provide on-site drainage easements; however, these may not encroach on required perimeter landscaping unless approved by the Department of Planning and Zoning; and (3) The developer shall provide off-site drainage easements; and (4) The developer shall provide for the handling of off-site runoff to an acceptable outlet in the same watershed pursuant to subsection (c) below. (b) *Watersheds*. For the purposes of this subtitle, there are 4 major outlets: the Patapsco Watershed, the Middle Patuxent Watershed, the Main Patuxent Watershed, and the Little Patuxent Watershed. (c) Options for Handling Off-site Runoff. Developers shall do one of the following for all subdivisions: (1) Provide for the construction of all necessary drainage structures through and between the developer's subdivision and an acceptable outlet in the same watershed; or (2) If all or part of the necessary drainage structures between the developer's subdivision and an acceptable outlet in the same watershed has been provided by another developer, the developer of the proposed subdivision shall pay the County an off-site drainage fee prior to recordation of the plat; or (3) Pay the County an off-site drainage fee prior to recordation of the plat. (d) Restriction on Construction in 100-Year Floodplain. Construction on land within the 100-year floodplain shall be subject to the restrictions of section 16.115, "Floodplain Preservation." (e) Use of the Off-site Drainage Fees. The County may expend off-site drainage fees paid by the developers of subdivisions in a given watershed only for the construction of drainage facilities in that watershed. (f) Deleted.
TITLE 16 – SUBTITLE 7 – FLOODPLAIN	
PLAN TOPIC & CITATION(S)	**CURRENT CLAUSE**
§ 16.705 Requirements and Restrictions Applicable to the Floodplain § 16.705(a) § 16.705(b) § 16.705(c)(1-6) § 16.705(d) § 16.705(e)(1-3)	(a) Within the floodplain, no development shall be permitted except as provided in this subtitle, the Howard County Building Code adopted at title 3, subtitle 1 of the Howard County Code and the Subdivision Regulations adopted at title 16, subtitle 1 of the Howard County Code.
	(b) Within the approximate floodplain for new subdivisions, site development plans, or single lots, the 100-year flood elevations (base flood elevations) shall be certified by a qualified design professional as determined by the Director of the Department of Public Works based on hydrologic and hydraulic analyses which include a floodway analysis. For a single lot, if no data are available, methods described in Federal Emergency Management Agency Publication No. 265, "Managing Floodplain Development in Approximate Zone A Areas", or a method approved by the Department of Planning and Zoning shall be used to determine the BASE flood elevation.
	(c) *Buildings and Structures*. In addition to the requirements set forth in the Howard County Building Code, new buildings and structures (including the placement and replacement of manufactured homes) and substantial improvement of existing structures (including

	manufactured homes) that are located, in whole or in part, in any special flood hazard area shall: (1) Be designed (or modified) and constructed to safely support flood loads. The construction shall provide a complete load path capable of transferring all loads from their point of origin through the load-resisting elements to the foundation. Structures shall be designed, connected and anchored to resist flotation, collapse or permanent lateral movement due to structural loads and stresses, including hydrodynamic and hydrostatic loads and the effects of buoyancy, from flooding equal to the flood protection elevation or the elevation required by these regulations or the Howard County Building Code, whichever is higher. (2) Be constructed by methods and practices that minimize flood damage. (3) Use flood damage-resistant materials below the elevation of the lowest floor required in section 3114 of the Howard County Building Code. (4) Have electrical systems, equipment and components, and mechanical, heating, ventilating, air conditioning, and plumbing appliances, plumbing fixtures, duct systems, and other service equipment located at or above the elevation of the lowest floor required in section 3114 of the Howard County Building Code. Electrical wiring systems are permitted to be located below elevation of the lowest floor provided they conform to the provisions of the electrical part of the Howard County Building Code for wet locations. If replaced as part of a substantial improvement, electrical systems, equipment and components, and heating, ventilation, air conditioning, and plumbing appliances, plumbing fixtures, duct systems, and other service equipment shall meet the requirements of this section. (5) Have the electric panelboard elevated at least three feet above the BFE. (6) Comply with the requirements of the most restrictive designation if located on a site that has more than one flood zone designation (a zone, designated floodway).
	(d) *Recreational Vehicles.* Recreational vehicles shall not be parked or stored in special flood hazard areas.
	(e) *Protection of Water Supply and Sanitary Sewage Systems.* (1) New and replacement water supply systems shall be designed to minimize or eliminate infiltration of floodwaters into the systems. (2) New and replacement sanitary sewage systems shall be designed to minimize or eliminate infiltration of floodwaters into systems and discharges from systems into floodwaters. (3) In addition to the requirements of section 3.808 of this Code, on-site waste disposal systems shall be located to avoid impairment to or contamination from them during conditions of flooding.
§ 16.706 Permits § 16.706(a) § 16.706(b) § 16.706(c)	(a) *Permits Required.* A person shall not begin any development or construction which is wholly within, partially within, or in contact with any flood hazard area established in section 16.703 of this subtitle, including but not limited to: Filling; grading; construction of new structures; the substantial improvement of buildings or structures, including repair of substantial damage; placement or replacement of manufactured homes, including substantial improvement or repair of substantial damage of manufactured homes; erecting or installing a temporary structure, or alteration of a watercourse, until a permit is

§ 16.706(d) § 16.706(e)(1-2) § 16.706(f)(1-2) § 16.706(g)	obtained from the County in accordance with the requirements of this subtitle and the Howard County Building Code.
	(b) In addition to the permits required in paragraph (a), Applicants for permits in nontidal waters of the state are advised to contact MDE. Unless waived by MDE, pursuant to Code of Maryland Regulations 26.17.04, construction on nontidal waters and floodplains, MDE regulates the "100-year frequency floodplain of free-flowing waters," also referred to as nontidal waters of the state. To determine the 100-year frequency floodplain, hydrologic calculations are based on the ultimate development of the watershed, assuming existing zoning. The resulting flood hazard areas delineated using the results of such calculations may be different than the special flood hazard areas established in section 16.703 of this subtitle.
	(c) *A Permit is Valid Provided the Actual Start of Work is Within 180 Days of the Date of Permit Issuance.* Requests for extensions shall be submitted in writing and justifiable cause demonstrated. The Floodplain Administrator may grant, in writing, one or more extensions of time, for additional periods not exceeding more than 90 days each and provided there has been no amendment or revision to the basis for establishing special flood hazard areas and BFEs set forth in section 16.703 of this subtitle.
	(d) *Application Required.* In accordance with the Howard County Building Code, an application for a permit shall be made by the owner of the property or the owner's authorized agent prior to the start of any work. The application shall be on a form provided by the Department of Inspections, Licenses and Permits.
	(e) *Additional Application Requirements—Certain Development.* In addition to the permit application requirements set forth in section 3.101 of this Code, a permit application for development proposals and subdivision proposals having the lesser of five lots or at least five acres in special flood hazard areas where base flood elevations are not shown on the FIRM shall include: (1) A determination of the base flood elevations; and (2) If hydrologic and hydraulic engineering analyses are submitted, such analyses shall be performed in accordance with the requirements and specifications of MDE and FEMA.
	(f) *New Technical Data.* (1) The Applicant may seek a letter of map change by submitting new technical data to FEMA, such as base maps, topography, and engineering analyses to support revision of floodplain and floodway boundaries and/or base flood elevations. Such submissions shall be prepared in a format acceptable to FEMA and any fees shall be the sole responsibility of the Applicant. A copy of the submittal shall be attached to the application for a permit. (2) An Applicant who submits new technical data to support any change in floodplain and designated floodway boundaries or base flood elevations shall submit a letter of map change from FEMA as soon as practicable, but not later than six months after the date such information becomes available. Such submissions shall be prepared in a format acceptable to FEMA and any fees shall be the sole responsibility of the Applicant.

	(g) *Application of Requirements.* The general requirements of this subtitle and the Howard County Building Code apply to all development proposed within all special flood hazard areas identified in section 16.703 of this subtitle.
§ 16.710 Subdivision Proposals and Development Proposals § 16.710(a-c)	In accordance with section 16.115 of this Code, in all flood zones, subdivision proposals and development proposals shall: (a) Be consistent with the need to minimize flood damage and are subject to all applicable standards in this subtitle and the Howard County Building Code. (b) Have utilities and facilities such as sewer, gas, electrical, and water systems located and constructed to minimize flood damage. (c) Have adequate drainage paths provided to reduce exposure to flood hazards and to guide floodwaters around and away from proposed structures.
§ 16.711 Variances § 16.711(a)(1-4) § 16.711(b)(1-6) § 16.711(c)(1-2)	(a) *Generally.* (1) *Authority to consider.* The Floodplain Administrator, through the Director of the Department of Inspections, Licenses and Permits, shall have the power to consider and authorize or deny variances from the strict application of the requirements of these regulations for construction adjacent to a floodplain in accordance with section 3112.4 of the Howard County Building Code. A variance shall be approved only if it is determined to not be contrary to the public interest and where, owing to special conditions of the lot or parcel, a literal enforcement of the provisions of these regulations, an unnecessary hardship would result. (2) *Conditions.* Upon consideration of the purposes of these regulations, the individual circumstances, and the considerations and limitations of this section, the Floodplain Administrator, through the Director of the Department of Inspections, Licenses and Permits, may attach such conditions to variances as it deems necessary to further the purposes of these regulations. (3) *Notification to Applicant.* The Floodplain Administrator, through the Director of the Department of Inspections, Licenses and Permits, shall notify, in writing, any Applicant to whom a variance is granted to construct or substantially improve a building or structure with its lowest floor below the elevation required by these regulations that the variance is to the floodplain management requirements of these regulations only, and that the cost of federal flood insurance will be commensurate with the increased risk, with rates up to $25.00 per $100.00 of insurance coverage and that the construction of structures below the base flood elevation increases risks to life and property. (4) *Records.* A record of all variance actions, including justification for issuance shall be maintained pursuant to section 16.709 of this subtitle.
	(b) *Considerations for Granting Variances.* The Floodplain Administrator, through the Director of the Department of Inspections, Licenses and Permits shall make an affirmative decision on a variance request for construction adjacent to a floodplain only upon: (1) A showing of good and sufficient cause. (2) A determination that failure to grant the variance would result in exceptional hardship due to the physical characteristics of the property. Increased cost or inconvenience of meeting the requirements of these regulations does not constitute an exceptional hardship to the Applicant. (3) A determination that the granting of a variance for development within any designated floodway, or flood hazard area with base flood elevations but no designated

	floodway, will not result in increased flood heights beyond that which is allowed in these regulations. (4) A determination that the granting of a variance will not result in additional threats to public safety; extraordinary public expense, nuisances, fraud or victimization of the public, or conflict with existing local laws. (5) A determination that the building, structure or other development is protected by methods to minimize flood damages. (6) A determination that the variance is the minimum necessary to afford relief, considering the flood hazard.
	(c) *Variance Prohibited.* (1) A variance shall not be issued within any designated regulatory floodway if any increase in flood levels during the base flood discharge would result. (2) A variance may not be issued for any property located in the Tiber Branch Watershed unless the variance: (i) Was requested on or before November 7, 2016; (ii) Is necessary for the reconstruction of existing structures or infrastructure damaged by flood, fire, or other disaster; (iii) Is necessary for the construction of a stormwater management or flood control facility as part of a redevelopment project; (iv) Is necessary for the retrofit of existing facilities or installation of new facilities intended solely to improve stormwater management or flood control for existing development; (v) Is requested as part of a development proposal and the Director of the Department of Public Works, or his designee serving as Floodplain Administrator, finds that upon completion of construction of the development, which may include off-site improvements within the Tiber Branch Watershed, there will be improvement to flood control in the Tiber Branch Watershed at least ten percent more than what would otherwise be required by law; or (vi) Is necessary for the construction of an addition, garage, driveway or other accessory use improvement of an existing residential structure on property located within the Tiber Branch Watershed that increases the square footage of the impervious surfaces on the property by no more than 25 percent over the square footage of impervious surfaces that existed on the property prior to the effective date of this bill [Dec. 9, 2016].
TITLE 18 – SUBTITLE 9 – STORMWATER MANAGEMENT	
PLAN TOPIC & CITATION(S)	**CURRENT CLAUSE**
§ 18.903 – Design Criteria; Minimum Control Requirements; Alternatives § 18.903(a-b)	(a) The minimum control requirements established in this section and the design manual are as follows: (1) The County shall require that the planning techniques, nonstructural practices, and design methods specified in the design manual be used to implement ESD to the MEP. The use of ESD planning techniques and treatment practices must be exhausted before any structural BMP is implemented. Stormwater management for development projects subject to this subtitle shall be designed using ESD sizing criteria, recharge volume, water quality volume, and channel protection storage volume criteria according to the design

	manual. The MEP standard is met when channel stability is maintained, predevelopment groundwater recharge is replicated, nonpoint source pollution is minimized, and structural stormwater management practices are used only if determined to be absolutely necessary. (2) Control of the two-year and ten-year frequency storm event is required according to the design manual and all subsequent revisions if the County determines that additional stormwater management is necessary because historical flooding problems exist and downstream floodplain development and conveyance system design cannot be controlled. (3) One-hundred-year peak management control is required according to the design manual. For purposes of calculating the 100-year 24-hour storm event, 8.51 inches of rainfall depth shall be the minimum depth used. (4) The County may require more than the minimum control requirements if: (i) Hydrologic or topographic conditions warrant; or (ii) Flooding, stream channel erosion, or water quality problems exist downstream from a proposed project. (b) Stormwater management where applicable, shall be consistent with adopted and approved watershed management plans or flood management plans as approved by the Maryland Department of the Environment in accordance with the Flood Hazard Management Act of 1976.
§ 18.904 Stormwater Management Measures § 18.904(a,g,h)	(a) *Required*. The ESD planning techniques and treatment practices and structural stormwater management measures established in this subtitle and the design manual shall be used, either alone or in combination, in a stormwater management design. A developer shall demonstrate that ESD has been implemented to the MEP before the use of a structural BMP is considered in developing the stormwater management design. (g) *Alternatives*. Alternative ESD planning techniques and treatment practices and structural stormwater measures may be used for new development runoff control if they meet the performance criteria established in the design manual and all subsequent revisions. Practices used for redevelopment projects shall be approved by the County. All alternative ESD practices shall be approved by the Administration. (h) *Modifications*. For the purposes of modifying the minimum control requirements or design criteria, the owner or developer shall submit to the County an analysis of the impacts of stormwater flows downstream in the watershed. The analysis shall include hydrologic and hydraulic calculations necessary to determine the impact of hydrograph timing modifications of the proposed development upon a dam, highway, structure, or natural point of restricted streamflow. The point of investigation is to be established with the concurrence of the County, downstream of the first downstream tributary whose drainage area equals or exceeds the contributing area to the project or stormwater management facility.
§ 18.905 Stormwater Management Design Process § 18.905(b)(6)	If a stormwater management plan involves direction of some or all runoff off of the site, the developer shall obtain from adjacent property owners any easements or other necessary property interests concerning flowage of water.

§ 18.908 Waivers; Watershed Management Plans § 18.908(a)(3)	(a) Waiver Requests. A request for a waiver under this section shall: (3) Be prohibited for any property located in the Tiber Branch Watershed unless the waiver: (i) Was requested on or before November 7, 2016; (ii) Is necessary for the reconstruction of existing structures or infrastructure damaged by flood, fire, or other disaster; (iii) Is necessary for the construction of a stormwater management or flood control facility as part of a redevelopment project; (iv) Is necessary for the retrofit of existing facilities or installation of new facilities intended solely to improve stormwater management or flood control for existing development; (v) Is requested as part of a development proposal and the Director of the Department of Public Works, or his designee serving as Floodplain Administrator, finds that upon completion of construction of the development, which may include off-site improvements within the Tiber Branch Watershed, there will be improvement to flood control in the Tiber Branch Watershed at least ten percent more than what would otherwise be required by law; or (vi) Is necessary for the construction of an addition, garage, driveway or other accessory use improvement of an existing residential structure on property located within the Tiber Branch Watershed that increases the square footage of the impervious surfaces on the property by no more than 25 percent over the square footage of impervious surfaces that existed on the property prior to the effective date of this bill [Dec. 9, 2016].
§ 18.910 Redevelopment § 18.910(b-c)	(b) All redevelopment projects shall reduce existing impervious area within the limit of disturbance by at least 50 percent. Where site conditions prevent the reduction of impervious area, then ESD practices shall be implemented to provide qualitative control for at least 50 percent of the site's impervious area. When a combination of impervious area reduction and stormwater management practice implementation is used, the combined reduction shall equal or exceed 50 percent of the existing impervious area within the limit of disturbance. (c) Alternative stormwater management measures may be used to meet the requirements in subsection (b) of this section if the owner or developer satisfactorily demonstrates to the County that impervious area reduction has been maximized and ESD has been implemented to the MEP. Alternative stormwater management measures include, but are not limited to: (1) An on-site structural BMP; (2) An off-site structural BMP to provide water quality treatment for an area equal to or greater than 50 percent of the existing impervious area; or (3) A combination of impervious area reduction, ESD implementation, and an on-site or off-site structural BMP for an area equal to or greater than 50 percent of the existing site impervious area within the limit of disturbance.
TITLE 3 – SUBTITLE 1 – BUILDING CODE	
PLAN TOPIC & CITATION(S)	**CURRENT CLAUSE**

§ 3114 Floodplain § 3114.1 § 3114.2 § 3114.3 § 3114.4 § 3114.5 § 3114.6 § 3114.7 § 3114.8 § 3114.9	**3114.1 General**. For the purpose of this Section, the floodplain is delineated in title 16, subtitle 7 of the Howard County Code. **3114.2 Within designated floodplain.** The construction, reconstruction, modification, alteration, repair, or improvement of buildings, manufactured homes, or other structures located within a designated floodplain shall be done in accordance with the requirements set forth in this section. **3114.2.1 New construction**. New residential or nonresidential construction shall not occur within a designated floodplain. Exception 1: An existing nonconforming structure located within a designated floodplain which is destroyed by fire or flood, or that sustains substantial damage may be restored to the same size and dimension and in the same location on the same lot as the destroyed structure, provided construction begins within 12 months of the date of destruction. Construction shall comply with the elevating and floodproofing requirements of subsection 3114.4 for new construction adjacent to a floodplain. A person shall not intentionally demolish or reconstruct any nonconforming structure. This exception does not apply to manufactured homes. A manufactured home cannot be restored under any condition within a designated floodplain. Exception 2: Transportation networks, utility installations, piers, open pier structures, and open decks approved by the Department of Public works. Streets, sidewalks, pathways, and utility systems in accordance with the Howard County Design Manual and all other applicable codes, ordinances, resolutions, and regulations. **3114.2.2 Additions and enlargements**. Existing nonconforming structures located within a designated floodplain shall not be expanded or enlarged. **3114.2.3 Modifications, alterations, and repairs**. Modifications, alterations, repairs, or improvements that cost less than 50% of the fair market value of the structure may be made to existing nonconforming structures located within a designated floodplain without floodproofing or elevating if the owner demonstrates through a Maryland State registered professional engineer that floodproofing or elevating is impractical. **3114.3 Substantial improvements within a designated floodplain**. Substantial improvements within a designated floodplain shall meet the standards set forth in this subsection and Title 16, Subtitle 7 of the Howard County Code. **3114.3.1 Residential**. The lowest floor, including a basement, of substantial improvements to existing nonconforming residential structures located within a designated floodplain shall be elevated to at least 2 feet above the 100-year flood elevation. **3114.3.2 Nonresidential**. The lowest floor, including a basement, of substantial improvements to existing nonconforming nonresidential structures shall be elevated to at least 2 feet above the 100-year flood elevation or shall be designed so that any area of the building which is lower than 2 feet above the 100-year flood elevation, as determined or approved by the Department of Public Works, is watertight with walls substantially impermeable to the passage of water and with structural components having the capability of withstanding applicable hydrostatic, hydrodynamic, impact, soil, and, when applicable, hurricane and tidal wave loading conditions. The water tightness and structural capabilities shall be those described in floodproofing regulations published by the Office of the Chief of Engineers, U.S. Army, Washington, D.C., December 1995, or subsequent revisions, and section 16.705(c) of the Howard County Code.

3114.4 Construction adjacent to a designated floodplain. Where buildings are located adjacent to a designated floodplain the following subsections and title 16, subtitle 7 of the Howard County Code shall apply:

3114.4.1 Residential. In new construction of residential buildings or additions or substantial improvements to residential buildings, all floors, including those of basement and storage areas, shall be elevated at least 2 feet above the 100-year flood level.

3114.4.2 Nonresidential. In new construction of nonresidential buildings or additions or substantial improvements to nonresidential buildings, either:

(i) All floors (including those of basement and storage areas) and all electrical, heating, ventilation, plumbing, air conditioning equipment, and other service facilities associated with the buildings shall be elevated at least two feet above the 100-year flood level, as determined or approved by the Department of Public Works; or

(ii) The construction or improvement shall be designed so that any areas of the building that are lower than two feet above the 100-year flood elevation, as determined or approved by the Department of Public Works, are watertight with walls substantially impermeable to the passage of water and with structural components having the capability of withstanding applicable hydrostatic, hydrodynamic, impact, soil, and, when applicable, hurricane and tidal wave loading conditions. The water tightness and structural capabilities shall be those described in floodproofing regulations, published by the office of the Chief of Engineers, U.S. Army, Washington, D.C., December 1995, or subsequent revisions, and section 16.705(c) of the Howard County Code.

3114.4.3. Modifications, alterations or repairs. Modifications, alterations, repairs, or improvements that costs less than 50% of the fair market value of the structure may be made to existing nonconforming structures located adjacent to a designated floodplain without floodproofing or elevating.

3114.4.4. Variances. Variances to the requirements set forth in this subsection may be granted by the Building Official in accordance with section 16.711 of the Howard County Code.

3114.5 Substantial improvements adjacent to a designated floodplain. Substantial improvements adjacent to a designated floodplain shall meet the standards set forth in this subsection and title 16, subtitle 7 of the Howard County Code.

3114.5.1 Residential. The lowest floor, including a basement, of substantial improvements to existing nonconforming residential structures located adjacent to a designated floodplain shall be elevated to at least 2 feet above the 100-year flood elevation.

3114.5.2 Nonresidential. The lowest floor, including a basement, of substantial improvements to existing nonconforming nonresidential structures and all electrical, heating, ventilation, plumbing, air conditioning equipment, and other service facilities associated with the buildings shall be located adjacent to a designated floodplain shall be elevated to at least two feet above the 100-year flood elevation or shall be designed so that any area of the building which is lower than two feet above the 100-year flood elevation, as determined or approved by the Department of Public Works, is watertight with walls substantially impermeable to the passage of water and with structural components having the capability of withstanding applicable hydrostatic, hydrodynamic impact, soil, and, when applicable, hurricane and tidal wave loading conditions. The water tightness and structural capabilities shall be those described in floodproofing regulations published by the Office of the Chief of

Engineers, U.S. Army, Washington, D.C., December 1995, or subsequent revisions, and section 16.705(c) of the Howard County Code.

3114.6 Verification. For the purpose of verifying compliance with Section 3114.4 for construction adjacent to a designated floodplain, the following shall apply:

(i) When floodproofing by means other than elevating, a document stating that the proposed construction has been adequately designed to withstand the loading conditions stated in subsection 3114.4.2(ii) shall be certified by a professional engineer or architect currently registered in Maryland. This document shall be required prior to issuance of a building permit.

(ii) When floodproofing by elevating is used, the owner shall agree, in writing, to provide a FEMA elevation certificate form 086-0-33, completed by a professional engineer or professional land surveyor currently registered in Maryland, certifying that the as-built lowest floor of the structure is elevated at least 2 feet above the 100-year floodplain elevation. The agreement shall be made prior to the issuance of the building permit and the completed certification shall be submitted prior to foundation approval by the Building Official.

(iii) Fair market value of a structure shall be established by a recent (within 6 months) formal appraisal from a qualified appraiser. Fair market value shall not include land value.

(iv) Cost to repair or improve a structure shall be established by a recent (within 6 months) written estimate from a licensed contractor and shall include the complete cost of repairs or improvements to the point of use or occupancy.

3114.7 Definitions. Notwithstanding Chapter 2 of the International Building Code, the following definitions shall apply to Section 3114.0, Floodplain, of this Code:

Accessory structure. A detached structure on the same parcel or property as the principal structure that has a use that is incidental to the principal structure including, but not limited to, a shed or detached garage.

Adjacent to a floodplain. Sharing a common border with a floodplain.

Basement. An enclosed area that is below grade on all sides.

Floodplain. Shall be as delineated in title 16, subtitle 7 of the Howard County Code.

Floodproofing. Any combination of additions, changes, or adjustments to a structure which reduce or eliminate flood damage to real estate or improved real property, water or sanitary facilities, or structures and their contents , such that the buildings or structures are watertight with walls substantially impermeable to the passage of water and with structural components having the capability of resisting hydrostatic and hydrodynamic loads and effects of buoyancy.

Historic structure. A building listed on the national register of historic places, a state inventory of historic places, or an inventory of historic structures adopted by resolution of the County Council. A historic structure also includes a structure that is certified or preliminarily determined by the United States Secretary of the Interior as contributing to the historical significance of a registered historic district or a district preliminarily determined by the Secretary to qualify as a registered historic district.

Lowest floor. The lowest floor or the lowest enclosed area, including a basement. Lowest floor does not include an unfinished or flood resistant enclosure used solely for parking vehicles, building access, or storage in an area other than a basement area. The enclosure

shall not be built so as to render the structure in violation of the applicable non-elevation design requirements of subsections 3114.4 and 3114.6 of this Code.

Manufactured home. A manufactured home shall have the meaning set forth in title 16, subtitle 7 of the Howard County Code.

New construction. Structures, including additions and improvements, and the placement of manufactured homes, for which the start of construction commenced on or after 3/15/1977, the initial effective date of the Howard County Flood Insurance Rate Map, including any subsequent improvements, alterations, modifications, and additions to such structures.
The repair or replacement of a manufactured home because of substantial damage is considered to be new construction and is prohibited in accordance with Section 3114.2.1 of this Code.

Structure. For purposes of this Subsection 3114 to this Code, shall have the meaning set forth in title 16, subtitle 7 of the Howard County Code.

Substantial damage. Damage of any origin sustained by a structure where the cost of returning the structure to its condition prior to damage would equal or exceed 50% of the structure's fair market value before the damage occurred.

Substantial improvement. The repair, reconstruction, or improvement of a building or structure, the cost of which is equal to or greater than 50% of the fair market value of the building or structure prior to damage, improvement, or repair. For the purpose of this definition, "substantial improvement" occurs when the first alteration of a wall, ceiling, floor, or other structural part of the building begins, whether or not that alteration affects the external dimensions of the building or structure. The term does not include any project for improving a building or structure to comply with existing State or local health, sanitary, or housing code requirements which are necessary to assure safe living conditions. This term does not include an alteration of a historic structure provided that the alteration will not preclude the structure's continued designation as a historic structure.

Variance. The grant of relief from a term of this subtitle.

3114.8 Variances and waivers. Except as provided in Section 3114.4 of this Code, a variance or waiver of this section is not allowed. The building official shall consider a variance in accordance with the provisions of section 16.711 of the Howard County Code.

3114.9 Other agencies. A permit issued by the Building Official under this subtitle is not valid until all necessary permits for the development are obtained. Receipt of federal or State permits do not exempt a development from the provisions of this subtitle.

Howard County Office of Emergency Management Strategic Plan 2020-2025

The following goals and objectives of the Howard County OEM Strategic Plan, developed by the Howard County OEM, relate directly to mitigation and are echoed in this document.[155]

HOWARD COUNTY EMERGENCY STRATEGIC PLAN 2020-2025		
PLAN TOPIC	**ITEM TYPE**	**CURRENT CLAUSE**
Strategic Goal 1	Goal	Strengthen Howard County's capabilities to restore and stabilize government operations, economy, and community life, and ensure that compatible continuity programs are developed and maintained for all Howard County departments.
	Objectives	• Ensure departments are maintaining Continuity of Operations (COOP) Plans. • Coordinate COOP training and maintain County-wide COOP uniformity. • Annually assess the COOP and COG programs.
Strategic Goal 3	Goal	Prevent, protect, and mitigate against human-caused and natural hazards.
	Objectives	• Synchronize the timelines of all mitigation planning activities. • Seek additional mitigation grant funding and ensure match availability, as applicable. • Maintain the mitigation steering committee to implement mitigation planning objectives and strategies. • Integrate prevention, protection, and mitigation plans with appropriate departmental plans.
Strategic Goal 4	Goal	Tailor emergency management funding, projects, and planning initiatives according to the HIRA, Threat and Hazard Identification and Risk Assessment (THIRA), and any relevant risk and vulnerability assessments.
	Objectives	• Use risk and vulnerability assessments to determine funding priorities, and to direct County investments. • Use risk and vulnerability assessments to increase preparedness, reduce risk, and increase the capacity to respond and recover. • Ensure OEM staff members are well-versed in current HIRA and THIRA to best utilize plan findings.

[155] *Strategic Plan 2020-2025*, HOWARD CNTY. OFFICE OF EMERGENCY MGMT. (June 2020), https://live-hoco-d9.pantheonsite.io/sites/default/files/2021-05/Signed%20Final%202020-2025%20OEM%20Strategic%20Plan.pdf.

Strategic Goal 5	Goal	Further develop the community outreach program by seeking out best practices and identifying additional opportunities to strengthen and foster relationships among individuals and community groups.
	Objectives	• Lead the emergency management-related content and dissemination efforts of County public information officers with County and regional partners to ensure messages resonate with targeted and general audiences. • Coordinate and expand community outreach efforts and actively establish and maintain partnerships with community leaders. • Ensure that pre-disaster preparedness, mitigation information, and post-disaster assistance programs and services are available to all people in the community. • Develop a plan to provide leadership and support through guidance documents and dissemination of best practices, to encourage businesses and nonprofits to prepare mitigation and recovery plans. • Develop a process to identify trending community issues both for preparedness information before a disaster and to focus post-disaster information on the real questions and needs of the community. • Identify and target community preparedness education efforts for communities without adequate resources.
Strategic Goal 7	Goal	Maintain and continually improve the strategic planning process, which holistically integrates planning, training, exercises, and evaluation, and that ensures plans are vertically and horizontally synchronized with appropriate departments, stakeholder agencies, and jurisdictions.
	Objectives	• Ensure emergency management program maintenance is followed accordingly, and plans are reviewed and updated as necessary. • Ensure that progress is made on correcting gaps identified during the after-action process. • Maintain records of plan maintenance and of corrective actions on plans exercised or tested during real or planned events. • Continue to standardize emergency procedures, protocols, and policies throughout the County in order to promote a unified response when necessary.
Strategic Goal 8	Goal	Maintain a formal training and exercise program that is driven by hazard vulnerabilities, corrective actions from After Action Reports (AARs), and gaps in capabilities and plans.

	Objectives	• Ensure training and exercises are implemented as appropriate to evaluate and improve capabilities, preparedness, plans, strategies, and operational readiness in a fault-free environment. • Ensure revised plans or newly created plans are trained on and followed with appropriate exercise building blocks. • Incorporate and organize training opportunities for officials and emergency management and response personnel, as well as the public, in an effort to improve inter and intradepartmental collaboration. • Ensure departments are following through with recommended items in Improvement Plans and AARs. • Continue to host a variety of exercise types to adequately train County staff (tabletop, functional, full scale, and etc.)
Strategic Goal 9	Goal	Continually improve Emergency Operations Center (EOC) and Departmental Operation Centers (DOCs) functions and capabilities. Design, build, and operationalize a permanent EOC that meets the current and future capacity needs identified in multiple AARs.
	Objectives	• Improve the resource management system, complete with an inventory of equipment, with information for appropriate agencies on location and availability as well as accessibility directions. • Pursue building a permanent "state of the art" EOC to nationally accepted standards in a strategic location within the County. • Maintain a Joint Information System with current information on hazards and activities to prevent injuries and property loss in Howard County.
Strategic Goal 10	Goal	Enhance and expand partnerships and collaboration with Non-Governmental Organizations (NGOs), faith-based organizations, the private sector, and public sector agencies. Ensure the effective management, appropriate oversight, integrity, and security of supply chains within the County via these partnerships.

	Objectives	• Improve private-sector knowledge of County government plans and procedures, and vice-versa. • Link businesses, together with government resources, to create a resource network for emergency events to enable the marshaling of resources to confront novel or complex disasters. • Provide businesses with encouragement and tools to improve their resilience. • Increase private-sector involvement, information, tools, and education in countywide preparedness and recovery. • Communication and collaboration with public sector agencies external to Howard County Government. • Ensure engagement with private critical infrastructure partners. • Ensure engagement with supply chain leaders and partners within the County.

Plans in Development

Howard County continuously works to integrate hazard mitigation planning into additional County planning mechanisms, such as through its forthcoming General Plan update, *HoCo by Design*, the *Climate Action and Resiliency Plan,* and the 2024-2029 *FMP*.

HoCo By Design

Howard County's forthcoming General Plan update, *HoCo by Design*, is scheduled for final approval and release in 2023, after the time of writing this NHMP. The DPZ is responsible for this plan. Howard County OEM served as part of the Technical Advisory Group for the development of this plan. As of July 2023, *HoCo by Design* has been released in draft form and is being reviewed by County Council,[156] and it seeks to provide a long-term vision for "how and where the County should develop and grow as it adjusts to evolving economic, environmental, and social conditions over the next 20 years."157 *HoCo by Design* will incorporate *PlanHoward 2030* and its amendments, such as the *Ellicott City Watershed Master Plan*,[158] which the County adopted in December 2020 to address hazard mitigation lessons learned from the historic Ellicott City floods of 2016 and 2018. Additionally, *HoCo By Design* will focus on equity as a guiding principle, and cites the "protect[ion of] populations in vulnerable areas from natural hazards" as a best practice.[159]

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[156] *HoCo by Design Public Draft Release*, HOWARD CNTY., https://www.hocobydesign.com/public-draft (last visited Apr. 7, 2023).
[157] *HoCo by Design Chapter 1,* HOWARD CNTY. (Dec. 1, 2022), https://www.hocobydesign.com/18058/widgets/57052/documents/37629
[158] *Ellicott City Watershed Master Plan*, HOWARD CNTY. DEPT. OF PLANNING & ZONING (Dec. 7, 2020), https://www.howardcountymd.gov/sites/default/files/media/2020-12/Ellicott%20City%20Watershed%20Master%20Plan%20Final%20Adopted.pdf at 3.
[159] *Id.* at 15.

Howard County Climate Forward: Climate Action and Resiliency Plan

In June 2023, the Howard County Office of Community Sustainability (OCS) published its first climate action plan since 2015, *HoCo Climate Forward*.[160] On page 6 of this plan, it is described how the Office of Community Sustainability reviewed this Natural Hazard Mitigation Plan to "ensure Climate Forward is coordinated with and responsive to these emergency management plans". *HoCo Climate Forward* provides overviews of the following topics specific to Howard County:

- Climate risks and impacts
- Climate vulnerabilities, particularly for underserved populations
- Community-wide Greenhouse Gas (GHG) emissions inventory
- New climate goals
- Climate solutions

Development of this plan included a variety of research modalities, including, among other things:

- Review of relevant and local and regional climate action plans and climate vulnerability assessments
- Expert input from subcontractor ICF to prepare draft mitigation and resiliency strategies based on climate science and what would be the most impactful
- Focus groups with internal stakeholders to refine mitigation and resiliency strategies
- Community survey, specifically reaching out to underserved populations, to gather feedback on climate emergency preparedness[161]

2024-2029 Flood Mitigation Plan

The Howard County FMP was updated in conjunction with the update of this NHMP. The same JSC was used to ensure harmony in goals, objectives, and actions. Both plans note that the *Ellicott City Safe & Sound* structural projects as mitigation actions as well as the action items related to flood mitigation structures for Howard County's wastewater plant, Little Patuxent Water Reclamation Plant. The Flood Mitigation actions can be seen in Appendix C: Flood Mitigation Actions.

Howard County Government Organization

The Howard County Government includes an executive branch, legislative branch, and judicial branch. The County Executive leads the executive branch, and the County Council, representing five Council Districts, leads the legislative branch. The County Council enacts local legislation and authorizes an annual budget.

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[160] *Howard County Climate Forward: Climate Action and Resiliency Plan* (Draft Final Report 2023), https://gcc02.safelinks.protection.outlook.com/?url=https%3A%2F%2Flivegreenhoward.com%2Fwp-content%2Fuploads%2F2023%2F04%2FHoCo-Climate-Forward-Final-Draft-Report-Appendices.pdf&data=05%7C01%7Ccmcraney%40howardcountymd.gov%7Cb05c8e00cf1046fc221408db34762a70%7C0538130803664bb7a95b95304bd11a58%7C1%7C0%7C638161454520127308%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C3000%7C%7C%7C&sdata=Xj9pkLoBTIVRiu2whL%2FH5gxEtrLvhFH2cScSBO%2BsWFY%3D&reserved=0.

[161] *Id.* at 1

County Emergency Response Capabilities and Responsibilities

The Howard County Government is organized into many departments, offices, bureaus, and/or divisions. Several departments and offices are responsible for planning for and responding to natural hazard events that occur within the County. The primary departments/offices that plan for and respond to natural hazard events include:

- **Department of Fire and Rescue Services**
  "[The Department of Fire and Rescue Services (DFRS) is] a combination system of nearly 900 career and volunteer providers operating from 14 stations across Howard County. The department is located between Baltimore City and the District of Columbia and provides and receives automatic aid to and from our surrounding partners in Prince George's, Anne Arundel, Baltimore, Carroll, Montgomery[,] and Frederick [C]ounties. The department is statutorily responsible for the administration of the affairs for the [C]ounty in fire suppression and prevention, fire training, arson investigation, rescue services and emergency medical services."[162]
- **Department of Inspections, Licenses, and Permits**
  "The Department of Inspections, Licenses and Permits (DILP) is responsible for the approval and issuance of various permits, licenses and the enforcement of county building codes and standards. These include building, mechanical, plumbing, electrical, sign and property maintenance codes. The department inspects and licenses rental housing properties, mobile home parks, and animal licensing. It is responsible for staff duties associated with the Plumbing Advisory Board and the Board of Electrical Examiners."[163]
- **Department of Planning and Zoning**
  "The Department of Planning and Zoning (DPZ) shapes the growth and future of Howard County by facilitating the development of safe, healthy, equitable, connected, and sustained communities, while respecting individual rights and protecting the County's natural environment, historical integrity and character."[164]
- **Department of Public Works**
  "The Department of Public Works (DPW) advances the quality of life for our community by providing exceptional level of public service. Employees coordinate the daily functions, customer service, the capital improvement program and real estate services. Howard County Department of Public Works is composed of the Director's Office and the following Bureaus and Divisions:
    - Bureau of Engineering
    - Bureau of Environmental Services
    - Bureau of Facilities
    - Bureau of Highways

[162] *Fire and Rescue Serv.*, HOWARD CNTY. MD, https://www.howardcountymd.gov/fire-and-rescue-services (last visited Apr. 3, 2023).
[163] *Inspections, Licenses, & Permits*, HOWARD CNTY. MD, https://www.howardcountymd.gov/inspections-licenses-permits (last visited Apr. 3, 2023).
[164] *Planning & Zonning*, HOWARD CNTY. MD, https://www.howardcountymd.gov/planning-zoning (last visited Apr. 3, 2023).

- Bureau Of Utilities
- Real Estate Services Division"[165]

- **Police Department**
  "The Howard County Police Department (HCPD) provides a secure environment for the citizens of Howard County by protecting life and property, reducing the opportunity for crime and disorder, enforcing the law, assisting victims and providing other police-related services as required by the community in a manner consistent with the values of a free society."[166]
- **Office of Emergency Management**
  "The Howard County OEM develops and maintains emergency management plans, which encompass all hazards and phases of emergency management, and include stakeholder engagement and coordination across internal and external agencies and stakeholders.
  In addition to Countywide planning, the office provides technical guidance, facilitation support, and training and exercise to help the County prepare for natural, technological, and/or human-caused emergencies. OEM also manages and coordinates the County's response and recovery to emergencies and disasters through the EOC."[167]

The following statistics for emergency response resources are current as of the writing of this 2024 NHMP. However, they are subject to change and will be updated as needed.

- **Critical Facilities**
  The list of County critical facilities and infrastructures was re-evaluated and updated in 2022. HCPD and OEM as needed identify the facilities and infrastructures that are considered the most critical to County Government operations. These critical facilities include Emergency Services, Key Government, Criminal Justice, Transportation, Water/Wastewater Treatment, Research, Major Retail, Schools, and Entertainment.
- **Fire Departments**
  Howard County is served by DFRS. The County maintains 14 fire stations throughout the County.
- **Law Enforcement**
  Howard County is served by HCPD. HCPD has two stations, Northern District (Headquarters) and Southern District. Also, the Maryland State Police – Waterloo Barrack is located in Howard County.
- **Medical Services**
  Howard County General Hospital (HCGH) is an acute-care medical center and a member of Johns Hopkins Medicine. Sheppard Pratt Hospital in Ellicott City is a psychiatric facility serving a range of patients. Medstar Health is part of the largest healthcare provider in Maryland, and it has locations in the County. Altogether, Howard County has:
  - One inpatient hospital (HCGH);
  - Two hospice and palliative care facility;
  - Four nursing homes;
  - 14 large-assisted living facilities (17+ residents); and,
  - 69 small-assisted living facilities (one -16 residents).

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[165] *Public Works*, HOWARD CNTY. MD, https://www.howardcountymd.gov/public-works (last visited Apr. 3, 2023).

[166] *Police*, HOWARD CNTY. MD, https://www.howardcountymd.gov/police (last visited Apr. 3, 2023).

[167] *Emergency Management*, HOWARD CNTY. MD, https://www.howardcountymd.gov/emergency-management (last visited Apr. 3, 2023).

- **Department of Recreation and Parks**
  The Department of Recreation and Parks (DRP) maintains more than 50 parks and 9,768 acres of land. In addition, DRP manages and oversees recreation facilities, community centers, the Robinson Nature Center, historic sites, and natural resource areas. The Department owns and operates 27 historic sites, all of which are either stand-alone sites or structures located within County-owned parks[168]. As of 2020, the Maryland Department of Natural Resources (DNR) owns over 9,200 acres within the County[16].

  DRP also fulfills many roles in supporting emergency response and recovery in the County as outlined in the Howard County Comprehensive Emergency Response and Recovery Plan (CERRP). DRP is imperative in organizing volunteers, transportation needs, and assisting in shelter operations.

[168] *Howard County Land Preservation, Parks and Recreation Plan Update,* MD. DEPT. OF NAT. RES. (June 2022), https://dnr.maryland.gov/land/Documents/Stewardship/Howard-2022-LPPRP-Draft.pdf.

Community Capability Assessment

The following tables, based on the FEMA Community Capability Assessment Worksheet,[169] detail the County's capabilities in five areas:

- Planning and Regulation;
- Codes and Ordinances;
- Education and Outreach;
- Technical; and,
- Financial.

***Please note: the Capability Expansion column includes suggestions for capability expansion and not official mitigation action items at this time. Information in this column will be considered at annual reviews and moved to hazard mitigation action items as needed.*

TABLE 1: PLANNING AND REGULATORY CAPABILITIES

Title	Author / Owner	Effective Date	Next Update	Relation to Hazard Mitigation	Capability Expansion
Plan Howard 2030	Department of Planning and Zoning	2012	2023	This Plan includes several clauses in relation to hazard mitigation. A table summarizing these points is in Chapter 6.	This Plan is updated every 10 years and updated as necessary to incorporate new plans or studies.
Howard County Climate Action Plan	Department of County Administration--Office of Community Sustainability	2023	2028	This Plan will include recommendations to improve the County's ability to respond to and mitigate the effects of climate change.	Once this Plan is adopted by County Council, it will be incorporated into the Hazard Mitigation Plan.

[169] *Region 3 Hazard Mitigation Plan Guidance: Community Capability Assessment Worksheet*, FEMA, https://www.fema.gov/sites/default/files/documents/fema_community-capability-assessment_worksheet_region-three_06-2021.pdf (last visited February 17, 2023).

Howard County Comprehensive Emergency Response and Recovery Plan	Department of Fire and Rescue Services--Office of Emergency Management	2022	2023	This Plan outlines the overall strategy for how the County will organize and operate for response and recovery in the event of a planned event, incident, emergency, or disaster. It includes County Coordinating Functions (CCFs) that provide the structure for coordinating function-specific County response and recovery operations.	This plan is updated every year and as needed after an incident.
Community Rating System Program	Department of Public Works--Bureau of Environmental Sciences--Stormwater Management Division	2007	2025	Goals of Community Rating System (CRS) Program is to: reduce and avoid flood damage to insurable property, strengthen and support the insurance aspect of the NFIP, and foster comprehensive floodplain management.	Initiate and/or improve programs that elevate the County's CRS Class designation. Potential programs include: Elevation Certificates; Outreach Projects; Hazard Disclosure; Flood Protection Information; Flood Protection Assistance; Flood Insurance Promotion; Flood Hazard Mapping; Open Space Preservation; Higher Regulatory Standards; Stormwater Management; Floodplain Management Planning; Acquisition and Relocation; Flood Protection; Drainage System

					Maintenance; Flood Warning and Response; Dams.
Howard County Continuity of Government Plan	Department of Fire and Rescue Services--Office of Emergency Management	May-22	Mar-23	As part of the Continuity of Government (COG) planning process, it incorporates the results of the Howard County Hazard Identification and Risk Assessment (HIRA). These results were considered when developing the County Essential Functions (CEFs) that enable an organization to provide vital services, exercise civil authority, maintain the safety of the general public, and sustain the industrial or economic base during an emergency.	Continuity Program Coordinator(s) who lead the bi-annual review and update process for the COG Plan attend trainings when possible, to ensure all best practices are being incorporated. In addition, all County departments are required to have their own COOP.
2017 Howard County Economic Development Authority Strategic Plan	Howard County Economic Development Authority	2017	2024	One of the Strategic Plan's tactics is to "dedicate resources for special projects" and this has included addressing unexpected situations, such as the 2016 flooding of Ellicott City.	This Plan could be expanded by OEM working with Howard County Economic Development Authority (EDA) to address/describe the hazards most likely to affect businesses in Howard County in the Plan.

Howard County Flood Mitigation Plan	Department of Public Works--Bureau of Environmental Sciences--Stormwater Management Division	2018	2024	This Plan includes a flood-risk analysis to include the effect on critical infrastructure. It also includes policies, ordinances, and other projects that are already included in this NHMP's Implementation Plan table in Chapter 6. In addition, the Flood Mitigation Plan is updated on the same planning cycle and with the same Joint Steering Committee as the NHMP.	The most recent risk analysis was conducted with the Hazus tool, which didn't include all of the County's critical facilities. This new update will include all the County's critical facilities.
Transit Development Plan	Department of County Administration--Office of Transportation	2018	2023	This Plan allows the County to evaluate and prioritize how it can effectively and efficiently expand the transit system to achieve more ridership and reduce the demand for single occupancy vehicles and therefore, greenhouse gas emissions.	The next plan update in late 2023 will discuss the need to develop a transition plan toward zero emission transit vehicles.
Ellicott City Watershed Master Plan	Department of Planning and Zoning	2020	2023	This General Plan Amendment provides policies and implementing actions for protecting and enhancing flood-impacted Ellicott City and the surrounding Tiber-Hudson Watershed.	Ensure that best practices regarding riverine flood mitigation are included in the plan as new techniques develop.

TABLE 2: CODES AND ORDINANCE CAPABILITIES

Code / Ordinance Type	Name	Responsible Agency	Effective Date & Next Update	Relation to Hazard Mitigation	Capability Expansion
Building Code	"The Howard County Building Code" which includes the International Building Code and the Residential Code	Department of Inspections, Licenses, and Permits	2022/2024	By adopting the current codes, we ensure construction is kept up to date with the latest standards and technologies.	The International Code Council does a good job making sure the code is up to date and takes into account new building technologies. Howard County has a number of employees who participate in these committees to make sure we stay up to date on these advancements.
International Property Maintenance Code	2021 International Property Maintenance Code	Department of Inspections, Licenses, and Permits	2022/2024	The adoption of the property maintenance code is for rental properties only at this time. The adoption of this code makes sure rental properties are maintained so that they remain protected from hazards.	Howard County is currently evaluating utilizing this code to apply to critical structures like multistory buildings to make sure they remain structurally sound for the life of the structure.
Zoning Ordinance	Subtitle 2 Zoning	Department of Planning and Zoning		This Subtitle promotes practices that provide the best use of land and the stewardship of our environmental resources.	Continue to adopt best practices and developments in technology.
Floodplain Management	Section 3114 Floodplain	Department of Inspections,	2022/2024	Prevents new residential/nonresidential construction from happening	Adopt and implement higher standards.

Ordinance/NFIP Compliance		Licenses, and Permits		within designated floodplains with exceptions for existing structures and structures approved by public works. Also ensures that existing structures are elevated to 2 feet above the 100-year flood elevation.	
	Section 16.115-Floodplain Preservation	Department of Planning and Zoning	2022/2024	This Section delineates what can and can't be done within the 100-year floodplains to protect the floodplain.	Adopt and implement higher standards.
	Subtitle 7-Floodplain	Department of Planning and Zoning	2022/2024	This Subtitle works to minimize flood hazards by protecting floodplains, encouraging appropriate building practices, and ensuring the County meets NFIP requirements.	Adopt and implement higher standards.
Fire Department Inspections	Howard County Fire Prevention Code (Title 17, Subtitle 1, Sec. 17.104)	Department of Fire and Rescue Services	2021/2024	Provides authority for DFRS personnel to inspect non-residential properties in the County for compliance with fire and life safety regulations. Also allows DFRS to work with Public Works to review site plans for fire department accessibility, water supply, and other life safety issues.	Periodic revisions to keep up with changing best practices in fire prevention as well as developments in building construction and fire protection systems.

Stormwater Ordinance	Subtitle 5- Storm Drainage Systems	Department of Public Works		The purpose of this Subtitle is to provide for the proper functioning of the storm drainage systems in Howard County. It also requires the repair and maintenance of privately owned storm drainage facilities.	Adopt and implement higher standards. Update design storms for drainage infrastructure. Require downstream upgrades beyond the property lines of upstream development.
	Subtitle 9 Stormwater Management	Department of Public Works		This Subtitle establishes minimum requirements and procedures to control adverse impacts associated with stormwater runoff. Uses environmental site design to reduce stream channel erosion and local flooding.	Adopt and implement higher standards. Require management for more storm events and in more areas of the County. Require downstream upgrades beyond the property lines of upstream development.
Steep Slope Ordinance	Sec. 16.116- Protection of wetlands, streams, and steep slopes	Department of Planning and Zoning		This Section works to protect wetlands, streams, and sleep stopes by restricting removal of vegetative cover and trees, paving, and new structures within a certain amount of feet.	Continue to adopt new best practices to better protect wetlands, streams, and steep slopes.

TABLE 3: EDUCATION AND OUTREACH CAPABILITIES

Activity Type	Name or Description of Effort	Responsible Agency/Organization	Relation to Hazard Mitigation	Capability Expansion
StormReady Certification	Falls under mitigation program.	Department of Fire and Rescue Services--Office of Emergency Management	Provides guidelines on how the County can improve hazardous weather operations. County must meet guidelines and renew every three years.	The County has recently become Weather-Ready Nation Ambassadors to further promote national resilience against extreme weather.
Seasonal Emergency Management and Mitigation Outreach	Preparedness messaging is sent out via social media by the Office of Emergency Management, County PIO, and other County social media pages prior to severe weather.	Office of Emergency Management; County Public Information Office; DFRS; etc.	This messaging allows members of the public to prepare for disasters before they arrive to mitigate their own risks. This reduces stress on County resources and shortens the recovery period.	County departments attend trainings and workgroups to promote best practices and to share success stories.
Community Organizations Focused on Emergency Preparedness	Howard County Community Organizations Active in Disaster (COAD)	Howard County Community Organizations in Disaster Executive Committee	The COAD's goal is to bring together Howard County non-profits, faith-based organizations, local businesses, and community groups in times of disaster to provide resources and assistance to those in need. The COAD works alongside the County and helps meet outstanding needs.	This program was started in 2019 and is growing. Additional training and tabletops are needed to improve capabilities.

	Radio Amateur Emergency Communications (RACES); Columbia Amateur Radio Association (CARA)	Radio Amateur Emergency Communications (RACES); Columbia Amateur Radio Association (CARA)	This group mitigates impacts from loss of communication before, during, and after an event.	Improved antenna coverage would improve this capability.
Local citizen groups or non-profit organizations focused on environmental protection, emergency preparedness, access and functional needs populations, etc.	Howard County Community Organizations Active in Disaster	Howard County Community Organizations in Disaster Executive Committee	The COAD's goal is to bring together Howard County non-profits, faith-based organizations, local businesses, and community groups in times of disaster to provide resources and assistance to those in need. The COAD works alongside the County and helps meet outstanding needs.	This program was started in 2019 and is growing. Additional training and tabletops are needed to improve capabilities.
Natural disaster or safety related school programs	Annual drills conducted at each school (14 drills are required each year)	Howard County Public School System (HCPSS)	Drills relate to natural disasters and evacuation, or shelter-in-place needed after an incident.	This capability is being fully leveraged.

Ongoing public education or information program (e.g. environmental education, fire safety, household preparedness, responsible water use, etc.)	Partnership with local libraries to exchange traditional lightbulbs with LED bulbs.	Office of Community Sustainability; Howard County Public Libraries	This project relates to hazard mitigation in that it helps people live more sustainably. The LED bulbs use far less energy than normal bulbs and can reduce the stress on electrical grids during extreme temperature events.	This program is new, so after it has had a chance to perform, opportunities for expansion will be noted.
	Social media posts focused on household preparedness, publication of Community Hazard Handbook, and presentations to educate the public	Office of Emergency Management	Through education on what hazards threaten the County and how to be prepared, the County can help citizens understand how to prepare for disasters to mitigate losses and reduce recovery time.	More targeted messaging to underserved populations and relationship building.

TABLE 4: TECHNICAL CAPABILITIES

Position Type	Full/Part Time	Title	Current Position Holder	Relation to Hazard Mitigation	Capability Expansion
Chief Building Officer	Full	Director (Building Official)	Robert J. Frances	Ensuring private properties or public properties are not built in hazardous areas and enforcing local codes by issuing citations for violations.	The Building Official has the ability to delegate to qualified deputies, division chiefs, and supervisors for the review, approval, and enforcement duties needed to ensure code compliance.
Civil Engineer--Construction	Full	Chief, Bureau of Engineering	Amah Binde	Ensuring projects are aligned with County code and are constructed in a way that mitigates against natural	Monitor and enhance use of project manager focused guides noted below.

Project Management				hazards that occur in that area.	
Civil Engineer-Design	Full	All Engineers in Transportation and Special Projects Division Engineers in Utility Design Division	Multiple	Ensures infrastructure is constructed in areas not at high risk to natural hazards. Knowledge of maps, topographical surveys, and design techniques allow for more resilient infrastructure.	Increase training on Baltimore Metro Council's (BMC) "Enhancing Climate Resilience" project deliverables in the focus areas of transportation, water, and stormwater. Also, to increase training on the BMC's "Climate Change Resource Guide and Toolkit."
Grant Administrator	There's no one grant administrator for the County, but most departments designate this responsibility to an employee.	n/a	There's no one grant administrator for the County, but most departments designate this responsibility to an employee.	Ensures or meets agency meets grant eligibility and opens the way for access to additional funding for mitigation projects.	Prioritize funding and increase training for grant management.

Grant Writer	There's no one grant writer for the County, but most departments designate this responsibility to an employee.	n/a	There's no one grant writer for the County, but most departments designate this responsibility to an employee.	Knows how to find funding sources and write thorough applications that bring in additional mitigation funding.	Prioritize funding for and increase training opportunities for grant writing classes.
Chief Financial Officer	Full	Director of the Department of Finance	Rafiu Ighile	Ensures County projects are within budget and plans for capital budget projects. Many of these projects are large infrastructure projects that can lead to reduced vulnerability to natural hazards.	Ensure the Finance Director is looped into mitigation projects looking for funding to ensure County resources are being used efficiently and grants are pursued when needed.
Community Planner	Full	Director of the Department of Planning and Zoning	Amy Gowan	Ensures the County is growing in an organized way that is also aligned with public opinion. This can relate to hazard mitigation in that citizens want communities built in a way that mitigates the effects of natural hazards. It also helps ensure the resources citizens need are met.	Ensure the Director of DPZ is notified when mitigation grant opportunities are released as well as included in grant discussion meetings.

Emergency Manager	Full	Director of the Office of Emergency Management	Michael Hinson	Develops and maintains emergency management plans, which encompass all hazards and phases of emergency management. Also serves the function of educating the public in emergency preparedness.	Evaluate how mitigation grants are being discussed among County departments and if OEM needs to organize additional meetings with all possible stakeholders to discuss these opportunities.
GIS Coordinator	Full	Technical Serv Manager I	Rob Slivinsky	Assists in the creation of maps and tracking down data for analyzing hazards.	Hazus training to assist in risk analyses.
Floodplain Administrator	Full	Acting Director of Public Works	John Seefried	Responsible for ensuring that all existing and new construction is reasonably safe from flooding and that NFIP and local regulations are followed.	Improve the coordination of duties and responsibilities among DPW, DILP, and DPW. Improve the documentation process for decisions made related to review and permitting of floodplain development.

TABLE 5: FINANCIAL CAPABILITIES

Funding Resource Type	Name/Description	Responsible Agency/Organization	Relation to Hazard Mitigation	Capability Expansion
Capital Improvements Program	Capital Improvement Program (CIP)	County Council; Department of Finance	Allots funding for infrastructure planning, bridge repairs, and other large-scale projects.	This resource is being fully leveraged.

Funding Programs-Federal (Non-FEMA)	Community Development Block Grant Programs; US EDA grants; Natural Resources Conservation Service	Office of Emergency Management; Economic Development Authority	Allots funding for infrastructure planning, bridge repairs, and other large-scale projects.	This resource is being fully leveraged.
Utility Fees for Stormwater, Water, Sewer, Gas, or Electric Services	The County charges fees for water, sewer, and trash services. Gas and electric services are provided by private companies.	Department of Public Works	These fees are needed to allow for implementation of appropriate mitigation actions regarding utilities.	This resource is being fully leveraged.
FEMA Hazard Mitigation Assistance	Building Resilient Infrastructures and Communities; Flood Mitigation Assistance; Hazard Mitigation Grant Program	Department of Public Works--Bureau of Environmental Services--Stormwater Management Division; Department of County Administration--Office of Community Sustainability; Office of Emergency Management	These funding resources have been used in the past to fund flood mitigation projects and the updating of hazard mitigation plans.	This capability can be expanded by completing Benefit Cost Analyses (BCA) in advance of grant openings and training employees to complete or hiring contractors to complete in-depth BCAs. This would increase access to grant funding.

Emergency Management Funding	Emergency Management Performance Grant (EMPG)	Office of Emergency Management	This funding sustains the core capabilities of the five emergency management mission areas (prevention, protection, mitigation, response, and recovery). Promotes an all-hazards approach to emergency management.	This resource is being fully leveraged.
Funding Programs - State	State Homeland Security Program (SHSP)	Office of Emergency Management; Howard County Police Department; Department of Fire and Rescue Services	Funding promotes building capabilities to enhance national resilience to absorb disruptions and rapidly recover from incidents both natural and manmade.	Ensure national priorities required for SHSP grant applications are communicated to mitigation program manager in OEM.
General Obligation Bonds and/or Special Tax Bonds	The County has authority to incur debt through general obligation bonds, special tax bonds, and revenue bonds.	Department of Finance		
Impact Fees for New Development	The County levies development excise taxes on new developments.	Department of Finance		

Chapter 6: Mitigation Strategy

Requirements for Mitigation Strategy

44 CFR § 201.6(c)(3): The plan must include [a] mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools. This section must include:

> (i) The hazard mitigation strategy shall include a description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.
>
> (ii): The mitigation strategy shall include a section that identifies and analyses a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.
>
> (iii): The mitigation strategy section shall include an action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.

Mitigation Goals and Objectives

The mitigation strategy serves as the short and long-term road map to reduce the potential losses, vulnerabilities, and shortcomings identified in *Chapter 4: Hazard Identification, Profiling, and Risk Assessment*. It also considers the County's capabilities that can be mobilized to support hazard mitigation that were identified in *Chapter 5: Capability Assessment*. This mitigation strategy includes a list of goals and objectives, along with specific mitigation actions to address the goals and objectives. Actions are then prioritized, based on scoring criteria developed by the previous Joint Steering Committee along with additional considerations, such as climate change.

This chapter comprises the following six subsections:

- Mitigation Goals and Objectives
- Identification of Mitigation Actions
- Prioritization of Mitigation Actions
- Implementation Plan
- Funding Sources
- NFIP and Continued Compliance

Chapter Definitions

- Goals – Represent broad statements that are achieved through the implementation of more specific, action-oriented objectives. Goals provide the framework for achieving the intent of the mission statement.

- Objectives – Define strategies or implementation steps to attain the identified goals. Compared to goals, objectives are more specific and measurable.
- Hazard Mitigation Projects – Projects are defined as specific actions taken to address defined vulnerabilities to existing buildings or systems. Potential funding sources are listed for each project.
- Mitigation Action Plan – Prioritized listing of actions (policies and projects), including a categorization of mitigation technique, hazards addressed, individual or organization responsible for implementation, estimated timeline for completion and list of potential funding sources.

Howard County's Mitigation Goals and Objectives

For the purposes of this Plan, goals are defined as general policy guidelines or broad statements that represent a vision for a community. Howard County's mission is to develop practical planning solutions for the variety of hazards that pose a risk to Howard County.

The following table contains the 2024 Howard County NHMP goals and objectives. The goals and objectives have been organized to be in harmony with the goals from the State Plan, categorized to match the goals in the Howard County FMP, and to be applicable at the local level. The Joint Steering Committee evaluated these from the 2019 NHMP and elected to keep these goals and objectives. consistent for the 2024 NHMP

PROPERTY PROTECTION		
Goal #	Description	Objectives
1	Identify future mitigation actions from lessons learned during preparedness, response, and recovery activities throughout the County.	Document and review after action reports (AAR) and improvement plans (IP) for various incidents, events, and hazards throughout the County to identify future mitigation actions.
		During response and recovery activities, solicit ideas and recommendations, as well as experiences, both positive and negative, to develop potential mitigation actions.
2	Identify and pursue available mitigation funding opportunities for future mitigation projects.	Identify and apply for grant opportunities that will support structural and non-structural hazard mitigation projects.
		Identify and apply for grant opportunities that will support hazard mitigation awareness and training programs.
		Providing information to business and property owners on potential funding sources for private property mitigation projects and actions.

PUBLIC EDUCATION AND AWARENESS		
Goal #	Description	Objectives
3	Engage and educate the community on the roles, responsibilities, and activities of the Office of Emergency Management (OEM).	Promote OEM activities and initiatives at County sponsored events and through County-operated media channels.
		Provide opportunities, events, and/or mechanisms for citizens to meet with, or speak to emergency management professionals.
4	Engage and educate the public on natural hazards and potential mitigation actions to encourage personal awareness and responsibility.	Develop and support disaster preparedness education and awareness programs that target residents, visitors, businesses, and elected officials.
		Support incentive programs, for both public and private sections, that promote structural retrofits where appropriate.
PREVENTIVE MEASURES		
Goal #	Description	Objectives
5	Reduce the potential impact of natural disasters on public and private property to protect people and minimize losses.	Discourage new development in high hazard areas through appropriate regulations and land use planning.
6	Ensure hazard mitigation goals are consistent with all other County plans and ordinances.	Incorporate hazard mitigation principles into new and existing County plans and ordinances.
		Encourage private business, industry, and institutional entities to integrate emergency plans with County mitigation/emergency plans, where appropriate.
7	Develop an accountability plan and a mechanism for tracking mitigation action implementation.	On an annual basis, examine mitigation action implementation progress, and encourage timeline completion.
NATURAL RESOURCE PROTECTION		
Goal #	Description	Objective
8	Protect natural resources and open spaces that provide flood, and other hazard mitigation functions.	Prioritize actions that protect natural resources while supporting community resiliency and other hazard mitigation efforts.
EMERGENCY SERVICES		
Goal #	Description	Objectives
9	Ensure critical facilities (fire stations, police stations, hospitals) and infrastructure (water and sewer facilities, electrical and other utilities,	Identify appropriate mitigation techniques for any critical facilities currently in the 100-year floodplain and direct construction of any future critical facilities out of the 100-year floodplain.

	and transportation systems) vital to disaster response and recovery, are less vulnerable to, and better able to withstand, natural hazards.	Ensure roads/access to facilities located near the 100-year floodplain are not impeded.
STRUCTURAL PROJECTS		
Goal #	Description	Objectives
10	Reduce potential disruption of the County's critical infrastructure during hazard events.	Ensure regular maintenance of the County's critical infrastructure that lies within the 100-year floodplain.
		Identify vulnerable existing critical facilities and infrastructure and encourage pre-disaster retrofitting.
		Coordinate with the managing entities for any privately-owned infrastructure, including dams, retaining ponds, and berms, to encourage regular inspections on all structures, and improvements when and where warranted.
HISTORIC AND CULTURAL RESOURCES		
Goal #	Description	Objectives
11	Protect historical and cultural assets across the County from flooding and other natural hazards.	Utilize historical preservation data to identify protective measures for historical properties and cultural resources.

Further description of the action categories is found in the sections below.

Identification of Mitigation Actions

Mitigation Categories

This mitigation strategy addresses six mitigation categories while considering the County's capabilities to attain the Plan's goals and objectives. These include:

- Preventive Measures
- Property Protection
- Natural Resource Protection
- Structural Projects
- Emergency Services
- Public Outreach and Education

These categories formed the basis of the mitigation actions in the Plan update. Descriptions of these categories and examples for each category are included below:

1. Preventive Measures

a. Measures include those actions that are performed to keep hazard related issues from exacerbating in the community. They are effective in reducing a community's future vulnerability, particularly in areas where development has not occurred. Examples of preventive actions include zoning and subdivision regulations; building code; hazard mapping; open space preservation; floodplain regulations; stormwater management; drainage system maintenance; and capital improvements programming.

2. Property Protection
    a. Measures include those actions that can be undertaken by private homeowners, so their structures can: better withstand hazard events, be removed from hazardous locations, or can be insured to cover potential losses. Examples include acquisition; relocation; building elevation; critical facilities protection; retrofitting (i.e., wind proofing, flood proofing, seismic design standards, etc.); insurance; drainage; and safe room construction.
3. Natural Resource Protection
    a. Measures include those actions that can reduce the impact of hazards by preserving or restoring the function of natural systems. Natural systems that can be classified as high hazard include floodplains, wetlands, and barrier islands. Thus, natural resource protection can serve the dual purpose of protecting lives and property while enhancing water quality or recreational opportunities. These actions are usually implemented by parks, recreation, or conservation agencies. Examples include floodplain protection; fire resistant landscaping; erosion and sediment control; wetland restoration; habitat preservation; and slope stabilization.
4. Structural Projects
    a. Measures include those actions designed to reduce the impact of hazards by building new structures or hardening existing structures. Structural projects are usually designed by engineers and managed or maintained by public works staff. Examples include reservoirs; levees, dikes, and floodwalls; detention and retention basins; channel modification; and storm sewer construction.
5. Emergency Services
    a. Although emergency services are not necessarily considered mitigation techniques, these services minimize the impact of a hazard on people and property. Actions taken immediately prior to, during, or in response to a hazard event include warning systems; search and rescue operations; evacuation planning and management; and flood fighting techniques.
6. Public Outreach and Education
    a. Measures include those actions conducted to advise and educate residents, business owners, potential property buyers, and visitors about hazards and mitigation techniques that can be used to protect lives and property. Examples of measures used to educate and inform the public include outreach and education; training; demonstrations; real estate disclosure; and hazard expositions.