County Council Of Howard County, Maryland

2023 Legislative Session

Legislative Day No. 11

Resolution No. 169 -2023

Introduced by: The Chairperson at the request of the County Executive

A RESOLUTION adopting the Howard County Natural Hazards Mitigation Plan.

Introduced and read first time Oct 2, 2023.

By order Michelle Harrod
Michelle Harrod , Administrator

Read for a second time at a public hearing on Oct 16, 2023.

By order Michelle Harrod
Michelle Harrod , Administrator

This Resolution was read the third time and was Adopted ✓, Adopted with amendments___, Failed___, Withdrawn___, by the County Council on Nov 6, 2023.

Certified By Michelle Harrod
Michelle Harrod , Administrator

NOTE: [[text in brackets]] indicates deletions from existing law; TEXT IN SMALL CAPITALS indicates additions to existing law; ~~Strike-out~~ indicates material deleted by amendment; Underlining indicates material added by amendment

WHEREAS, the County Council of Howard County, Maryland, recognizes that natural hazards are common occurrences throughout the region and cause significant property damage and loss of life; and

WHEREAS, by passage of County Council Resolution No. 112-2004, the County took proactive measures to reduce the impact of these hazards by adopting the first Natural Hazards Mitigation Plan (NHMP); and

WHEREAS, by passage of County Council Resolution No. 22-2013 and Council Resolution No. 6-2019, the County adopted the second and third NHMP; and

WHEREAS, the County remains committed to the mitigation of natural hazards through the concerted efforts of Howard County departments, government partners, and community members; and

WHEREAS, OEM and the Natural Hazard Mitigation Update Steering Committee have updated the NHMP consistent with a federally mandated planning process; and

WHEREAS, the NHMP articulates a comprehensive strategy for implementing technically feasible mitigation activities for the area affected by natural hazards; and

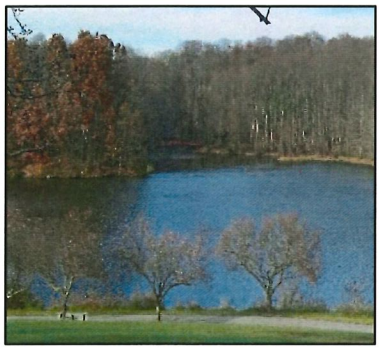
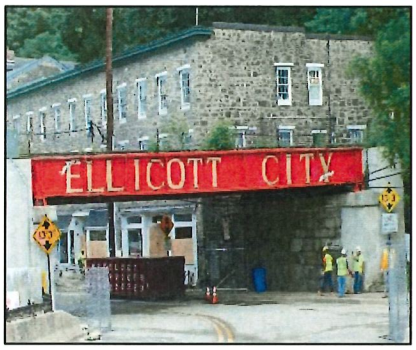
WHEREAS, adoption of the NHMP will make the County eligible for future Federal and State grants to implement the NHMP's recommendations, if and when funds become available; and

WHEREAS, the County Executive recommends that the NHMP be adopted by the County Council.

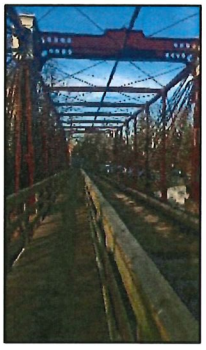
NOW, THEREFORE, BE IT RESOLVED by the County Council of Howard County, Maryland this 6 day of November 2023 that the effort to become more disaster resistant is deemed worthy of support, and that the Howard County Natural Hazards Mitigation

Plan prepared by the Howard County Office of Emergency Management, attached and incorporated by reference, is adopted.

2024-2029 Howard County Natural Hazard Mitigation Plan Update





Acknowledgements

This Hazard Mitigation Plan was prepared under the guidance of the Howard County Office of Emergency Management, and the Joint Steering Committee. The Howard County Office of Emergency Management would like to thank the following departments and organizations for their assistance with the development of this Plan as well as their dedication and continued commitment to making Howard County a more resilient County:

- Baltimore County Office of Emergency Management
- Columbia Association
- Constellation Home (formerly Baltimore Gas and Electric)
- Howard County Administration
- Howard County Community Organizations Active in Disaster
- Howard County Department of Community Resources and Services
- Howard County Economic Development Authority
- Howard County Department of Fire and Rescue Services
- Howard County Department of Inspections, Licenses, and Permits
- Howard County Department of Planning and Zoning
- Howard County Department of Public Works
- Howard County Department of Recreation and Parks
- Howard County Health Department
- Howard County Department of Technology and Communication Services
- Howard County Office of Community Sustainability
- Howard County Office of Human Rights and Equity
- Howard County Office of Law
- Howard County Office of Transportation
- Howard County Police Department
- Howard County Public School System
- Howard EcoWorks
- University of Maryland Center for Health and Homeland Security

Acronyms

Acronym	Definition
AAR	After Action Report
ACS	American Community Survey
APL	Applied Physics Laboratory
ASL	American Sign Language
BCA	Benefit Cost Analysis
BES	Howard County Department of Public Works Bureau of Environmental Services
BFE	Base Flood Elevation
BGE	Baltimore Gas and Electric/Constellation Home
BMP	Best Management Practices
BOE	Board of Education
BRIC	Building Resilient Infrastructure and Communities
BWI	Baltimore Washington International Thurgood Marshall Airport
CAG	Community Advisory Group
CAV	Community Assistance Visit
CFR	Code of Federal Regulations
CDBG	Community Development Block Grant
CIP	Capital Improvement Plan
CRS	Community Rating System
CSA	Combined Statistical Area
DFIRM	Digital Flood Insurance Rate Map
DFRS	Howard County Department of Fire and Rescue Services
DILP	Howard County Department of Inspections, Licensing, and Permits
DMA2K	Disaster Mitigation Act of 2000
DNR	Department of Natural Resources
DPW	Howard County Department of Public Works
DPZ	Howard County Department of Planning and Zoning

Acronym	Definition
DRP	Howard County Department of Recreation and Parks
EDA	Economic Development Authority
EF-Scale	Enhanced Fujita Scale
EOC	Emergency Operations Center
EMPG	Emergency Management Performance Grant
EPA	Environmental Protection Agency
F-Scale	Fujita Scale
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
FMP	Flood Mitigation Plan
GBS	General Building Stock
GIS	Geographic Information System
H&H	Hydrology & Hydraulic
HCC	Howard County Community College
HCGH	Howard County General Hospital
HCPD	Howard County Police Department
HCPSS	Howard County Public School System
HHPD	High Hazard Potential Dams
HIRA	Hazard Identification and Risk Assessment
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
HUD	Department of Housing and Urban Development
IA	Individual Assistance
ICS	Incident Command System
IP	Improvement Plan
ISDN	Integrated Services Digital Network
JSC	Joint Steering Committee
LOMA	Letter of Map Amendment

Acronym	Definition
LOMR	Letter of Map Revision
MARC	Maryland Area Regional Commuter
MDE	Maryland Department of the Environment
MDEM	Maryland Department of Emergency Management
MDP	Maryland Department of Planning
MGS	Maryland Geological Survey
MSA	Metropolitan Statistical Area
MSD	Maryland School for the Deaf
MTA	Maryland Transit Administration
MUIH	Maryland University of Integrative Health
NCDC	National Climate Data Center
NCR	National Capital Region
NEC	National Electrical Code
NFIP	National Flood Insurance Program
NHMP	Natural Hazard Mitigation Plan
NOAA	National Oceanic Atmospheric Administration
NIMS	National Incident Management System
NWS	National Weather Service
OEM	Howard County Office of Emergency Management
PA	Public Assistance
PDM	Pre-Disaster Mitigation Grant
PDSI	Palmer Drought Severity Index
PGA	Peak Ground Acceleration
PHEP	Public Health Emergency Preparedness
PIO	Howard County Office of Public Information
PSAP	Public Safety Answering Point
RL	Repetitive Loss
RLP	Rural Legacy Program
RTA	Regional Transportation Agency
SHA	State Highway Administration
SHEDLUS	Spatial Hazard Events and Losses Database

Acronym	Definition
SHSP	State Homeland Security Grant Program
SRL	Severe Repetitive Loss
SWMD	Howard County Department of Public Works – Stormwater Management Division
UASI	Urban Area Security Initiative
UMD	University of Maryland
USFS	United State Forest Service
USGS	United States Geological Survey
VPC	Vision Planning and Consulting, LLC
WATS	Wide Area Telephone Service
WUI	Wildland-Urban Interface
ZIP	Zone Improvement Plan

Table of Contents

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Chapter 1: Introduction

This Chapter provides a general introduction to the 2024-2029 Howard County Natural Hazard Mitigation Plan (NHMP) update and includes the following sections:

- Background
- Purpose
- Scope
- Authority
- Organization

Background

The Disaster Mitigation Act of 2000 established a requirement that jurisdictions must develop and implement NHMPs to remain eligible for various pre-and post- disaster Federal Emergency Management Agency (FEMA) grant programs.

Hazard mitigation is defined by FEMA as "any sustainable action that reduces or eliminates long-term risk to people and property from future disasters."[1] The hazard mitigation planning process involves the formulation of actions to reduce injuries, deaths, property damage, economic losses, and degradation of natural resources caused by natural and human-caused disasters. Mitigation is one of five mission areas in emergency management. FEMA's definitions of these areas are listed below:

- Prevention – Prevent, avoid, or stop an imminent, threatened, or actual act of terrorism.
- Protection – Protect our citizens, residents, visitors, and assets against the greatest threats and hazards in a manner that allows our interests, aspirations, and way of life to thrive.
- Mitigation – Reduce the loss of life and property by lessening the impact of future disasters.
- Response – Respond quickly to save lives, protect property and the environment, and meet basic human needs in the aftermath of a catastrophic incident.
- Recovery – Recover through a focus on the timely restoration, strengthening and revitalization of infrastructure, housing, and a sustainable economy, as well as the health, social, cultural, historic, and environmental fabric of communities affected by a catastrophic incident.[2]

While this Plan focuses on only the mitigation of natural hazards, the County has also developed and updated two other Annexes as part of the 2024-2019 update: Annex A: Human-Caused Hazards Mitigation Plan and Annex B: Cultural and Historical Hazard Mitigation Plan. The first Annex addresses human-caused hazards and the second addresses hazards that threaten cultural and historical elements

[1] *Hazard Mitigation Assistance Grants*, FEMA, https://www.fema.gov/grants/mitigation (last visited Feb.10, 2023).
[2] *Mission Areas and Core Capabilities*, FEMA, https://www.fema.gov/emergency-managers/national-preparedness/mission-core-capabilities (last visited Feb. 10, 2023).

in the County. All County Hazard Mitigation Plans have been developed using an all-hazards approach, utilize a comprehensive and protective planning process, and establish more efficient mobilization of resources to ensure effective mitigation measures to protect life, property, and the environment in Howard County.

Purpose

This Plan seeks to reduce the County's human, social, environmental, and economic losses from future disasters. The NHMP was developed in accordance with FEMA's hazard mitigation requirements found in 44 C.F.R. § 201.6, Local Mitigation Plans. An essential aspect of comprehensive disaster mitigation planning is developing a thorough understanding of potential hazards, vulnerabilities, and risks. As stated in the regulation, the purpose of the hazard vulnerability analysis is to:

- Identify the natural hazards that impact the County;
- Identify actions and activities to reduce any losses from those hazards; and
- Establish a coordinated process to implement the plan, taking advantage of a wide range of resources.[3]

This Plan works in tandem with, and includes sections from, the County's 2023 Hazard Identification and Risk Assessment (HIRA), which was completed independent of this effort and is updated regularly.

Scope

In July 2022, the Howard County Office of Emergency Management (OEM) began the process of updating this Plan for the next five-year cycle (2024-2029). This Plan will receive annual updates to the mitigation action items and relevant statistics, and it will cover Howard County and its communities. This update will include changes to the County's Hazard Identification and Risk Assessment (HIRA) and updates to the mitigation actions reviewed each year by the Joint Steering Committee (JSC).

This update continues the planning cycle with previous iterations of the Plan. The Plan's goals and objectives will be revisited to ensure their continued relevance and efficacy. Mitigation actions from the previous Plan are evaluated to determine which have been completed, which are pending, and which, if any, were deferred or cancelled, and new actions will be developed with the input and collaboration from the JSC, and prioritization and implementation plan developed for all ongoing and new actions.

Authority

Federal:

- Robert T. Stafford Disaster Relief and Emergency Assistance Act, Pub. L. 100-707, as amended. The Act is codified at 42 U.S.C. 5121, *et. seq.*

[3] 44 C.F.R. § 201.1(b).

- Code of Federal Regulations (CFR), Title 44, Parts 201 and 206.
- Disaster Mitigation Act of 2000, Public Law 106-390, as amended.

State of Maryland:

- State of Maryland Hazard Mitigation Plan, 2021.

Howard County Code of Ordinances:

- Title 3, Subtitle 1 – Building Code.
- Title 16, Subtitle 1 – Subdivision and Land Development Regulations.
- Title 16, Subtitle 7 – Floodplain.
- Title 18, Subtitle 9 – Stormwater Management.

FEMA Guidance Documents:

- FEMA. Local Mitigation Planning Policy Guide. April 2022.
- FEMA. Local Mitigation Planning Handbook. March 2013.
- FEMA. Local Mitigation Plan Review Guide. October 2011.

Organization

This Plan comprises seven chapters:

- Chapter 1: Introduction
- Chapter 2: Community Profile
- Chapter 3: Planning Process
- Chapter 4: Hazard Identification, Profiling, and Risk Assessment
- Chapter 5: Capability Assessment
- Chapter 6: Mitigation Strategy
- Chapter 7: Plan Monitoring and Maintenance

Chapter 2: Community Profile

This Chapter presents a brief overview of Howard County, mirroring the "Introduction" section of the County's Comprehensive Emergency Response and Recovery Plan (CERRP). Factors relevant to the causes and effects of hazard risks in the County, including its geographic layout, climate, demographic makeup, and employment and industry profile, are described in this Chapter.

Howard County in Context

Located in central Maryland between Baltimore and Washington (18 miles from Baltimore City and 27 miles from Washington D.C.), Howard County is the smallest of Maryland's 23 counties at about 254 square miles. Only Baltimore City, the 24th jurisdiction in Maryland, is smaller at 92 square miles. In terms of total population, however, Howard County ranks 6th in the State with an estimated population of 335,000 in 2021. The five other jurisdictions with greater populations are also all located in central Maryland adjacent to Howard County. Including Carroll and Frederick Counties (ranked 7th and 9th in the State, respectively), a total of just over to 4.8 million residents live in central Maryland, 78% of the State's total 6.2 million residents. Howard County's 335,000 residents make up 5.4% of the State total.

FIGURE 1: CENTRAL MARYLAND POPULATION

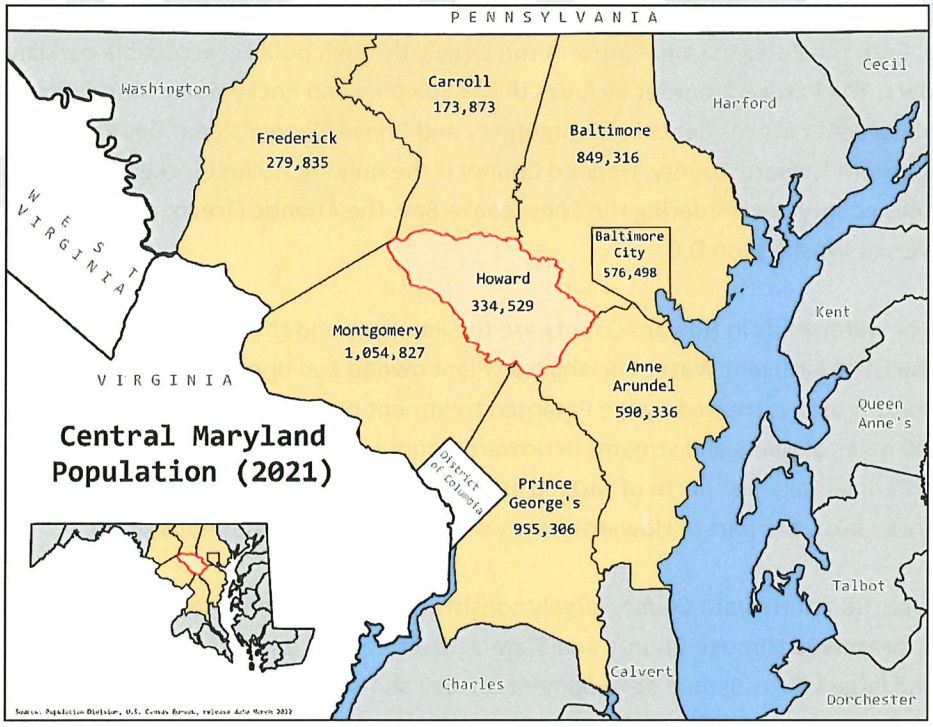


FIGURE 2: POPULATION RANKING OF MARYLAND COUNTIES AND BALTIMORE CITY

Population Ranking of Maryland Counties and Baltimore City - July 1, 2021

1	Montgomery County	1,054,827	**13**	Wicomico County	103,980
2	Prince George's County	955,306	**14**	Cecil County	103,905
3	Baltimore County	849,316	**15**	Calvert County	93,928
4	Anne Arundel County	590,336	**16**	Allegany County	67,729
5	Baltimore City	576,498	**17**	Worcester County	53,132
6	**Howard County**	**334,529**	**18**	Queen Anne's County	50,798
7	Frederick County	279,835	**19**	Talbot County	37,626
8	Harford County	262,977	**20**	Caroline County	33,386
9	Carroll County	173,873	**21**	Dorchester County	32,489
10	Charles County	168,698	**22**	Garrett County	28,702
11	Washington County	154,937	**23**	Somerset County	24,584
12	St. Mary's County	114,468	**24**	Kent County	19,270
	Maryland Total				**6,165,129**

Source: Population Division, U.S. Census Bureau, release date March 2022

Physical Geography and Climate

Howard County is in the Piedmont Plateau region of Maryland, with rolling hills making up most of the landscape. It is bounded on the north and northeast by the Patapsco River, on the southwest by the Patuxent River, and on the southeast by the Deep Run River and the Chessie Seaboard Express (CSX) railroad line. Both the Patapsco and Patuxent run largely through publicly accessible parkland along the County borders. The Patuxent border includes the Triadelphia and Rocky Gorge reservoirs, which provide drinking water for residents in Montgomery and Prince George's Counties as well as a small portion of southern Howard County. Howard County is the only "Maryland-locked" county in the state—that is, the only county not bordering the Chesapeake Bay, the Atlantic Ocean, another state, the Potomac River, or Washington D.C.

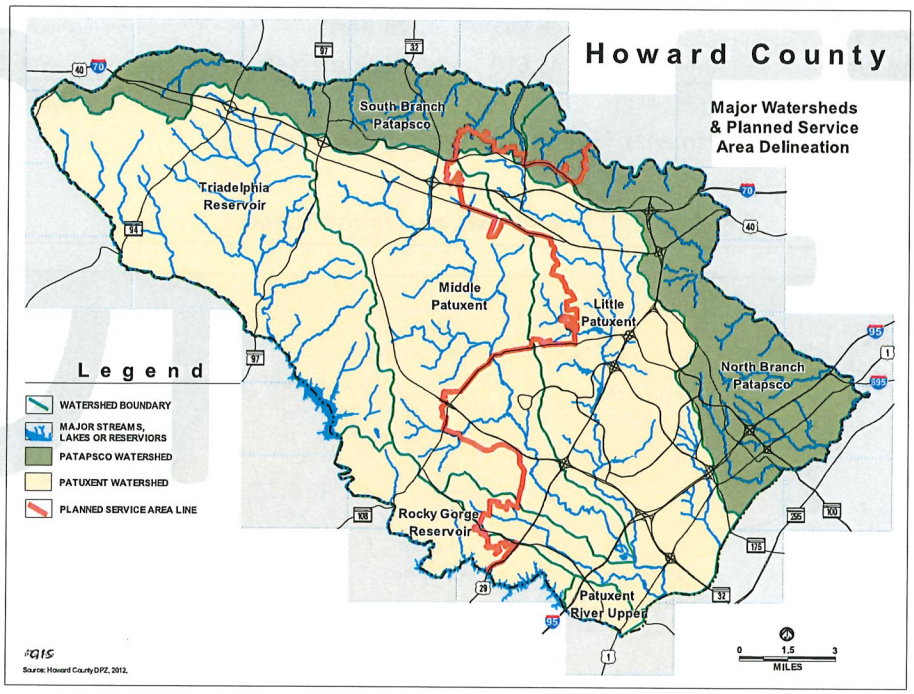
The two major watersheds in Howard County are the Patapsco and the Patuxent. Most wastewater is treated by the Little Patuxent Water Reclamation Plant owned and operated by Howard County. Waste from the Patapsco area is treated by the Patapsco treatment plant located in Baltimore City. There are close to 1,000 miles of rivers and streams in Howard County and several moderately sized artificial lakes, including Centennial Lake just north of MD108 and east of US29 and lake Kittamaqundi in Downtown Columbia. These lakes are part of Howard County's stormwater management system.

The western portion of Howard County largely consists of farmland and forest, much of which has been permanently preserved through County and State agricultural and environmental preservation programs, and large lot residential development on well and septic systems. This area, known as the Rural West, is approximately 60% of the total County land area and is delineated by the Planned Service Area line. The roughly 40% of county land east of this line is served by the public water and sewer system owned and operated by Howard County. The eastern portion of the County includes higher

density suburban development with a population density about 8 times that of the west—3.9 persons per acre compared to 0.5 persons per acre.

Howard County lies in the humid subtropical climate zone. Utilizing data from September 1900 to August 2022, the 12-month average temperature for Howard County is 53.3°F, which is a 3.2°F increase from September 1900. The average annual rainfall has increased by 5.5 inches from September 1900 to August 2022 and is approximately 43.2 inches annually. The County's average yearly snowfall is about 24 inches. The National Climatic Data Center (NCDC) Storm Events Database[4] provides data on the impacts to the County that were associated with wind, hail, and tornadic activity hazards. Based on the collected data, the County has been impacted by over 500 events since 1950.

FIGURE 3: HOWARD COUNTY WATERSHEDS



Jobs and Economy

Howard County has a significant job base, ranking 6th highest in the State with 178,000 jobs located in the County, most all of which are in the east. This represents about 6.9% of the total 2.6 million jobs Statewide. The eight jurisdictions in central Maryland have 2.1 million of the 2.6 million total, representing about four out of every five jobs in the State.

[4] *Storm Events Database*, NAT'L CTRS. FOR ENVTL. INFO., https://www.ncdc.noaa.gov/stormevents/ (last visited Feb.16, 2023).

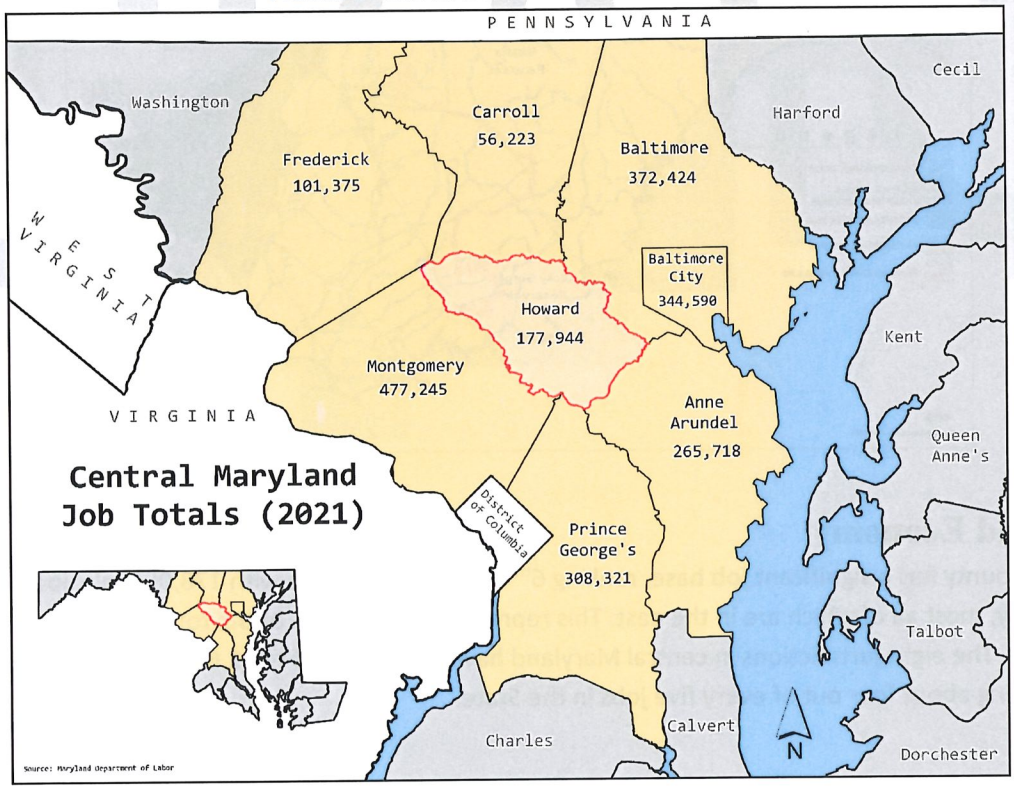
FIGURE 4: JOB RANKING OF MARYLAND COUNTIES AND BALTIMORE CITY

Job Ranking of Maryland Counties (and Baltimore City) -- 4th quarter 2021

1	Montgomery	477,245	**13**	Charles	40,355
2	Baltimore County	372,424	**14**	Cecil	33,470
3	Baltimore City	344,590	**15**	Allegany	27,047
4	Prince George's	308,321	**16**	Queen Anne's	23,083
5	Anne Arundel	265,718	**17**	Worcester	22,344
6	**Howard**	**177,944**	**18**	Calvert	21,459
7	Frederick	101,375	**19**	Talbot	16,874
8	Harford	94,336	**20**	Garrett	11,835
9	Washington	63,065	**21**	Dorchester	12,231
10	Carroll	56,223	**22**	Caroline	9,889
11	St. Mary's	46,441	**23**	Kent	7,555
12	Wicomico	45,619	**24**	Somerset	6,501
	Total				**2,585,944**

Source: Maryland Department of Labor, Licensing and Regulation

FIGURE 5: CENTRAL MARYLAND JOB TOTALS



Service-providing employment makes up about 79% of the 178,000 jobs in Howard County, while about 11% are goods-producing jobs and the remaining 9% are government jobs. Professional and business services account for more than 33% of all jobs located in Howard County, followed by trade,

transportation, and utility jobs (19%), and then education and health services (11%). An estimated 5% of all jobs are for manufacturing and 6% for construction. The table below summarizes all jobs by job type in Howard County. Note that these jobs reported by the Maryland Department of Labor Licensing and Regulation do not include proprietors who are not on an employer payroll. According to the latest available 2020 U.S. Bureau of Economic Analysis (BEA) data, there were an additional 50,073 proprietor jobs in Howard County.

FIGURE 6: JOBS IN HOWARD COUNTY BY JOB TYPE

Jobs in Howard County by Job Type - 4th Quarter, 2021

Job Type	Jobs	Percent
Government Sector		
Federal Government	721	0.4%
State Government	1,754	1.0%
Local Government	14,332	8.1%
Subtotal/Average	***16,807***	***9.4%***
Goods Producing		
Natural Resources and Mining	298	0.2%
Construction	10,722	6.0%
Manufacturing	8,818	5.0%
Subtotal/Average	***19,838***	***11.1%***
Service Providing		
Trade, Transportation, and Utilities	32,853	18.5%
Information	3,163	1.8%
Financial Activities	8,911	5.0%
Professional and Business Services	59,665	33.5%
Education and Health Services	19,365	10.9%
Leisure and Hospitality	13,142	7.4%
Other Services	4,188	2.4%
Subtotal/Average	***141,287***	***79.4%***
TOTAL	**177,944**	**100.0%**

Source: Maryland Dept. of Labor, Licensing, and Regulation

The latest labor force statistics from the Maryland Department of Labor (August 2022) indicate that of the 192,866 Howard County residents in the labor force, 186,157 are employed, resulting in 3.5% unemployment, the lowest unemployment rate in Maryland. The Statewide average is 4.4%.

According to the latest American Community Survey (ACS), conducted in 2021 by the U.S. Census Bureau, 98,980 Howard County residents work in Howard County and 72,574 residents commute to work outside the County. The 2021 ACS also estimates that 74,590 out-of-county residents commute into Howard County to work. Subtracting the 72,574 Howard County residents who leave the County each day for work from the 334,529 estimated 2021 resident population and then adding back in the 74,590 out-of-county in-commuters results in a "daytime population" estimate of 336,545. Given in-commuters exceed out-commuters by a modest 2,016 workers, the daytime population is only slightly higher than the resident population total. Thus, Howard County does not "empty out" during the

workday, nor does the population swell by a very large amount either—the County's population remains relatively consistent over the course of the day amid a significant regional commuting pattern.

The table below summarizes the major public and private sector employers in Howard County. The largest employer in the county is the Howard County Public School System (HCPSS), followed by the Johns Hopkins Applied Physics Lab (APL) and then the Howard County Government. These three employers combined employ close to 19,000 people and account for about 11% of all jobs in the County.

FIGURE 7: MAJOR EMPLOYERS IN HOWARD COUNTY

Major Employers in Howard County - 2021

1	Howard County Public School System	8,561	**11**	Freshly	820
2	Johns Hopkins Applied Physics Lab	7,200	**12**	Wells Fargo	810
3	Howard County Government	3,200	**13**	Maxim Healthcare Services	675
4	Howard County General Hospital	1,800	**14**	Oracle	650
5	Verizon	1,700	**15**	W.R. Grace	600
6	Howard Community College	1,400	**16**	Sysco Food Services	515
7	The Columbia Association	1,200	**17**	Enterprise Community Partners	505
8	Lorien Health Systems	1,190	**18**	Humanim	475
9	Coastal Sunbelt Produce	1,050	**19**	Leidos	450
10	Nestle Dreyer's Ice Cream	835	**20**	Tenable Network Security	415

Sources: Howard County Economic Development Authority, Howard County Public School System

Race and Languages

Howard County has a racially diverse population. According to the latest American Community Survey (2021), about 48% of Howard County residents are White, 20% African American, 20% Asian, and 8% Hispanic. The minority populations in Howard County have steadily increased over time and the County became a "majority-minority" County for the first time with the release of the 2019 ACS survey data, when the white population was less than 50% of the total. The adjacent counties of Montgomery, Prince George's, and Baltimore City have been "majority-minority" for many years. Of all races, Howard County's Asian population has increased the most significantly since 2010, growing by 63% over the last 11 years. During this same period the white population in Howard County has decreased by 4%. Asian Indians make up the greatest number of Asians in Howard County, followed by Korean, other Asians, Chinese, and then Vietnamese, Filipino, and Japanese.

FIGURE 8: HOWARD COUNTY POPULATION BY RACE AND HISPANIC ORIGIN

Howard County Population by Race and Hispanic Origin - 2021

Race	Estimate	Margin of Error	%	% Margin of Error
White alone	159,429	+/-1,360	47.7%	+/-0.4
African American	67,713	+/-1,479	20.2%	+/-0.4
Asian	66,297	+/-1,771	19.8%	+/-0.5
Hispanic or Latino	25,589	****	7.6%	****
Two or More Races	13,082	+/-2,483	3.9%	+/-0.7
Some Other Race	1,752	+/-1,065	0.5%	+/-0.3
American Indian & Alaskan Native	429	+/-331	0.1%	+/-0.1
Native Hawaiian & Pacific Islander	238	+/-395	0.1%	+/-0.1
TOTAL	**334,529**	****	**100.0%**	****

Source: 2021 American Community Survey, US Census Bureau

Note that, other than the Hispanic or Latino category, all are non-Hispanic only

**** No sample observation, controlled to annual Population Division estimate

FIGURE 9: HOWARD COUNTY POPULATION BY SELECT MINORITY RACE

Howard County Population by Select Minority Race Detailed Breakdown - 2021

Race	Estimate	Margin of Error	%	% Margin of Error
Asian	**66,297**	**+/-1,771**	**19.8%**	+/-0.5
Asian Indian	23,313	+/-3,521	7.0%	+/-1.1
Korean	15,183	+/-2,937	4.5%	+/-0.9
Other Asian	11,388	+/-3,018	3.4%	+/-0.9
Chinese	9,435	+/-2,193	2.8%	+/-0.7
Vietnamese	3,031	+/-1,489	0.9%	+/-0.4
Filipino	2,957	+/-1,221	0.9%	+/-0.4
Japanese	990	+/-718	0.3%	+/-0.2
Hispanic or Latino	**25,589**	*****	**7.6%**	****
Other Hispanic or Latino	16,241	+/-2,337	4.9%	+/-0.1
Mexican	5,955	+/-2,227	1.8%	+/-0.7
Puerto Rican	2,729	+/-1,337	0.8%	+/-0.4
Cuban	664	+/-413	0.2%	+/-0.1

Source: 2021 American Community Survey, US Census Bureau

Note that percents are percent of total Howard County population

**** No sample observation, controlled to annual Population Division estimate

As expected in a place with a significant minority population, over a quarter of Howard County residents five years and older speak a language other than English. However, most are also proficient in English—only 8.2% of the population five years and older speak English less than "very well" according to the latest American Community Survey. The largest portion of these less than very well English speakers are Asians. Despite these relatively low percentages, the County should nonetheless be prepared to communicate to all its residents, as the less than "very well" English speakers in the County number

more than 26,000 residents. Including this group's young children under five not accounted for in this statistic, the number would be even greater.

FIGURE 10: LANGUAGE SPOKEN AT HOME & ENGLISH PROFICIENCY IN HOWARD COUNTY

Language Spoken at Home & English Proficiency in Howard County - 2021
(Population 5 years and over)

Language & English Proficiency	Estimate	Margin of Error	%	% Margin of Error
English Only	225,962	+/-5,453	71.4%	+/-1.7
Language other than English	**90,333**	**+/-5,453**	**28.6%**	**+/-1.7**
Speak English less than "very well"	**26,020**	**+/-3,227**	**8.2%**	**+/-1**
Spanish	18,698	+/-2,298	5.9%	+/-0.7
Speak English less than "very well"	7,365	+/-1,765	2.3%	+/-0.6
Other Indo-European languages	24,461	+/-4,432	7.7%	+/-1.4
Speak English less than "very well"	5,159	+/-1,394	1.6%	+/-0.4
Asian and Pacific Islander languages	33,733	+/-3,571	10.7%	+/-1.1
Speak English less than "very well"	11,576	+/-2,116	3.7%	+/-0.7
Other languages	13,441	+/-3,187	4.2%	+/-1
Speak English less than "very well"	1,920	+/-987	0.6%	+/-0.3
TOTAL	**316,295**	**+/-4**	**100%**	

Source: 2021 American Community Survey, US Census Bureau
Note that percents are percent of total Howard County population 5 years and over

Children and the Elderly

According to the latest American Community Survey conducted in 2021, the median age in Howard County is 39.9 years old. About 6% of the population is under five years old (18,234 residents) and 1.3% is 85 and over (4,419 residents). About 24% of the population is under 18 and 14% is 65 and over. School-aged residents in Howard County—those five to 17 years old—amount to about 19% of the population, close to 1 out of every 5 residents.

The baby boomers—those born between 1946 and 1964—are currently aged 58 to 76 years old. The leading edge of this large demographic group began turning 65 in 2011. As this group continues to age, the 65 and older population is expected to increase by close to 50% between 2020 and 2030 when the youngest boomers turn 66. At that time, about one out of every five Howard County residents will be 65 and older (21% of the population). Also, by 2030, more than 9,700 residents in Howard County are expected to be 85 and older, more than double the number in that age group today. It is important to anticipate and plan for this rapid growth of the older and more vulnerable population in Howard County.

FIGURE 11: AGE OF HOWARD COUNTY RESIDENTS

Age	Estimate	Margin of Error	%	% Margin of Error
Under 5 years	18,234	+/-4	5.5%	+/-0.1
5 to 9 years	22,271	+/-2,037	6.7%	+/-0.6
10 to 14 years	24,944	+/-2,040	7.5%	+/-0.6
15 to 19 years	22,528	+/-954	6.7%	+/-0.3
20 to 24 years	18,868	+/-907	5.6%	+/-0.3
25 to 29 years	18,974	+/-488	5.7%	+/-0.1
30 to 34 years	20,732	+/-119	6.2%	+/-0.1
35 to 39 years	21,275	+/-2,076	6.4%	+/-0.6
40 to 44 years	27,476	+/-2,079	8.2%	+/-0.6
45 to 49 years	23,404	+/-417	7.0%	+/-0.1
50 to 54 years	22,700	+/-427	6.8%	+/-0.1
55 to 59 years	22,779	+/-2,087	6.8%	+/-0.6
60 to 64 years	21,145	+/-2,099	6.3%	+/-0.6
65 to 69 years	16,531	+/-1,263	4.9%	+/-0.4
70 to 74 years	13,462	+/-1,308	4.0%	+/-0.4
75 to 79 years	8,672	+/-1,101	2.6%	+/-0.3
80 to 84 years	6,115	+/-1,032	1.8%	+/-0.3
85 years and over	4,419	+/-1,008	1.3%	+/-0.3
TOTAL	**334,529**	****	**100.0%**	
18 years and over	254,023	+/-129	75.9%	+/-0.1
21 years and over	243,310	+/-1,225	72.7%	+/-0.4
62 years and over	61,383	+/-1,870	18.3%	+/-0.6
65 years and over	49,199	+/-400	14.7%	+/-0.1
75 years and over	19,206	+/-347	5.7%	+/-0.1

Source: 2021 American Community Survey, US Census Bureau

**** No sample observation, controlled to annual Population Division est.

Income and Poverty

Howard County is the wealthiest jurisdiction in Maryland and one of the wealthiest in the United States. In 2021, the median household income in Howard County was $133,267. The mean was $165,657. By comparison, the Statewide median household income in 2021 was $90,203 and the mean was $119,958. For the U.S., the median and mean household incomes were an even lower $69,717 and $97,962, respectively.

The poverty rate in Howard County was estimated to be 6.4% in 2021. For residents under 18, the poverty rate was 8.1%. Given the small sample size, there are large margins of error associated with this data and the actual numbers or residents are not reported. A separate dataset from Census Bureau's Small Area Income and Poverty Estimates (SAIPE) program reports that the overall poverty rate in Howard County was 5.5% (+/-1.1%) in 2020 (latest available). Overall, poverty in Howard County is relatively low compared to Maryland as a whole, which had a reported SAIPE poverty rate of 9.0% (+/-0.3%) in 2020.

FIGURE 12: HOWARD COUNTY HOUSEHOLD INCOME

Howard County Household Income - 2021
(Occupied Housing Units)

Household Income	Estimate	Margin of Error	%	% Margin of Error
Less than $10,000	3,496	+/-1,095	2.9%	+/-0.9
$10,000 to $14,999	1,929	+/-935	1.6%	+/-0.8
$15,000 to $24,999	3,496	+/-1,236	2.9%	+/-1
$25,000 to $34,999	2,893	+/-1,011	2.4%	+/-0.8
$35,000 to $49,999	6,871	+/-1,396	5.7%	+/-1.2
$50,000 to $74,999	11,693	+/-1,659	9.7%	+/-1.4
$75,000 to $99,999	11,331	+/-1,694	9.4%	+/-1.4
$100,000 to $149,999	25,917	+/-2,365	21.5%	+/-1.9
$150,000 to $199,999	20,734	+/-2,093	17.2%	+/-1.7
$200,000 or more	32,186	+/-2,175	26.7%	+/-1.8
TOTAL	**120,546**	**+/-1,453**	**100%**	
Median household income	$133,267	+/-7,347		
Mean household income	$165,657	+/-10,819		

Source: 2021 American Community Survey, US Census Bureau

Individuals with Disabilities

An estimated 7.6% of all noninstitutionalized residents in Howard County have disabilities, and 22.9% of all noninstitutionalized residents 65 years have disabilities. For Maryland, these rates are higher—11.3% of all residents and 28.6% of residents 65 years and older, and for the U.S., the rates are even higher—13.0% of all residents and 32.6% of residents 65 years and older.

Given the County's rapidly aging population, these disability rates are expected to increase in the future. It is important that the County plan for a corresponding increase in the number of residents who may require enhanced assistance during an emergency in the years ahead.

FIGURE 13: DISABILITY STATUS OF THE CIVILIAN NONINSTITUTIONALIZED POPULATION IN HOWARD COUNTY

Disability Status	Estimate	Margin of Error	%	% Margin of Error
Total Population	330,151	+/-1,935		
With a disability	25,030	+/-3,280	7.6%	+/-1
Under 18 years	80,500	+/-129		
With a disability	2,626	+/-915	3.3%	+/-1.1
18 to 64 years	201,326	+/-1,496		
With a disability	11,341	+/-2,378	5.6%	+/-1.2
65 years and over	48,325	+/-817		
With a disability	11,063	+/-1,454	22.9%	+/-2.9

Source: 2021 American Community Survey, US Census Bureau

Household Composition

Of the more than 120,000 households in Howard County, about 60% are married-couple households. Just over 4% are cohabitating couple households, 13% are male households with no spouse or partner present, and 23% are female households with no spouse or partner present.

FIGURE 14: HOUSEHOLDS BY TYPE IN HOWARD COUNTY

Household Type	Estimate	Margin of Error +/-	%	% Margin of Error
Married-couple family	72,667	+/-2,810	60.3%	+/-2.2
With children of the householder under 18 years	35,105	+/-2,198	29.1%	+/-1.8
Cohabiting couple household	4,974	+/-1,025	4.1%	+/-0.8
With children of the householder under 18 years	1,373	+/-607	1.1%	+/-0.5
Male householder, no spouse/partner present	15,612	+/-1,880	13.0%	+/-1.5
With children of the householder under 18 years	1,513	+/-835	1.3%	+/-0.7
Householder living alone	9,096	+/-1,587	7.5%	+/-1.3
65 years and over	1,956	+/-589	1.6%	+/-0.5
Female householder, no spouse/partner present	27,293	+/-2,232	22.6%	+/-1.9
With children of the householder under 18 years	7,099	+/-1,468	5.9%	+/-1.2
Householder living alone	12,797	+/-1,579	10.6%	+/-1.3
65 years and over	7,022	+/-991	5.8%	+/-0.8
TOTAL HOUSEHOLDS	**120,546**	**+/-1,453**	**100.0%**	

Source: 2021 American Community Survey, US Census Bureau

About 37% of Howard County households include children under 18 years old. For Maryland and the U.S., only 27% and 26% of households, respectively, include children under 18. Compared to other counties, Howard County has a relatively high percentage of households with children. About 18%, almost one out of every five households in the County, are single occupancy households where the residents live alone. This compares to 28% both Statewide and nationally. Close to 7.5% of households

in Howard County include residents 65 years and older living alone. This compares to a higher 11% Statewide and nationally.

Commuting to Work & Access to Transportation

Close to 64%, or two out of every three workers in Howard County, drive alone to work. About 4% carpool to work and only about 1% use public transportation. The remaining 1% walk, 2% commute by other means, and a significant 29% work from home. Statewide, 62% of workers drive alone, 7% carpool, 3% use public transportation, and as of 2021, 24% work from home. The percentage of Howard County residents working from home increased dramatically with the COVID-19 Pandemic. Prior to the pandemic, only about 8% of Howard County residents worked from home in 2019. Looking at these numbers for the U.S., 68% drive alone, 8% carpool, 3% use public transportation, and 18% work from home.

FIGURE 15: COMMUTING TO WORK IN HOWARD COUNTY

Commuting to Work in Howard County (civilian employed population 16 years and over) - 2021

Commuting to Work	Estimate	Margin of Error +/-	%	% Margin of Error
Car, truck, or van—drove alone	108,892	+/-4,397	63.5%	+/-2.1
Car, truck, or van—carpooled	7,542	+/-1,708	4.4%	+/-1.0
Public transportation (excluding taxi)	1,455	+/-742	0.8%	+/-0.4
Walked	1,173	+/-703	0.7%	+/-0.4
Other means	2,693	+/-1,157	1.6%	+/-0.7
Worked at home	49,799	+/-3,586	29.0%	+/-1.9
TOTAL COMMUTERS	**171,554**	**+/-4,042**	**100.0%**	

Source: 2021 American Community Survey, US Census Bureau

The Maryland Transit Administration (MTA) provides limited commuter bus service from within Howard County to Baltimore City and Washington D.C. Buses stop at park and ride lots, village centers, and in Downtown Columbia. MTA also operates the Maryland Area Rail Commuter (MARC) trains along Route 1 that provide rail access to Baltimore and Washington D.C. The Regional Transportation Agency (RTA) also provides more localized bus service in Howard County, Anne Arundel County, the City of Laurel, and Northern Prince George's County. Like most suburbs, however, transit ridership in Howard County is limited.

Howard County Office of Transportation's rider surveys have concluded that the local bus system in Howard County mostly attracts riders who are transit dependent—that is, they do not have access to vehicles. The system does not attract riders who choose to take transit as an alternate means, but primarily only riders who have no other means of transportation. Surveys also determined that two-thirds of riders live within 3 blocks of a bus stop, as transit dependent riders typically choose to live near bus stops. The table below summarizes the availability of vehicles to Howard County workers. A relatively small number of Howard County households do not have access to a vehicle.

FIGURE 16: VEHICLES AVAILABLE AT OCCUPIED HOUSING UNITS

Vehicles Available	Estimate	Margin of Error	%	% Margin of Error
No vehicles available	4,143	+/-1,347	3.4%	+/-1.1
1 vehicle available	33,119	+/-2,705	27.5%	+/-1.2
2 vehicles available	55,169	+/-2,870	45.8%	+/-2.3
3 or more vehicles available	28,115	+/-2,224	23.3%	+/-1.8
OCCUPIED HOUSING UNITS	**120,546**	**+/-1,453**	**100.0%**	

Source: 2021 American Community Survey, US Census Bureau

FEMA Community Resilience Index

The FEMA Community Resilience Index (CRI) is a composite index of 22 indicators commonly used across 14 peer-reviewed community resilience methodologies. The index provides a relative composite value by county and by census tract, measured as an average of counts of standard deviations from the national mean for each indicator.

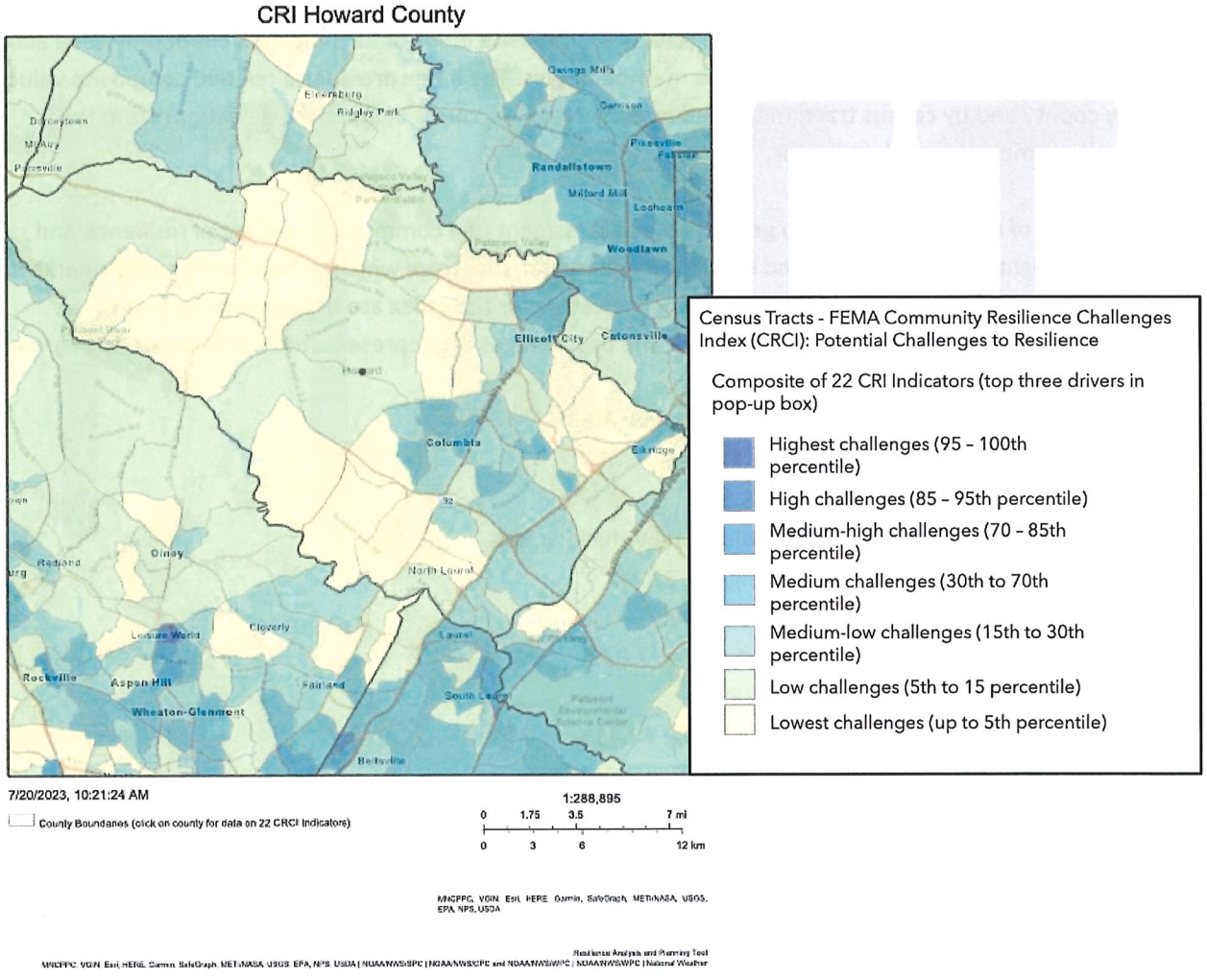
The goal of using this index is to get a relative assessment of a community's potential resilience and gives insights into population and community characteristics from which to build emergency operations plans and targeted outreach strategies. The indicators for the index are below with the first three representing the top drivers for the index. The percentages are representative for ***Howard County as a whole***.

- **Percent without Highschool Diploma: 4.63%**
- **Percent Age 65 and Older: 13.93%**
- **Percent with a Disability: 8.25%**
- Percent Households (HH) without a Vehicle: 3.85%
- Percent HH with Limited English: 3.11%
- Percent Single-Parent HH: 18.40%
- Percent HH without a Smartphone: 7.07%
- Percent Mobile Homes: 0.78%
- Percent Owner-Occupied Housing: 70.44%
- Number of Hospitals per 10,000 People: 0
- Number of Medical Practitioners per 1,000 People: 34.07
- Percent without Health Insurance: 3.88%
- Percent Below Poverty Level: 5.50%
- Median HH Income: $129,549
- Percent Unemployed Labor Force: 3.81%
- Percent Unemployed Women in Labor Force: 3.52%
- Percent Workforce Employed in Predominant Sector: 25.56%
- Income Inequality: 0.41 (Gini Index)
- Social/Civic Organizations per 1,000 People: 0.33

- Percent Without Religious Affiliation: 56.90%
- Percent Inactive Voters: 2.62%
- Population Change: 0.42

Please see the legend and map below for Howard County's Community Resilience Index ***by Census Tract***. You can see that in Howard County, there are no "Highest Challenges" census tracts. Most "Medium Challenges" to "Medium-High Challenges" cluster around population centers, such as Columbia, Elkridge, Ellicott City, and North Laurel. This tells us that more resources and outreach need to be targeted to these underserved populations to improve Howard County's overall resilience.

FIGURE 17: FEMA COMMUNITY RESILIENCE INDEX IN HOWARD COUNTY



Planning Zones and Communities

Howard County is part of the Baltimore-Columbia-Towson Metropolitan Statistical Area (MSA), which includes the City of Baltimore, Columbia, Towson, and six other counties in addition to Howard County. Howard County is also part of the Baltimore-Washington-Northern Virginia Combined Statistical Area (CSA), one of the largest populous metropolitan areas in the United States. The figure below shows the boundaries of the Baltimore-Columbia-Towson MSA, and its location within the Baltimore-Washington-Northern Virginia CSA.

FIGURE 18: WASHINGTON-BALTIMORE-NORTHERN VIRGINIA COMBINED STATISTICAL AREA

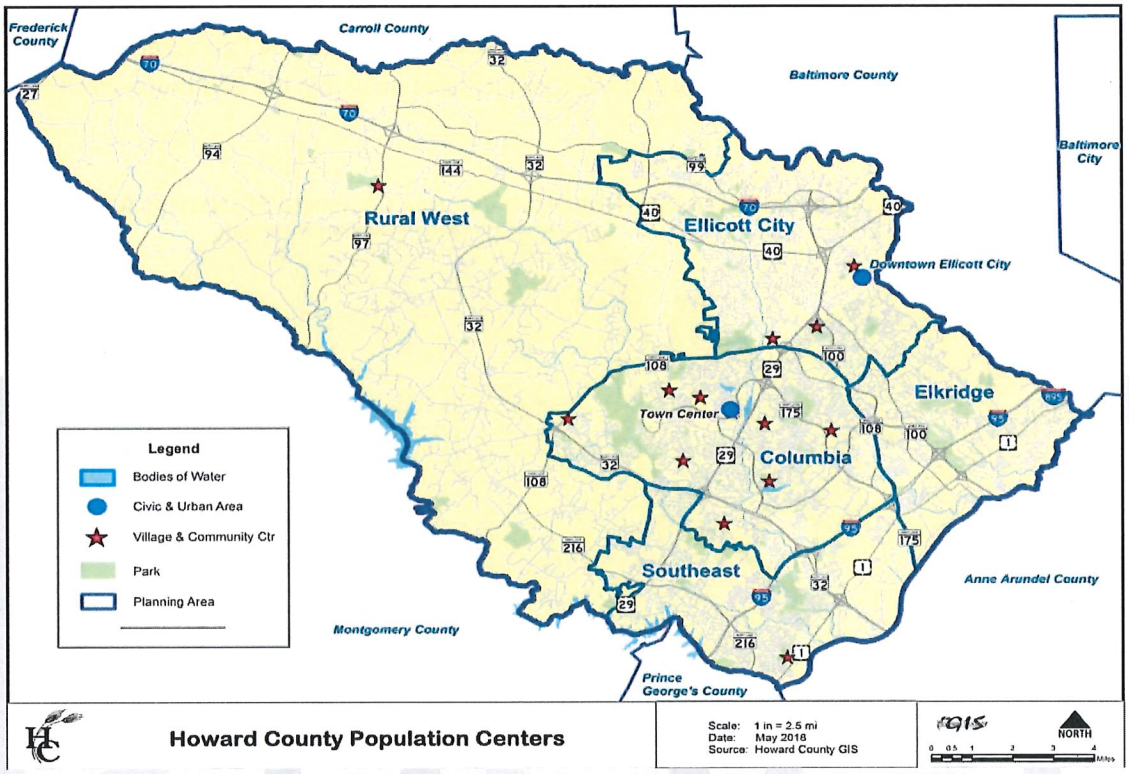
There are no incorporated municipalities in the County. The major population centers include:

- Columbia;
- Ellicott City;
- Elkridge;
- Savage;
- North Laurel; and,
- West Friendship.

Columbia, developed by James Rouse in 1965, is considered a popular example of the New Town Movement in the United States. Columbia was designed to be a self-sustaining community and a model for future urban development. Rouse's plan introduced the village and neighborhood concept, plans for business and industry, recreation and open space, and the Town Center. According to the United States Census Bureau, Columbia's population is estimated at 104,681 (as of 2020) and would be Maryland's second largest city if incorporated.

Ellicott City, located in the northeastern part of the County, serves as the County Seat. Founded in 1772, Ellicott City is prone to flooding from the Patapsco River and surrounding tributaries, which have had a major impact on the history of the town.

FIGURE 19: HOWARD COUNTY POPULATION CENTERS



**Source: Howard County Department of Technology and Communication Services, GIS Division*

History of Howard County

Howard County played an important role not only in the development and progress of the State of Maryland, but also in the development of the nation. Howard County's most prominent resident, Charles Carroll of Carrolton, was the only Roman Catholic signer of the Declaration of Independence. Howard County is named after John Eager Howard, a Revolutionary War hero and three-term governor of Maryland. The B&O Rail Terminal in Ellicott City was the first station along the Baltimore and Ohio Railroad.

Elkridge

Howard County's central location between Baltimore and Washington D.C., and its abundant natural resources, were both instrumental to the development of the County. Prior to the 1700's, settlement in the area was slow until tobacco became a valuable export. The area now known as Elkridge was initially developed by farmers selling their tobacco to English merchants. As the Industrial Revolution progressed, iron became a major export through the port. Simultaneously, the population was increasing along the Patapsco and Patuxent Rivers.

Ellicott City

In 1772, three brothers from Pennsylvania, known as the Ellicott Brothers, purchased land on the Patapsco River. The Patapsco River's strong currents provided ideal conditions for milling. The three brothers constructed a mill and settled the area then known as Ellicott's Mills, now known as Ellicott City. The Ellicott Brothers further expanded their holdings and acquired several flour and iron mills. Although the opportunities for workers encouraged settlers to migrate towards the Patapsco River region, these settlements remained sparse. By 1851, the area was officially recognized as separate from Anne Arundel County.

The railroad system changed Ellicott Mills from a small industrial town into a robust commercial hub. The first section of the Baltimore and Ohio Railroad was constructed in Ellicott Mills in the early 1900s. As the first station along the railroad, it revitalized the economy in the Patapsco valley. However, by the 1950s, the town began to decline as the push to migrate to the suburbs gained popularity.

Columbia

In the early 1960s, land developer James Rouse purchased over 1,000 acres of land in Howard County. This area became the community of Columbia. The community was intended to eliminate racial, religious, and income segregation. Columbia was to be self-sustaining with resources such as jobs, schools, commercial districts, and health and medical facilities. The "New Town District," designed by Rouse, gave developers more flexibility on where they could develop throughout the community.

Land Use

Maryland has been progressive in adopting Statewide land use planning and natural resource protection policies. The Maryland State Legislature passed the Economic Growth, Resource Protection, and Planning Act of 1992, which outlines seven goals to guide economic growth. It also requires local plans to include an environmentally sensitive areas section. In 1997, the Maryland State Legislature passed several programs known as the Smart Growth and Neighborhood Conservation initiatives. The main initiative was the "Priority Funding Areas," which limited State infrastructure funding and economic development in areas local government found unsuitable for growth. The Rural Legacy Program of 1997 provides financial resources to protect agricultural land and natural resources.

Initially, the adopted State resolutions strengthened Howard County's informal growth boundary. The concept was implemented as the "Residential Zoning and Development Stage Plan" in the 1960s. Today, the Planned Service Area has a defined boundary. The area is contained in the eastern portion of the County, which covers approximately 40% of the County's land area. The rest of the County is rural and has been preserved through programs such as the Rural Legacy Program, the County's Agricultural Land Preservation Program, cluster zoning, and Density Exchange Option. Although development can occur outside this Rural West boundary, public sewer and water is not provided to that area by the County.

There are 16 different types of generalized land use in Howard County, including six residential, two commercial, two industrial, one mixed-use and two government and institutional land uses. In addition,

there is a Transportation, Communications, and Utilities land use, as well as a use for parks, open space, and recreation. The Planned Service Area contains all six residential land uses, with the higher density residential land uses, including single family attached, rental apartments, and condo apartments typically located in Columbia, Elkridge, Ellicott City, Savage, and North Laurel. The residential land uses in the Rural West are mainly characterized by low-density residential uses, including single family detached and undeveloped residential. The combination of the preservation easements, park and open space, and low density single-family residential land uses make up a significant portion of the rural West. In the Planned Service Area, the park and open space land use is frequently located around residential development, acting as a buffer between the floodplain and residential properties. Higher density forms of residential development, such as townhouses and apartments, are almost exclusively found within the Public Service Area and single family detached residential has a lower average parcel acreage than within the Rural West.

Approximately 39% of land in Howard County, approximately 64,000 acres, is preserved through some type of land conservation measure. "Howard County preserves land by a wide variety of means including public parkland, Columbia Association [,] and other homeowners' association open space, agricultural preservation, environmental and forest conservation easements, and regulations on floodplain, riparian buffer, and steep slopes in private development."[5]

Howard County's two commercial land uses are commercial and undeveloped commercial. The commercial land use is primarily located in the Planned Service Area, with several small defined locations along Ten Oaks Road, Route 27, Route 32, Route 94, Route 97, Route 144, Interstate 70, and other small defined locations in the Rural West. The majority of the commercial land use is found near major population centers, such as Clarksville, Columbia, Jessup, Elkridge, Ellicott City, Fulton, Savage, and North Laurel. Columbia Town Center, including The Mall in Columbia, which serves as a major retail center. Another retail cluster can be found on the Interstate 95 corridor, particularly between Route 32 and Route 175, as well as off Snowden River Parkway.

The Route 1 corridor is the principal location of the County's industrial land use. The majority of the industrial land is located east of Route 1 and makes up a significant portion of the land between Route 1 and Howard County's border with Anne Arundel County. Clusters of industrial uses are also located off Snowden River Parkway. There are numerous Government and Institutional land uses scattered throughout the County. The most prominent institutional land use is the University of Maryland's Central Maryland Research & Education Center - Clarksville facility, a dairy research center. Other Government and Institutional land uses include schools, hospitals, and County government buildings.

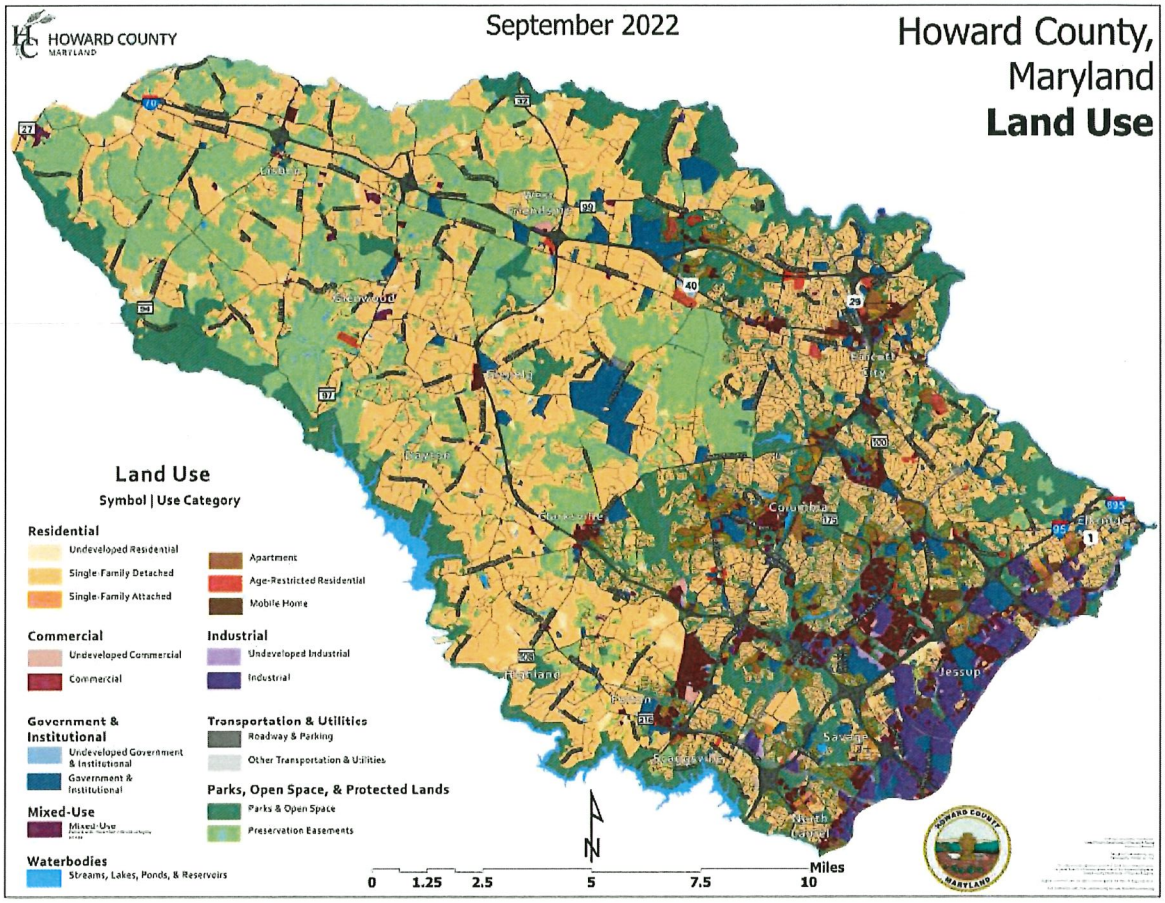
Growth and Development

The Countywide population density average as of 2021 was roughly 1,320 persons per square mile. The eastern portion of the County, inside the Planned Service Area, has a much greater population density

[5] HOWARD CTY., MD., *PlanHoward 2030* 27 (2018) https://www.hocobydesign.com/5676/widgets/17345/documents/10762.

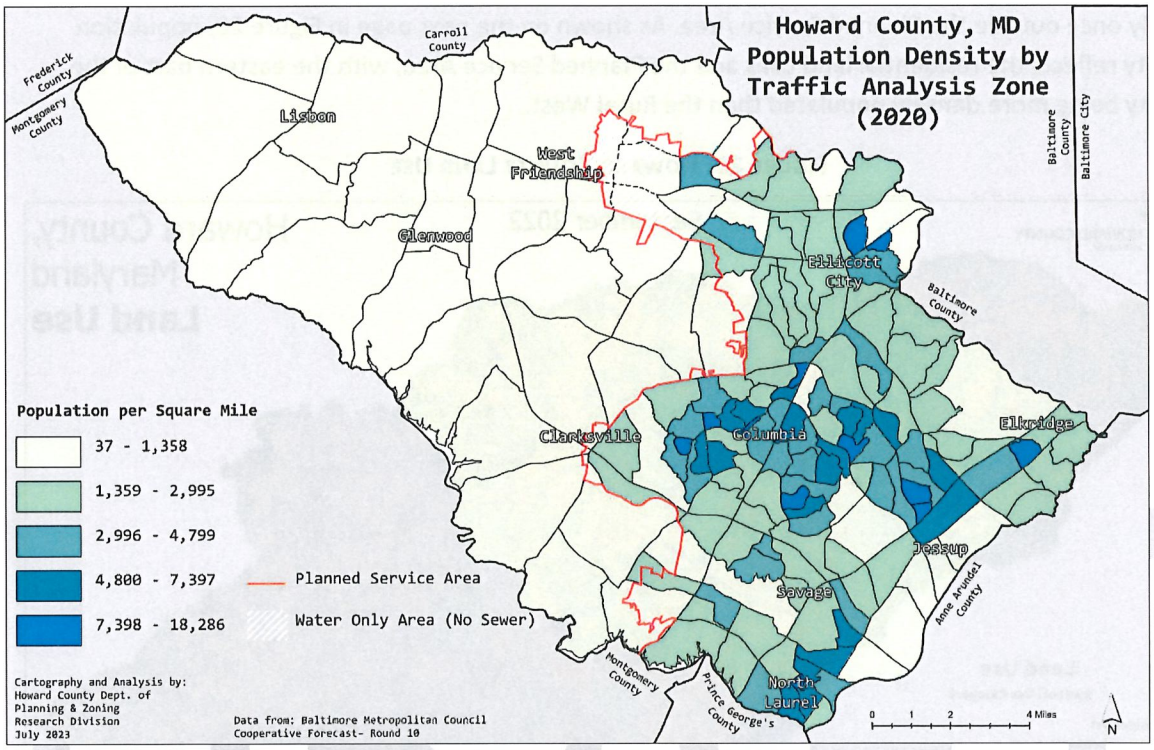
per square mile than compared to the rural western portions, where population density decreases rapidly once outside the Planned Service Area. As shown on the next page in Figure 20, population density reflects the residential land uses and the Planned Service Area, with the eastern part of the County being more densely populated than the Rural West.

FIGURE 20: HOWARD COUNTY LAND USE



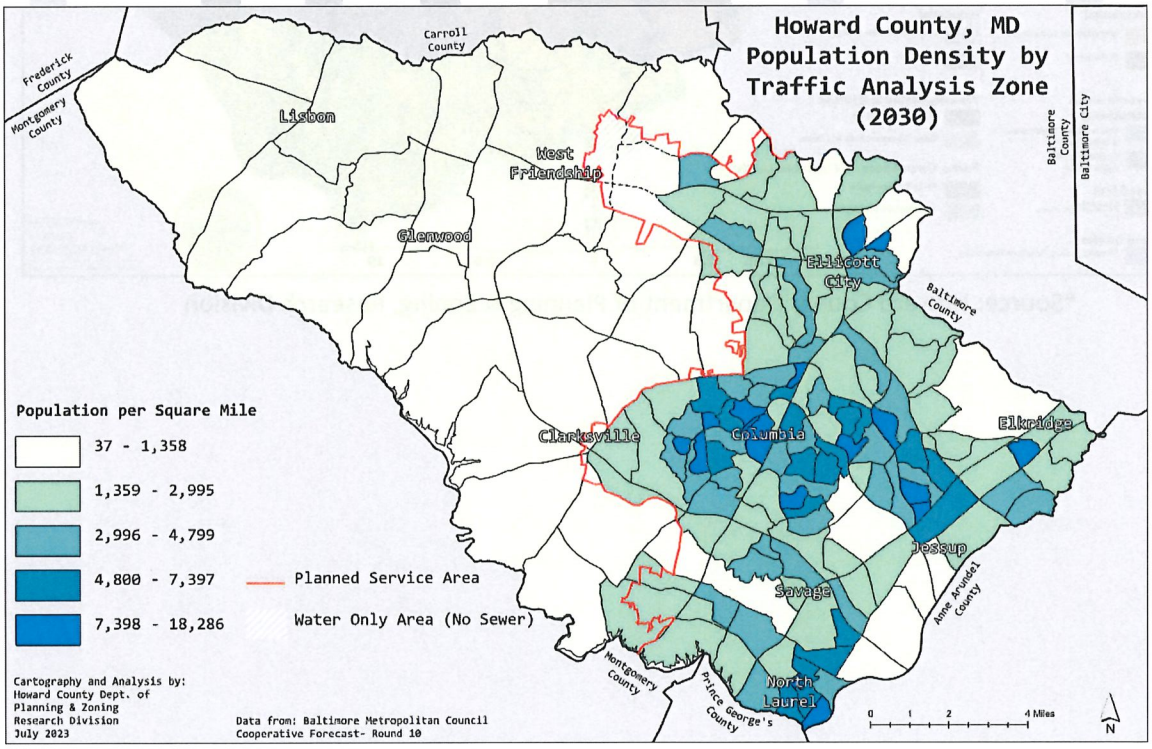
*Source: Howard County Department of Planning & Zoning, Research Division

FIGURE 21: POPULATION DENSITY



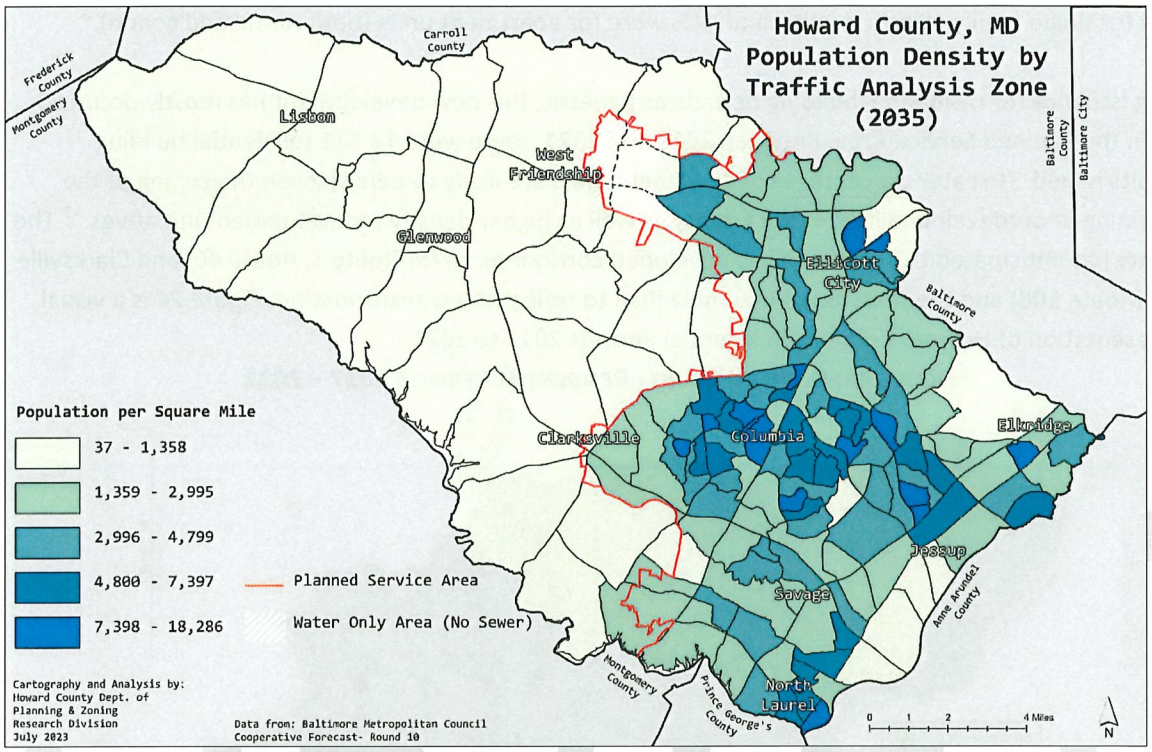
Source: Howard County Department of Planning & Zoning, Research Division

FIGURE 22: POPULATION DENSITY IN 2030



Source: Howard County Department of Planning & Zoning, Research Division

FIGURE 23:POPULATION DENSITY IN 2035



**Source: Howard County Department of Planning & Zoning, Research Division*

If trends continue as the above maps predict, population density is not going to change significantly, and it will continue to stay around Columbia and Ellicott City with patches in Elkridge and North Laurel.

The U.S. Census Bureau estimates that the region's population growth has steadily increased over the last 10 years. The decennial census shows a 15.5% increase between 2000 and 2010, and a 15.8% increase between 2010 and 2020. Estimates project a 7.5% increase from 2020 to 2030. With the above traffic analysis zone population density maps and the U.S. Census Bureau statistics, the region is expected to continue to grow, but at a slower rate in the coming years, primarily due to limited land for new development. The table below provides the total number of residential building units with issued permits in the County from 2012 to 2021.

FIGURE 24: RESIDENTIAL BUILDING UNIT PERMITS ISSUED

UNITS	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total = 12,611	945	1,311	959	1,153	1,077	1,185	2,114	895	1,173	1,799

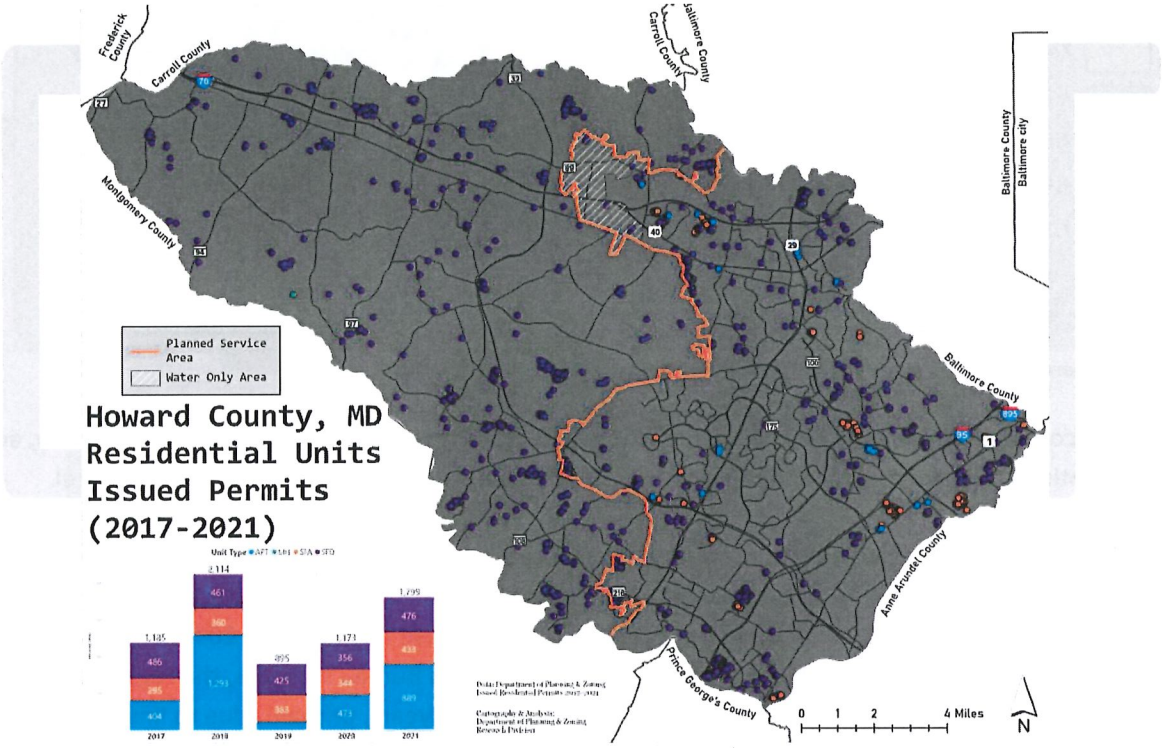
**Source: Howard County Department of Planning and Zoning, 2022 Development Monitoring System Report*

According to DPZ's 2022 Development Monitoring System Report, between 2017 and 2021, a total of 7,166 residential units were permitted, coming out to an average of 1,433 new residential units per

year. Over that five-year period, 30% of the permitted units were for single family detached units, 25% were for single family attached units, and 44% were for apartment units (both rental and condo).[6]

Using issuance for residential building permits as a metric, this new development has mostly occurred within the Planned Service Area. Between 2012 and 2021, there were 12,611 residential building permits issued. "Greater percentages of apartment units are likely to persist given the zoning of the remaining underdeveloped land in the County as well as higher density redevelopment initiatives."[7] The County has anticipated this shift and has developed corridor plans for Route 1, Route 40, and Clarksville Pike (Route 108) and the Downtown Columbia Plan to reflect this transformation. *Figure 24* is a visual representation of Howard County's Residential Permits 2017 to 2021.

FIGURE 24: HOWARD COUNTY RESIDENTIAL PERMITS 2017 – 2021



**Source: Howard County Department of Planning & Zoning, Division of Research*

The upcoming general plan, HoCo by Design further emphasizes this shift towards higher-density residential development and a focus on redevelopment and infill opportunities as available developable land reduces. There is also considerable respect paid towards the further protection and preservation of environmentally sensitive areas and agricultural lands. The County recognizes that climate change will impact hazards such as flooding, drought, and wildfires, and efforts to mitigate these risks will be largely driven by controlled and sustainable development and land use policies.

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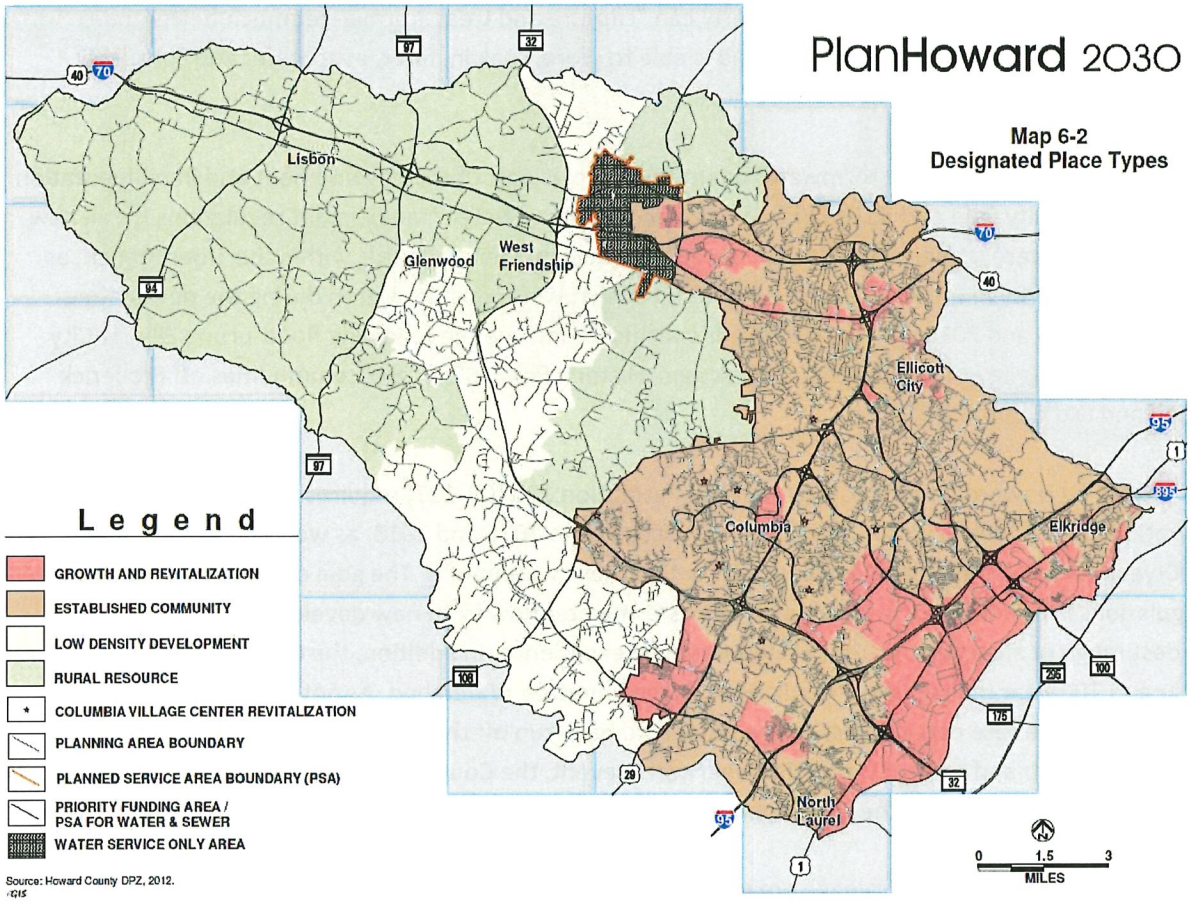
[6] HOWARD CTY. DEPT. OF PLANNING AND ZONING, *Development Monitoring System Report: Howard County, Maryland* (April 2022), https://www.howardcountymd.gov/sites/default/files/2022-04/2021%20DMS%20%281%29.PDF.

[7] *Id. at* 3.

Future Development

To further understand how development is occuring in the County, please refer below to the Designated Place Type map from PlanHoward 2030. This map shows the Growth and Revitalization area where future population and empoyment growth is expected to be conentrated over the next 20 years. Howard County's Zoning and Land Development regulations and other land use policies are designed to allow and direct future development and in-fill development in this Growth and Revitalization area. This area includes Downtown Columbia, the other nine Columbia village centers, areas along Route 1 and Route 40 Corridors, Maple Lawn and Turf Valley. There will be some in-fill developmetn in the Established Community, Low Density, and Rural Resource areas, as shown on the map, but the most significant growth will occur in the Growth and Revitalization area.

FIGURE 25: DESIGNATED PLACE TYPES BY 2030



Development in Hazard-Prone Areas

Since the last NHMP that was approved in January of 2019, the County has proactively acquired multiple properties in hazard-prone areas (flood zones). This proactive approach decreases the community's vulnerability by removing occupied structures from flood-prone locations. In many instances, the County has razed these structures, and reforested the areas. In other instances, the structures remain, albeit uninhabited, while the County implements other flood mitigation strategies. Approximately 20

properties have been acquired in the Tiber-Hudson Watershed of the Patapsco River; three properties were acquired in the New Cut Watershed of the Patapsco River; and several other properties were acquired along the Autumn Hill Branch. According to County Code, no permits are issued for new structures within the 100-year flood plain.

Furthermore, the County continues to restrict development in known, mapped floodplain areas to protect vulnerable flood-prone communities. These restrictions include more rigorous stormwater management regulations in the Tiber Branch and Plumtree Watersheds by requiring stormwater quantity control for larger storm events than the State minimum requirements. Quality control requires stormwater facilities to have a post-development flow release rate equal to or less than the release rate of the property before development occurred. By definition, the pre-development release rate assumes the property is "woods in good condition" or that the property is in a natural state before development. This "natural state" means that the property can "capture and treat stormwater much better than typical residential land because the ground is able to store, soak in, filter, evaporate, and consume water"[8].

Additionally, more rigorous stormwater quantity control is part of the development and implementation of the Ellicott City Safe and Sound Plan. More rigorous stormwater management regulations for all new development were implemented in 2020 to ensure much higher standards within the Tiber Branch, as well as the nearby Plumtree Watershed—the areas that were most impacted during the devastating storms of 2016 and 2018. These watersheds specifically include the following flood-prone Ellicott City communities: Valley Mede, Chatham, Dunloggin, Historic Ellicott City, and communities off Frederick Road and Old Columbia Pike.

As passed by Howard County Council, Council Resolution 123 (CR-123) requires management of short duration, high-intensity storms like those that occurred in 2016 and 2018, as well as the 10-year and 100-year storms for all future development within these watersheds. The goal of these 2020 stormwater regulations is to mitigate the increase of peak stormwater flow from new development to address the widest range of storm events that Ellicott City may experience. In addition, the County added the 10-year and 100-year management regulations to the Plumtree Watershed. As noted above, by releasing stormwater at a rate equal or less than what would have run off the site in a "woods in good condition" for storms up to and greater than a 100-year storm event, the County can mitigate/reduce the effects of greater flows coming from the developed or more impervious sites.

While there are other low-drainage areas in the County that are prone to "nuisance" flooding, largely a result of unanticipated conditions, such as clogged inlets or roadway culverts, the prior standard management requirements were not enough to protect Ellicott City and its surrounding communities against the type of storms experienced in 2016 and 2018. Past stormwater management requirements

[8] Montgomery Cty. Dept. of Environmental Protection, *Water Quality Charge Single Family Residential Credit Guide, (April 2022),* https://www.montgomerycountymd.gov/DEP/Resources/Files/downloads/water/wqpc/How-Is-My-WQPC-Credit-Calculated-Guide.pdf.

addressed modeled storm events where the rainfall intensity is distributed in a bell curve over a 24-hour period. This type of long duration storm event allows time for ponds to fill slowly and release the runoff at a controlled rate over an extended window before the peak of the storm is realized. The precipitation of the 2016 and 2018 storms was so intense, the ponds and storm drains were quickly overwhelmed. It was determined that, of the two storms, the 2016 storm caused the highest runoff in the shortest period, i.e., 6.6 inches of rainfall in 3.55 hours.

In addition to the more standard 24-hour bell curve distribution rain events, the County wanted future development in these two watersheds to also provide quantity control for a short duration, high-intensity rainfall event like that which was experienced in 2016 and 2018. For this reason, the County added 6.6 inches in 3.55 hours rain event to the 10-year and 100-year, 24-hour rainfall events as the requirement for any development in the Tiber Hudson and Plumtree Watersheds. With the addition of this short-duration, high-intensity storm management, the County's stormwater management practices for this watershed include both long-duration and short-duration events while maintaining requirements to also provide the state-mandated one-year, 24-hour event and water quality using small scale filtering devices known as Environmental Site Design (ESD).

Results of the new regulations will require large-scale stormwater practices, such as ponds and underground storage pipes to be installed in conjunction with the water quality ESD practices on all future development sites. These large facilities will reduce the stormwater impacts to both watersheds as well as adjacent and downstream property owners.

These new short-duration, high-intensity storm requirements became a complementary part of the County Executive's Ellicott City Safe and Sound Plan, which focused on comprehensive and holistic flood mitigation and recovery. The new regulations and the storage and conveyance projects (for example, drainage improvements to culverts and bridges to increase capacity) in the Safe and Sound Plan, will greatly reduce the depth of flooding and water velocity. All these efforts will help achieve the County's goals of mitigating flooding, preparing for a changing climate, ensuring public safety, protecting Ellicott City's historic charm while making it more resilient, and supporting property and business owners.

In summary, Howard County has proactively acquired many properties in hazard-prone areas and continues to restrict development in known, mapped floodplain areas. With new stormwater management regulations, County drainage projects, and the Ellicott City Safe and Sound Plan mitigation projects, Howard County is working to make these watersheds significantly less vulnerable to flooding hazards since the previous NHMP was approved.

Summary

Howard County has a diverse and growing population. It is a wealthy county located in the middle of a vibrant metropolitan area surrounded by other wealthy counties that are also diverse and growing. Situated between Washington D.C. and Baltimore, Howard County is in the heart of one of the largest regional economies in the United States. There is much activity and movement with commuters coming

into and leaving the County every day. The diverse economy attracts jobs and industries of all types, from basic services and retail to manufacturing and warehousing, to the high-tech jobs of the future.

Despite being the center of all this activity and regional growth, a large portion of Howard County remains rural with its western half made up of low-density housing and acres of farmland and natural resources, much of which is permanently preserved. The County's eastern half consists of higher density housing, including many apartment and townhome communities, and a significant number of jobs. The diversity of housing draws a diverse population made up of many races who speak a variety of languages.

Given the high quality of its school system, Howard County attracts many families with children. As a result, it has a higher proportion of families with children compare to Maryland and the U.S. However, like most places around the U.S., Howard County's population is rapidly aging, with increasing numbers of residents living alone and with disabilities.

This diversity in people and workers and household types, all of which are constantly changing over time, requires a flexible emergency response system. The leaders of OEM are keenly aware of this, and it is the goal of this Plan to put in place an emergency response system that will meet the needs of all County residents, job holders, and visitors.

Chapter 3: Planning Process

Requirements for the Planning Process

44 C.F.R. § 201.6(b): An open public involvement process is essential to the development of an effective plan. To develop a more comprehensive approach to reducing the effects of natural disasters, the planning process must include:

> (1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;
>
> (2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia, and other private and nonprofit interests to be involved in the planning process; and
>
> (3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.

44 C.F.R. § 201.6(c)(1): [The Hazard Mitigation Plan must include] documentation of the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.

44 C.F.R. § 201.6(d)(3): A local jurisdiction must review and revise its plan to reflect changes in development, progress in local mitigation efforts, and changes in priorities, and resubmit it for approval within 5 years in order to continue to be eligible for mitigation project grant funding.

What is Hazard Mitigation Planning?

A Hazard Mitigation Plan (HMP) is an all-encompassing plan that serves as a roadmap for a community's long-term strategy to reduce disaster losses and break the cycle of repeated destruction from all hazards. We refer to our all-encompassing plan as the HMP, and this includes the Natural Hazard Mitigation Plan (NHMP), and the following two annexes: Annex A: the Human-Caused Hazard Mitigation Plan (HCHMP), and Annex B: the Historical and Cultural Resources Mitigation Plan (HCRMP). This Plan is just the NHMP, which focuses on naturally occurring hazards and is required by FEMA to qualify for mitigation grant funding. The planning process used to develop an HMP involves risk-based decision making to reduce damage to people, property, and infrastructure from future disasters.

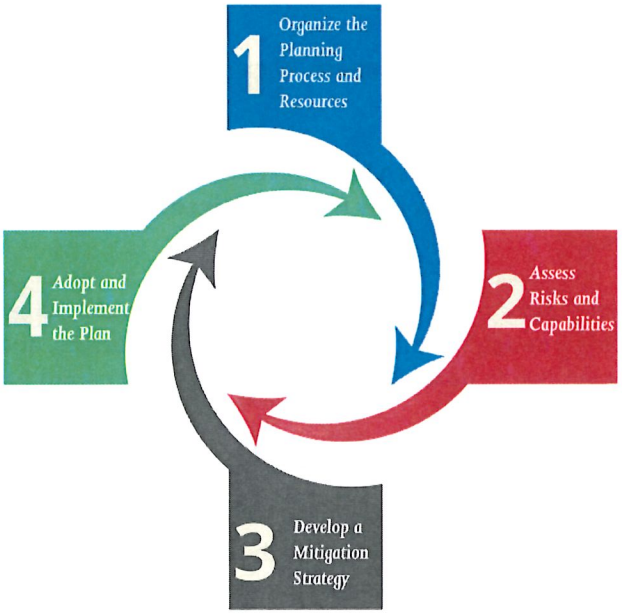
Hazard Mitigation Plan Update Process

Howard County first developed its NHMP in 2004 and has established its five-year planning cycle since conception. This iteration of the Plan will encompass the years 2024-2029. Howard County used an all-hazards approach when developing this Plan, which is a comprehensive and protective planning process. This Plan focuses on only natural hazards, but the County also developed and updated two other Annexes: Annex A: Human-Caused Hazards Mitigation Plan and Annex B: Cultural and Historical Hazard Mitigation Plan. The first Annex addresses human-caused hazards and the second addresses hazard that threaten cultural and historical elements in the County.

OEM began the 2024 Plan update in the fall of 2022 in coordination with and participation from internal and external stakeholders. OEM gathered supporting information from the County's 2023 HIRA update and integrated emerging trends in the causes and effects of natural hazards, such as the continuing threats of climate change and food insecurity in the 2022/2023 NHMP update. OEM adopted the same planning processes as required and defined by FEMA:[9]

- Organize the Planning Process and Resources;
- Assess Risks and Capabilities;
- Develop a Mitigation Strategy; and,
- Adopt and Implement the Plan.

FIGURE 26: HAZARD MITIGATION PLANNING PROCESS



Organize the Planning Process and Resources

Several entities at the local, State, and federal levels were involved in the planning process. Each of these groups was entrusted with specific responsibilities to ensure that outreach efforts were comprehensive and far-reaching.

- JSC NHMP/FMP – attendance at meetings, providing subject matter expertise, review of Plan sections and draft plan.
- Stakeholders – involvement in the NHMP's update progress via emails and through the County website.
- Public – plan input and attendance at the Public Outreach Meetings.
- Maryland Department of Emergency Management (MDEM) – plan review and approval.

[9] *Hazard Mitigation Planning Process*, FEMA, https://www.fema.gov/emergency-managers/risk-management/hazard-mitigation-planning/create-hazard-plan/process (last visited Feb. 10, 2023).

- FEMA – project funding, plan review, and approval.

Joint Steering Committee

This Committee is referred to as "Joint" since the same committee was used to update the FMP simultaneously. The JSC convened three times during the NHMP/FMP update process to review existing plans, update mitigation actions and goals, aid in developing new mitigation actions, and provide comments and feedback. The JSC is comprised of 52 representatives from several County departments, offices, and agencies as well as select County businesses and community representatives, such as the Columbia Association (CA), Howard EcoWorks, and Constellation Home (formerly BGE). The JSC is listed in detail in Appendix E: Detailed Joint Steering Committee List.

Multiple NHMP/FMP JSC meetings were held during the Plan update process to maximize participation and provide an integrated and efficient planning process. Copies of the agendas, sign-in sheets, and meeting summaries for all meetings are included in Appendix A: Meetings. All JSC members also received rough drafts to review throughout the process.

The first meeting was held on September 21, 2022, at the Howard County Emergency Operations Center (EOC) policy room in the Ligon Building in Ellicott City. OEM provided an overview of hazard mitigation planning, including the County's mitigation plans and annexes, federal mitigation funding, the planning process, the goals and objectives of hazard mitigation, the roles and responsibilities of JSC members, and OEM's milestone timeframe for the 2024 five-year update. After this introduction, the majority of the meeting focused on action item updates regarding natural hazard mitigation, human-caused hazard mitigation, and flood mitigation.

The second JSC meeting was held on February 1, 2023, at the County EOC. OEM updated the JSC on its progress updating the NHMP, including the status of each chapter. OEM recapped the first public meeting with a summary of the presentation and discussion. Next, OEM presented findings from the County's newly updated 2023 Hazard Identification and Risk Assessment (HIRA) and discussed the elements to be incorporated into the NHMP, such as the recalculated risk rankings and two additional hazards, space weather and pest infestation/zoonotic infection. After presenting the anticipated timeline for remaining NHMP update milestones, OEM reviewed the prioritization rubric that JSC members used to re-rank all hazard mitigation action items and to rank new items. OEM then provided an overview of highlights from the prioritizations. Finally, OEM led a discussion about the integration of other County plans into the NHMP, such as the forthcoming Climate Action Plan.

The third JSC meeting was held on April 19, 2023, in virtual format. OEM updated the JSC on recent public meetings about the Natural Hazard Mitigation Plan and Flood Mitigation Plan held on March 22, 2023, and March 29, 2023. Next OEM discussed the feedback from JSC members and from the public regarding drafts of both plans, and how this feedback was incorporated into the final drafts. OEM discussed the addition of several new action items, as well as their descriptions and prioritization in the Implementation Plan; no JSC members dissented to these items. OEM also discussed FEMA's regulatory requirements for Natural Hazard Mitigation Plan, and how the Plan includes a "Plan Review Checklist"

that identifies the sections and page numbers that satisfy each requirement. Finally, the JSC voted to approve both the NHMP and the FMP, authorizing their release to MDEM and FEMA for review.

Public Participation

Public input was solicited at three public meetings during the planning process. For the agendas and summaries of these meetings, please refer to Appendix D: Press Releases, Notices, and Public Participation.

This meeting was published through the Howard County Office of Public Information. All news releases went to local media outlets (TV, radio, and paper), as well as Howard County State Delegation. Additionally, the meeting notices were sent to fellow public information representatives in the HCPSS, Howard Community College (HCC), Howard County General Hospital (HCGH), etc. The meeting was also posted on the County's main social media pages.

In addition, the first draft was released for public comment on February 28, 2023, with the period ending on April 7, 2023. This was promoted on social media and through email distribution lists. In addition, an invitation to review was sent to the Baltimore Metropolitan Council, Offices of Emergency Management in Annapolis City, Anne Arundel County, Baltimore City, and Baltimore County. Please refer to Appendix D: Press Releases, Notices, and Public Participation to review this documentation.

Surveys

The Community Hazards Survey was developed for the HIRA to gather information from County's community members on their perception of natural hazard events and their confidence levels in their personal and communal readiness. The results of the surveys are published in Appendix B: Survey Results.

Additional short online surveys were developed for specific community meetings that OEM attended throughout the Plan update process. These meetings included the following:

- Howard County Rotary Club on January 13, 2023: OEM presented the survey as part of a community preparedness presentation. Participants were given access to the survey via physical copy (paper) and virtually (QR code and direct link).
- Oakland Mills Local Leadership Team 5th Annual Job and Career Fair on January 20, 2023: OEM set up a booth and provided participants with access to the survey via the same mechanisms detailed above.

Assess Risks and Capabilities

For this step, OEM reviewed data on local hazard events compiled in the 2023 HIRA. This information forms the basis for *Chapter 4: Hazard Identification, Profiling, and Risk Assessment* of the 2024 NHMP. Chapter 4 summarizes past occurrences, probability of future events, and estimates of potential losses due to identified hazards.

This NHMP also provides a general description of land uses and development trends in the County, so that mitigation options can be considered in future land use decisions. *Chapter 2: Community Profile*

describes land use in Howard County and *Chapter 5: Capability Assessment* includes a Plan Integration section that thoroughly reviews and analyzes current County plans and ordinances with consideration to hazard mitigation principles. This interdisciplinary approach enables Howard County to incorporate hazard mitigation principles into various County planning documents going forward.

Develop a Mitigation Strategy

In addition to a review and incorporation of hazard information from the 2023 HIRA, the JSC thoroughly examined and updated the 2018 NHMP and all associated annex goals and planned action items. Since the adoption of the initial Plan, several mitigation actions have been completed. As such, the JSC updated the prioritization of all action items by quantifying their life/safety impact, need for administrative or technical assistance, and project cost. This process is detailed further in *Chapter 6: Mitigation Strategy*. Further, with help from department representatives, the JSC considered the need for new/additional mitigation actions and projects to reduce the effects of hazards on the County.

The 2024 NHMP includes actions in the following six categories:

- Preventative Measures – Zoning, floodplain, stormwater, and other ordinances;
- Structural Projects – Levees, dams, reservoirs, and channel improvements;
- Property Protection – Relocation, floodproofing, and insurance;
- Emergency Services – Warning systems, sandbagging, evacuation routes;
- Natural Resource Protection – Wetlands protection, sediment erosion control, and other best management practices; and
- Public Outreach and Education – Outreach projects, environmental education, and technical assistance.

Adopt and Implement the Plan

Plan implementation is discussed in-depth in *Chapter 7: Plan Monitoring and Maintenance*. This Chapter describes the plan update process, plan distribution, plan monitoring and progress reports, circumstances that require plan review and update, benefit cost analysis, and continued public involvement. Moreover, plan funding and specific implementation of the mitigation actions items are discussed in *Chapter 6: Mitigation Strategy*.

Chapter 4: Hazard Identification, Profiling, and Risk Assessment

Requirements for Hazard Identification, Profiling, and Risk Assessments

Federal Authorities:

44 C.F.R. § 201.6(c)(2)(i): the plan must include "a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards." The "local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards," including:

> (i) A description of the type, location, and extent of all natural hazards that can affect the jurisdiction. The plan must include information on previous occurrences of hazard events and on the probability of future hazard events.
> (ii) A description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description must include an overall summary of each hazard and its impact on the community. All plans approved after October 1, 2008, must also address NFIP insured structures that have been repetitively damaged by floods. The plan should describe vulnerability in terms of:
>
> > (A) The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas;
> > (B) An estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate;
> > (C) Providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

Hazard Identification

Methodology for Hazard Identification

Hazard Identification and Risk Assessment Steering Committee

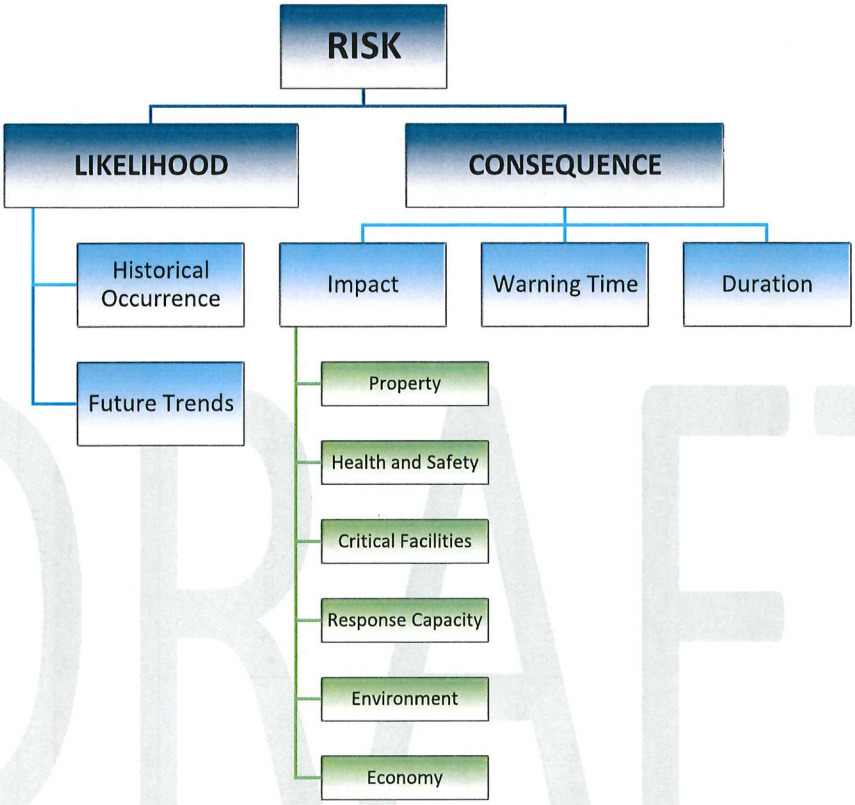
The County's 2023 Hazard Identification and Risk Analysis (HIRA) identified eleven natural hazards facing the County and assigned risk scores to each one for both the most likely scenario and least likely scenario. Development of the 2023 HIRA was guided by a multidisciplinary steering committee, which utilized guidance from literature, industry accreditation standards, model programs, federal documents, a public survey, and Subject Matter Experts (SMEs) to craft an assessment that met or exceeded industry standards while remaining relevant and specific to the Howard County context.

Risk Formula

Risk is most easily understood by analyzing the component parts of risk. The HIRA defines the components of risk in the following manner: Risk is a function of *Likelihood* and *Consequence*. Likelihood is defined by historical occurrence and future trends. Consequence is defined by Warning Time,

Duration, and Impact. Impact itself is defined by impacts to Property, Health and Safety, Critical Facilities, Response Capacity, the Environment, the Economy, and Standard of Living/Quality of Life. The chart below demonstrates this relationship visually:

FIGURE 27: RISK FORMULA



In summary, the HIRA Steering Committee used the following formula to determine the risk score for each identified hazard: RISK = LIKELIHOOD * CONSEQUENCE.

Howard County Risk Tool

After the HIRA Steering Committee selected the hazards, the Howard County Risk Tool was used to convert hazard information into a set of numerical scores that allow for comparison across many hazard types. Every hazard is assigned a numerical score in each of the four risk assessment categories: Likelihood, Impact, Warning Time, and Duration. Numerical scores range from one to four based on criteria that are defined explicitly in the tool. The scores from each section are multiplied by the assigned weighting factor. Likelihood is weighted at 50% of the Risk Score. Consequence is made up of Impact (40%), Warning Time (5%), and Duration (5%) for a combined total of 50% of the Risk Score. Once multiplied by the weighting factor, the sum of the scores becomes the total Risk Score for the hazard. The Howard County Risk Tool can be seen on the next page.

HOWARD COUNTY RISK TOOL

LIKELIHOOD FACTORS

LIKELIHOOD

Estimated chance of a single hazard event occurring in a given year based on historical incidence and trend forecasting.

UNLIKELY (1)	INFREQUENT (2)	LIKELY (3)	VERY LIKELY (4)
No documented occurrence. Less than 1% chance of annual occurrence.	1-10% chance of annual occurrence.	11-30% chance of annual occurrence.	30+% chance of occurrence annually.

CONSEQUENCE FACTORS

IMPACT

Estimated effect of a single hazard event on property, health and safety, critical facility functioning, response capacity, the environment, the economy, and standard of living.

LIMITED (1)	SIGNIFICANT (2)	CRITICAL (3)	CATASTROPHIC (4)
▪ Property damage is less than 5% of critical and non-critical infrastructure. ▪ Injuries are manageable with existing resources, no fatalities. ▪ Shutdown of critical facilities for less than 24 hours. ▪ Local resources are adequate to support the response. ▪ Little to no environmental impact. ▪ Little to no economic impact. ▪ Standard of living is only minimally disrupted.	▪ Property damage is 5-25% of critical and non-critical infrastructure. ▪ Injuries are manageable, may include at least one death. ▪ Critical facilities are down for 1-7 days. ▪ Local and mutual aid resources are adequate to perform response, with limited or no state assistance. ▪ Moderate environmental impact. ▪ Moderate economic impact. ▪ Standard of living is moderately affected.	▪ Property damage is between 26-50% of critical and non-critical infrastructure. ▪ Multiple deaths and serious injuries are probable. ▪ Shut down of critical facilities 1-4 weeks. ▪ Local resources are expended and require sustained support from mutual aid partners and/or the state/federal government. ▪ Serious environmental impact. ▪ Serious economic impact. ▪ Standard of living is seriously affected.	▪ Property damage is severe, greater than 50% of critical and non-critical infrastructure affected. ▪ Multiple deaths and serious injuries exceed jurisdiction response capacity. ▪ Shut down of critical facilities will be more than one month. ▪ Response capacity is overwhelmed and requires significant and long-lasting state and federal government support. ▪ Severe environmental impact. ▪ Severe economic impact. ▪ Standard of living is extremely impacted and may not be fully recoverable.

WARNING TIME

Estimated time of awareness prior to the onset of the hazard event.

VERY LONG (1)	LONG (2)	MODERATE (3)	SHORT (4)
More than 24 hours	12-24 hours	6-12 hours	Less than six hours

DURATION *Estimated time from onset to conclusion of the hazard event.*			
SHORT (1)	MODERATE (2)	LONG (3)	VERY LONG (4)
Less than six hours	6-24 hours	Less than one week	More than one week
RISK SCORE WEIGHTING			
LIKELIHOOD	IMPACT	WARNING TIME	DURATION
[50%]	[40%]	[5%]	[5%]
			
RISK = LIKELIHOOD + CONSEQUENCE			

Consequence Analysis Tables

In this chapter, each hazard's impacts are broken down into a Consequence Analysis Table. This table provides a detailed description of the hazard's anticipated impact to property, health and safety, critical facilities, response capacity, the environment, and the local economy. Each consequence sub-category is assigned a descriptive level to coincide with the associated score as specified in the Risk Tool. The information in this table reflects the data and experience of SMEs in each respective field.

Consequence Analysis Likely				
CATEGORY	**RANKING**	**DESCRIPTION**		
PROPERTY DAMAGE	*Limited*	▪ 0% damage to critical and non-critical infrastructure.		
HEALTH and SAFETY	*Limited*	▪ Zero deaths likely. ▪ 20 injuries likely		
CRITICAL FACILITIES	*Limited*	▪ *Utilities* – Shutdown unlikely. No effect on utilities. ▪ *Information/Communications* – Shutdown unlikely. ▪ *Transportation* – Traffic delays for less than one day.		
RESPONSE CAPACITY	*Significant*	▪ *Police* – Mutual aid needed. No great impact to response capability. ▪ *Fire and Rescue* – Moderate need for state or federal assistance. ▪ *Health* – Local resources adequate. Health Department operations will not be affected. ▪ *Hospitals* – Local resources adequate. No impact on the hospital system. ▪ *Emergency Management* – Local resources adequate.		
ENVIRONMENTAL IMPACT	*Limited*	▪ Limited to no environmental impact. Less than a day of clean-up.		
ECONOMIC IMPACT	*Limited*	▪ Minimal loss of economic output due to the limited area affected. ▪ Temporary business disruption in the area of the attack. Damage to image possible.		
TOTAL IMPACT[10]	***Limited***	▪ **Total Impact Score: 1 on a scale of 1 (Limited) to 4 (Catastrophic).**		
Limited		*Significant*	*Critical*	*Catastrophic*

- **Property Damage** details the anticipated percentage of Howard County critical and non-critical infrastructure that will suffer damage from the hazard and the type of damage that is expected.
- **Health and Safety** details the number of deaths and injuries that are expected to result from the hazard and the types of deaths and injuries that are expected.
- **Critical Facilities** details the expected shutdown duration of essential functions. Utilities, information/communication, and transportation are each assigned a descriptive level to coincide with the associated score as specified in the Risk Tool.

[10] The total impact score is created by Subject Matter Experts weighing the importance of the economic impact, environmental impact, response capacity, critical facilities, health / safety, and property damage for each hazard. These factors are weighed differently, depending on the specific hazard. The subject matter experts were divided into groups where they created one total score per hazard. Those individual scores were then averaged together to create the total impact score you see on the graph.

- **Response Capacity** details the expected shutdown duration of essential response functions. Police, fire and rescue, health, hospitals, and emergency management are each assigned a descriptive level to coincide with the associated score as specified in the Risk Tool.
- **Environmental Impact** details the hazard's expected impact to the environment.
- **Economic Impact** details the hazard's impact to the economy of Howard County. Loss of economic output and job loss refer only to the hazard's anticipated effect on the gross domestic product of the jurisdiction as calculated by SME analysis. Information in this section does not include the costs associated with cleanup or healthcare for those affected.
- **The Total Impact Score** was determined by SME teams through extensive consideration of Consequence Analysis data and specifications outlined in the Risk Tool.

Final Risk Scores

The table below shows the new Risk Scores for each identified natural hazard. The Most-Likely score is for the Likely Hazard Scenario, which refers to the emergency-level hazard scenario that is most likely to occur within the County. An emergency-level hazard is any hazard that requires a response from at least two agencies. The Least Likely score is for the Worst-Case Hazard Scenario, which refers to the worst hazard scenario that could reasonably occur within the County.

FIGURE 28: MOST-LIKELY SCENARIO RISK SCORES FROM 2023 HIRA

Hazard	Most Likely Risk Score	Least Likely Risk Score
Extreme Temperature	2.6	3.1
Lightning	2.6	3.0
Severe Winter Weather	2.3	3.0
Flood	2.3	2.9
Tornado	2.1	2.9
Drought	2.0	2.5
Hurricane/Tropical Cyclone	1.8	2.6
Wildfire	1.7	2.1
Earthquake	1.7	2.8
Space Weather	1.3	2.0
Pest Infestation/ Zoonotic Infection	1.2	1.3

In accordance with FEMA requirements, this Chapter profiles each of the hazards listed above (in order of Most Likely Risk Score) and addresses the County's vulnerabilities to these hazards and estimates the expected losses from their occurrences. There will be more data on certain hazards compared to others depending on records kept. For example, there will be a more in-depth analysis of the flood hazard that is drawn from Howard County's 2023 FMP.

Overview of Howard County's Natural Hazards History

This NHMP update uses the best available data to identify, describe, and explain the potential severity and extent of the impact of each hazard. While numerous agencies maintain records regarding natural hazard losses, no single source provides a definitive account of losses due to natural hazards. Although the data from different sources may not always align, this NHMP update relies heavily on data from the National Oceanic Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC), the 2023 Howard County HIRA, and FEMA guidance. By analyzing this data, this Plan paints a comprehensive picture of the extent, severity, and impact a natural hazard event may have on the County.

To begin, this section will provide an overview of the presidentially declared emergency declarations and major disaster declarations in Howard County. When the magnitude of an incident exceeds the state's capability to respond and supplemental federal assistance is necessary to support response activities, the Governor may request a Presidential Disaster Declaration (PDD). These declarations result in the distribution of a wide range of federal aid to individuals and families, certain private nonprofit organizations, and public agencies.

The Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988 (the Stafford Act) establishes a systematic way for a PDD to trigger financial and physical assistance for States and local jurisdictions. It is at the President's discretion to issue either a Major Disaster Declaration or an Emergency Declaration during an emergency. Both declaration types authorize the President to provide supplemental federal disaster assistance; however, the events related to the two different types of declaration and scope and amount of assistance differ. For example, major disaster declarations include hazard mitigation assistance, but emergency declarations do not; however, both declarations include Public Assistance (PA) programs and Individual Assistance (IA) programs. As part of the documentation process, FEMA maintains records of these types of declarations, along with federal expenditure records, on its website.[3]

The table below provides a summary of the past Emergency Declarations for the County, in which two have been severe winter weather related, and three have been hurricane/tropical cyclone related.

EMERGENCY DECLARATIONS IN HOWARD COUNTY (1993 TO 2022)[11]		
FEMA DISASTER # DATE	**EVENT TYPE**	**EVENT DESCRIPTION**
FEMA EM-3100 3/16/1993	Winter Storm	From March 13 - March 17, 1993, a snowstorm hit the State of Maryland. All counties in Maryland were eligible for FEMA PA (Category B – Emergency Protective Measures).
FEMA EM-3179 3/14/2003	Winter Storm	From February 14 -18, 2003, a storm bought three waves of wintery precipitation. Snowfall totals ranged from 20 to 32 inches across

[11] *Disaster Information*, FEMA, https://www.fema.gov/disaster (last accessed Feb. 27, 2023).

EMERGENCY DECLARATIONS IN HOWARD COUNTY (1993 TO 2022)[11]		
FEMA DISASTER # DATE	**EVENT TYPE**	**EVENT DESCRIPTION**
		northern and central Maryland and the Baltimore Metropolitan area. This was the heaviest snowfall event in the Baltimore region since records began in 1870 (the record will not be broken until the 2010 snowstorms).
FEMA EM-3251 9/13/2005	Hurricane Katrina Evacuation	Between August 29, 2005, and October 1, 2005, an Emergency was declared for the State of Maryland. This Emergency Declaration provided federal aid to State and local response efforts to assist evacuees after Hurricane Katrina.
FEMA EM-3335 8/27/2011	Hurricane Irene	DR-3335 was issued as a response to Hurricane Irene making landfall on the east coast, which brought tropical storm force winds and torrential rains to the region. While no IA was available, almost all Maryland counties with the exception of Garrett County, were eligible for FEMA PA (Category B – Emergency Protective Measures).
FEMA EM-3349 10/28/2012	Hurricane Sandy	From October 26, 2012 - November 8, 2012, an Emergency was declared for the State of Maryland in anticipation of Hurricane Sandy. A power outage at a water treatment plant in Howard County resulted in the release of wastewater. Water contamination became a significant threat to health and the environment for 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.

Howard County has received 16 Major Disaster Declarations since 1962, which are summarized in the table below. Of the 16, seven were severe winter weather events, four were flooding/severe storm-related events, and five were hurricanes/tropical storm events. These figures and events are discussed in more details in the hazard specific subsections that follow.

MAJOR DISASTER DECLARATION IN HOWARD COUNTY (1962 TO 2022)[12]		
FEMA DISASTER # DATE	**EVENT TYPE**	**EVENT DESCRIPTION**
FEMA DR-127 3/12/1962	Severe storms/flooding	No information available.
FEMA DR-309 8/17/1971	Severe storms/flooding	On August 17, 1971, storms caused flooding to the Baltimore and Washington, D.C. metropolitan regions. Declarations were made for local jurisdictions from Harford County to Prince George's County for FEMA PA (Category B – Emergency Protective Measures).
FEMA DR-341 6/23/1972	Tropical Storm Agnes	Hurricane Agnes made landfall on the Florida Panhandle and traveled northwestward, bringing with it strong winds and heavy

[12] *Disaster Information*, FEMA, https://www.fema.gov/disaster (last accessed Feb. 27, 2023).

		rains. The Patuxent, Little Patuxent, and Patapsco Rivers all exceeded their 100-year flood levels. Eight people were killed, and 700 families were left unhoused.
FEMA DR-489 10/4/1975	Heavy rains/flooding	On October 4, 1975, heavy rains caused flooding and 14 counties were declared for FEMA PA (Category B - Emergency Protective Measures).
FEMA-DR-1081 1/11/1996	Blizzard	A winter storm known as the "Blizzard of '96" crippled most of Maryland during the first weekend of January 1996. In general, snow totals were as follows: 20 inches in lower southern Maryland, 20 to 26 inches in central Maryland to include Howard County, and 26 to 36 inches over the northern tier.
FEMA DR-1324 4/10/2000	Winter Storm	A low-pressure system off Cape Hatteras rapidly intensified on January 24, 2000. The storm soon developed into a nor'easter and began to track northward along the eastern shoreline. On January 25, 2000, the storm brought snowfall totals ranging from one inch to 20 inches across the State. The higher amounts of snow occurred around the Chesapeake Bay. A total of 11.5 inches of snow fell in Columbia, Maryland.
FEMA DR-1492 9/19/2003	Hurricane Isabel	On September 18, 2003, Hurricane Isabel made landfall on the North Carolina coast. Isabel raced inland, bringing rain and wind. The storm did not cause major flooding; however, many trees were toppled from the wind combined with the saturated ground. At one point, over 50% of the County was without power. Five homes suffered major damage and another eight suffered minor damage.
FEMA DR-1875 2/19/2010	Winter Storm	This was the first of two major blizzards that occurred during the 2009-2010 winter. On December 18, 2009, two low pressure systems merged to form a strong low-pressure system over the Mid-Atlantic. The new low was able to gather moisture from the Gulf of Mexico and the Atlantic Ocean, while the high-pressure system to the north kept the cold air in place. From December 18-20, 2009, between 14 and 17 inches of snow fell across the County.
FEMA DR-1910 5/5/2010	Winter Storms	On April 8, 2010, Governor Martin O'Malley requested a major disaster declaration due to severe winter storms and snowstorms during the period of February 5-11, 2010. The Governor requested a declaration for PA, including snow removal assistance; Crisis Counseling and Disaster Unemployment Assistance under the IA program; and Hazard Mitigation for all 24 jurisdictions in the state. During the period of March 22-April 7, 2010, joint federal, State, and local Preliminary Damage Assessments (PDAs) were conducted in the requested counties and are summarized below.
FEMA DR-4034 9/16/2011	Hurricane Irene	Hurricane Irene left more than 700,000 Marylanders without power. Damages were estimated at approximately $16 million, with the most severe damages occurring in the eastern and southern portion of the State. A Presidential Disaster Declaration (FEMA-DR-4034) was declared for 13 of the 24 counties and all

		Maryland jurisdictions were eligible for the Hazard Mitigation Grant Program (HMGP).
FEMA DR-4038 10/05/2011	Remnants of Tropical Storm Lee	Following Tropical Storm Lee, assessments show Howard County suffered approximately $2 million worth of damage. Main Street in Historic Ellicott City was severely flooded, where 16 homes in the area sustained flood damage of various degrees. The Presidential Disaster Declaration (FEMA-DR-4038) was declared for the following counties: Anne Arundel, Baltimore County, Cecil County, Charles County, Harford County, Howard County, and Prince George's County.
FEMA DR-4091 11/20/2012	Hurricane Sandy	An Emergency Declaration had already been issued for the State on October 28, 2012. A power outage at a water treatment plant resulted in the release of wastewater. Water contamination became a significant threat to health and the environment for those downstream from the plant. Water mains feeding Howard County from the City of Baltimore failed, and the drinking water supply were limited for a period of one to two weeks. On November 20, 2012, President Obama declared that a major disaster exists in the State of Maryland. The Presidential Disaster Declaration (FEMA-DR-4091) was declared for the following counties: Allegany, Calvert, Caroline, Charles, Dorchester, Frederick, Garrett, Harford, Howard, Kent, Queen Anne's, Somerset, St. Mary's, Talbot, Washington, Wicomico, and Worcester Counties and the Independent City of Baltimore.
FEMA DR-4170 4/10/2014	Maryland Snowstorm	On April 10, 2014, following a severe snowstorm, President Obama declared that a major disaster for Maryland. This declaration made emergency protective measures (Category B), including snow assistance under the PA program available to State and eligible local governments and certain private nonprofit organizations on a cost-sharing basis for emergency work due to the snowstorm. The Presidential Disaster Declaration (FEMA-DR-4170) was declared for the following counties: Baltimore, Carroll, and Howard Counties.
FEMA DR-4261 3/4/2016	Maryland Severe Winter Storm and Snowstorm	The Presidential Disaster Declaration (FEMA-DR-4261) was declared on March 4, 2016, for the following counties: Allegany, Anne Arundel, Baltimore, Calvert, Caroline, Carroll, Cecil, Charles, Frederick, Garrett, Harford, Howard, Kent, Montgomery, Prince George's, Queen Anne's, Washington, and Worcester Counties and the Independent City of Baltimore. This declaration also authorized snow assistance for a period of 48 hours for the counties of Allegany, Anne Arundel, Baltimore, Calvert, Caroline, Carroll, Cecil, Charles, Frederick, Garrett, Harford, Howard, Kent, Montgomery, Prince George's, Queen Anne's, and Washington and the Independent City of Baltimore.

FEMA DR-4279 9/16/2016	Maryland Severe Storm and Flooding	A significant flooding event occurred on July 30, 2016, when a strong storm dropped six inches of rain over Ellicott City over a span of two hours. Massive flooding caused extensive damage to businesses and homes on Main Street in Old Town, Ellicott City. The July 2016 storm took two lives and caused at least $22.4 million in estimated damages and caused extensive damage to 90 businesses and 107 homes. On September 16, 2016, President Obama declared that a major disaster exists in the State of Maryland.
FEMA DR-4376 7/2/2018	Maryland Severe Storm and Flooding	A flash flooding event occurred on May 27, 2018, when a strong storm dropped eight to 10 inches of rain over Ellicott City in a span of five hours. The rapid floodwaters took one life and caused extensive damage to businesses and homes on Main Street in Old Town, Ellicott City.

Overall Losses Due to Major Disasters

According to the NCDC database, Howard County has experienced four deaths and seven injuries from natural hazards from January of 1950 through November of 2022.[13] Property damage from these natural hazards is estimated at slightly less than $41 million, with no accounting for inflation. Crop damage during the same period is estimated to be roughly $12,000.

As discussed above, no definitive record exists for all losses due to natural disasters in Howard County. In the United States, depending on the type of disaster, estimates for public and private costs of natural hazards range from $2.3 billion to $21 billion per event, according to the National Centers for Environmental Information.[14] In most declared disasters, the Federal government reimburses 75% of the cleanup and recovery costs, whereas the remaining 25% is covered by the State and affected local jurisdictions.

[13] *Storm Events Database*, NOAA NAT'L CTRS. FOR ENVTL. INFO., https://www.ncdc.noaa.gov/stormevents/ (last visited Feb. 27, 2023).

[14] *U.S. Billion-Dollar Weather and Climate Disasters,* NOAA NAT'L CTRS. FOR ENVTL. INFO., https://www.ncdc.noaa.gov/billions/ (last visited Feb. 27, 2023).

The estimated damages for the above listed major disasters are summarized in the table below.

ESTIMATED DAMAGES FOR FEDERALLY DECLARED DISASTERS IN HOWARD COUNTY, MARYLAND (1965 TO 2022)[15]			
FEMA DISASTER #	**EVENT DECLARATION DATE**	**EVENT TYPE**	**TOTAL ASSISTANCE OBLIGATED**
FEMA DR-127	3/12/1962	Severe storms/flooding	No Information available
FEMA DR-309	8/17/1971	Severe storms/flooding	$14,925,339
FEMA DR-341	6/23/1972	Tropical Storm Agnes	$117,161,571
FEMA DR-489	10/4/1975	Heavy rains/flooding	$6,112,771
FEMA DR-1081	1/11/1996	Blizzard	No information available
FEMA DR-1324	4/10/2000	Winter storm	$16,744,243
FEMA DR-1492	9/19/2003	Hurricane Isabel	No information available
FEMA DR-1875	2/19/2005	Winter storm	No information available
FEMA DR-1910	5/5/2010	Winter storms	$38,565,855
FEMA DR-4034	9/16/2011	Hurricane Irene	$18,290,538
FEMA DR-4038	10/05/2011	Remnants of Hurricane Irene	$25,302,710
FEMA DR-4091	11/20/2012	Hurricane Sandy	$32,974,192.47
FEMA DR-4170	4/10/2014	Maryland Snowstorm	$8,701,290.63
FEMA DR-4261	3/4/2016	Maryland Severe Winter Storm and Snowstorm	$69,605,697.91
FEMA DR-4279	7/30/2016	Maryland Severe Storm and Flooding	$7,079,614.80
FEMA DR-4376	5/27/2018	Maryland Severe Storm and Flooding	$22,000,000.00

Please note that the "Total Assistance Obligated" is for the entire declared disaster area, not for individual counties or jurisdictions affected and may only represent initial estimates, and not modified or up to date obligations.

Risk Analysis and Assessment

In this section, the eleven hazards will be described in order of their most-likely risk scores, starting with the highest risk score. Each hazard section will be organized in the following order:

- Hazard Description;
- Hazard Location;
- Hazard Extent;
- Hazard Impacts;
- Hazard Previous Occurrences; and,
- Hazard Future Likelihood.

[15] *Disaster Information*, FEMA, https://www.fema.gov/disaster (last visited Feb. 27, 2023).

Future likelihood will be broken into high, medium, and low probability for each hazard. The table below defines probability of each category in terms of its likelihood of future occurrence.

PROBABILITY	DEFINITION
High	Event is likely to occur more than once every five years
Medium	Event is likely to occur less than once every five years, but more often than once every 30 years
Low	Event is likely to occur less than once every 30 years

Extreme Temperature (Risk Score 2.6)

Hazard Description

An Extreme Temperature Hazard is the result of either extremely high or extremely low temperature variations. This hazard can present as either extreme heat or extreme cold hazards. Other environmental factors, such as wind speed or humidity, also factor into the impacts of the environment on the human body.

Generally, extreme heat "is a period of high heat and humidity with temperatures above 90°F for at least two to three days".[16] Extreme heat is a function of air temperature and humidity, which can exacerbate the impacts of high air temperatures. Exposure to direct sunlight also adds heat stress. Prolonged exposure to extreme heat can result in dehydration, heat exhaustion, and heat stroke, which can lead to death. Extreme cold conditions are generally those temperatures that approach freezing or below. Extreme cold is measured in wind chill, a function of air temperature and wind speed, that reflects how the human body perceives the cold. The most common injuries resulting from extreme cold exposure are hypothermia and frostbite. Prolonged hypothermia left untreated can result in death.

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

Extreme Temperature - Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	4 Very Likely		50%
CONSEQUENCE	**Impact**	1 Limited	2.3 Significant-Critical	40%
	Warning Time	1 Very Long	1 Very Long	5%
	Duration	2 Moderate	3 Long	5%
	TOTAL RISK SCORE	**2.6**	**3.1**	

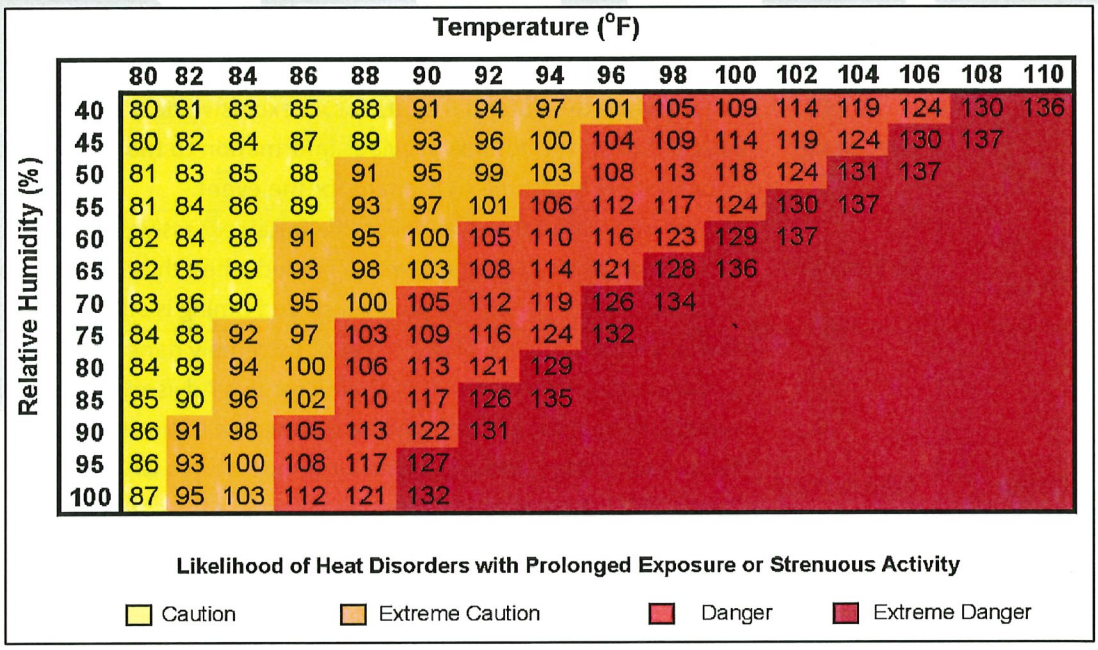
[16] *Extreme Heat*, READY, https://www.ready.gov/heat (last visited Feb. 27, 2023).

Hazard Location

All of Howard County is susceptible to an extreme temperature hazard. As Howard County has a generally mild climate, less extreme temperature variations may produce an extreme temperature hazard, as Howard County is not as accustomed to those extremes.

Hazard Extent

The severity of extreme temperature events is measured by temperature, duration, and humidity. Most events last for less than a week on average. In Northeastern United States, periods of warmer than normal temperatures typically occur several times over a single summer. Extreme heat waves may occur about once every five years. The passing of a cold front usually moderates temperatures after a few days to a week. However, it is expected that the duration and frequency of such events will increase in the coming years due to climate change and overall warming trends[17]. Below is NOAA's Heat Index for determining "apparent temperature."



Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

[17] *Climate Change and Extreme Heat: What You Can Do to Prepare, Environmental Protection Agency, https://www.epa.gov/sites/default/files/2016-10/documents/extreme-heat-guidebook.pdf, (last accessed July 27, 2023).*

The next graphic depicts the National Weather Service's (NWS) description of each of the above classifications.

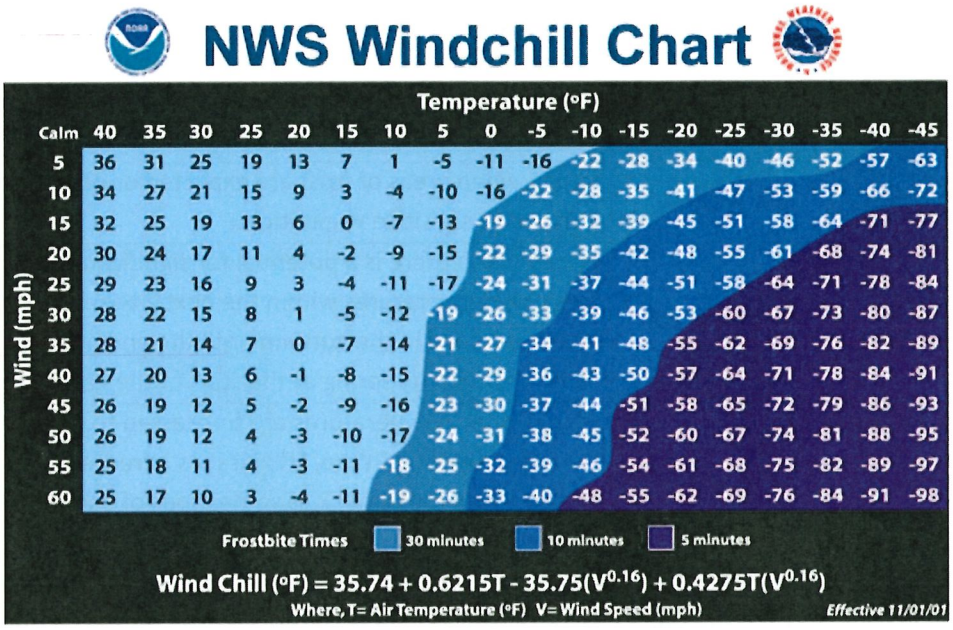
Classification	Heat Index	Effect on the body
Caution	80°F - 90°F	Fatigue possible with prolonged exposure and/or physical activity
Extreme Caution	90°F - 103°F	Heat stroke, heat cramps, or heat exhaustion possible with prolonged exposure and/or physical activity
Danger	103°F - 124°F	Heat cramps or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity
Extreme Danger	125°F or higher	Heat stroke highly likely

When temperatures rise to these levels, the NWS issues three types of watches, warnings, and advisories to the public depending on the heat index value[18].

Type of Product	Call to Action	Description
Excessive Heat Outlook	Be Aware!	Issued when the potential exists for an excessive heat event in the next 3-7 days. An Outlook provides information to those who need considerable lead-time to prepare for the event.
Excessive Heat Watch	Be Prepared!	Issued when conditions are favorable for an excessive heat event in the next 24 to 72 hours. A watch is used when the risk of a heat wave has increased but its occurrence and timing is still uncertain.
Heat Advisory	Take Action!	Issued within 12 hours of the onset of extremely dangerous heat conditions. The general rule of thumb for this Advisory is when the maximum heat index temperature is expected to be 100° or higher for at least 2 days, and nighttime air temperatures will not drop below 75°; however, these criteria vary across the country, especially for areas that are not used to dangerous heat conditions. Take precautions to avoid heat illness. If you don't take precautions, you may become seriously ill or even die.
Excessive Heat Warning	Take Action!	Issued within 12 hours of the onset of extremely dangerous heat conditions. The general rule of thumb for this Warning is when the maximum heat index temperature is expected to be 105° or higher for at least 2 days and nighttime air temperatures will not drop below 75°; however, these criteria vary across the country, especially for areas not used to extreme heat conditions. If you don't take precautions immediately when conditions are extreme, you may become seriously ill or even die.

[18] *Heat Watch vs. Warning, National Weather Service, https://www.weather.gov/safety/heat-ww, (last accessed July 27, 2023).*

The severity or extent of extreme cold temperatures can be measured using NWS's Windchill Chart. This chart helps the public determine the exposure time to certain temperatures that can be dangerous. This chart "takes into account heat loss from the human body to its surroundings during cold and windy weather. The calculation utilizes wind speed in miles per hour and temperatures in degrees Fahrenheit"[19].



By looking at this chart, jurisdictions and the public can see how long it takes to reach frostbite when being exposed to certain wind speeds and temperatures.

When temperatures drop to certain levels, NWS will issue certain advisories, warnings, and watches. The table below summarizes these messages[20].

Type of Product	Call to Action	Description
Wind Chill Advisory	**Be Aware!**	Issued when seasonably cold wind chill values but not extremely cold values are expected or occurring. Be sure you and your loved ones are dress appropriately and cover exposed skin when venturing outdoors.
Wind Chill Watch	**Be Prepared!**	Issued when dangerously cold wind chill values are possible. As with a warning, adjust your plans to avoid being outside during the coldest parts of the day. Make sure your car has

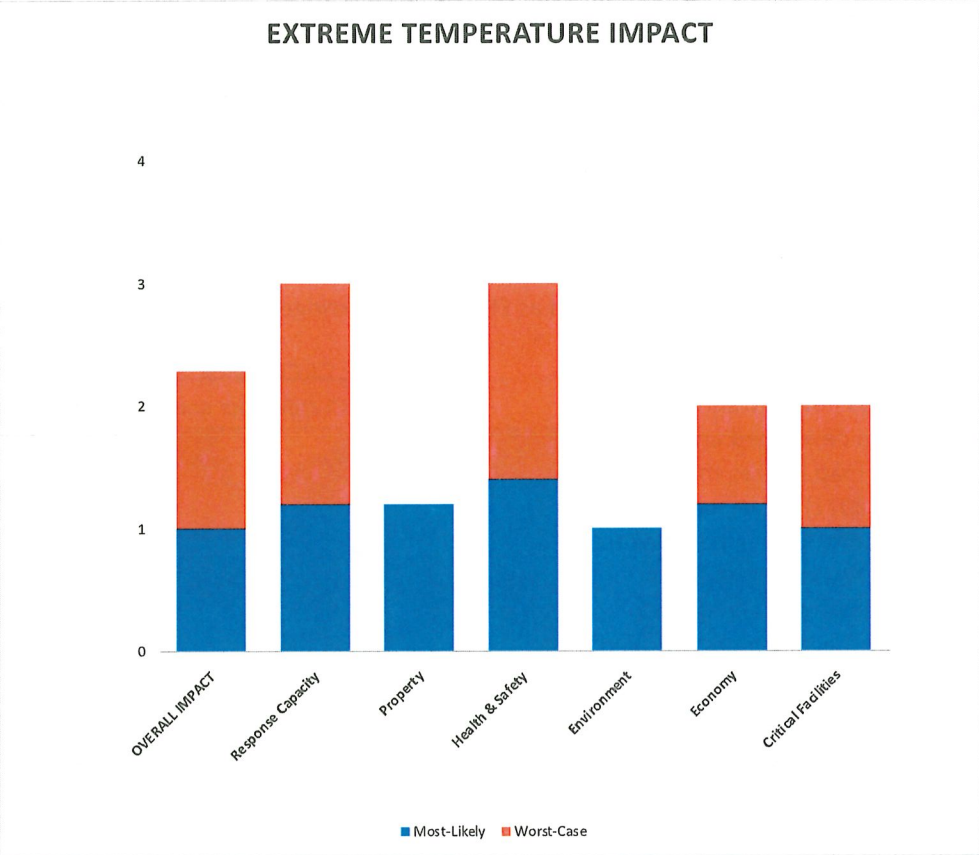
[19] *Wind Chill Safety, National Weather Service, https://www.weather.gov/bou/windchill, (last accessed July 27, 2023).*

[20] *Wind Chill Warning vs. Watch, National Weather Service, https://www.weather.gov/safety/cold-wind-chill-warning, (last accessed July 27, 2023).*

		at least a half a tank of gas and update your winter survival kit.
Wind Chill Warning	**Take Action!**	Issued when dangerously cold wind chill values are expected or occurring. If you are in an area with a wind chill warning, avoid going outside during the coldest parts of the day. If you do go outside, dress in layers, cover exposed skin, and make sure at least one other person knows your whereabouts. Update them when you arrive safely at your destination.
Frost Advisory	**Be Aware!**	Issued when areas of frost are expected or occurring, posing a threat to sensitive vegetation.
Freeze Watch	**Be Prepared!**	Issued when there is a potential for significant, widespread freezing temperatures within the next 24-36 hours. A freeze watch is issued in the autumn until the end of the growing season and in the spring at the start of the growing season.
Freeze Warning	**Take Action!**	Issued when temperatures are forecasted to go below 32°F for a long period of time, NWS issues a freeze warning. This temperature threshold kills some types of commercial crops and residential plants.
Hard Freeze Warning	**Take Action!**	Issued when temperatures are expected to drop below 28°F for an extended period of time, killing most types of commercial crops and residential plants.

Hazard Impacts

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



Extreme Temperature - Consequence Analysis Likely		
CATEGORY	**RANKING**	**DESCRIPTION**
PROPERTY DAMAGE	*Limited-Significant*	▪ Critical and non-critical infrastructure are not significantly damaged. ▪ Some frozen pipes may result in facilities being inaccessible/inoperable.
HEALTH AND SAFETY	*Limited-Significant*	▪ Zero to three deaths are expected. Cold exposure is particularly concerning among vulnerable populations. ▪ Zero to ten injuries are expected. Frostbite and hypothermia are likely causes of injuries.
CRITICAL FACILITIES	*Limited*	▪ Utilities – Some water lines may freeze and/or burst. Localized power outages likely. Other outages unlikely. ▪ *Information/Communications* – No shutdown. No major impact on information or communications infrastructure. ▪ *Transportation* – Minor impacts to support shelter transportations.
RESPONSE CAPACITY	*Limited-Significant*	▪ *Police* – Local resources adequate. ▪ *Fire and Rescue* – Local resources adequate. Potential delays in response times, due to increased calls for service. ▪ *Health* – Local resources adequate. Enhanced messaging to support vulnerable populations. ▪ *Public Works* – Local resources adequate.

ENVIRONMENTAL IMPACT	*Limited*	▪ Minimal environmental impact on air, water, and land is expected.		
ECONOMIC IMPACT	*Limited-Significant*	▪ Business-school closings likely. Some reduced economic output expected.		
TOTAL IMPACT	***Limited***	▪ **Total Impact Score: 1 on a scale of 1 (Limited) to 4 (Catastrophic).**		
Limited		*Significant*	*Critical*	*Catastrophic*

Vulnerability of County Assets

All Howard County is susceptible to extreme temperatures, whether that be extreme cold or extreme heat. Assets that are vulnerable are the following:

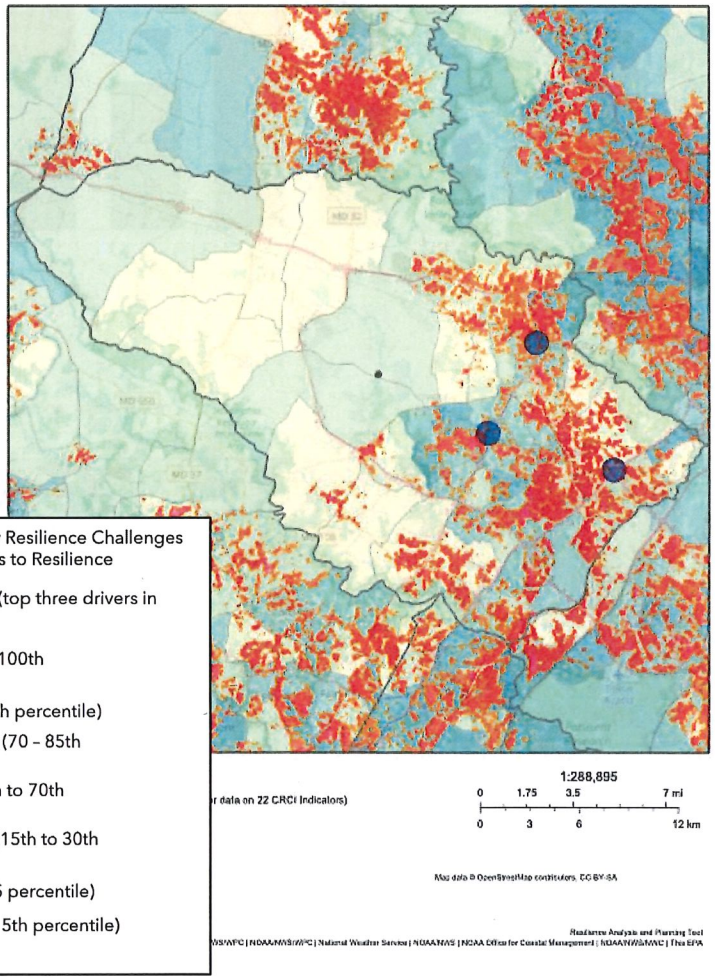
People

- People living in population centers, such as Ellicott City, Elkridge, and Columbia; and,
- People with challenges to resilience.

The map below shows how extreme heat typically affects more developed areas with less vegetation. This map utilizes the Heat Severity in the USA (2021) layer[21] combined with FEMA's Community Resilience Index to show areas of high heat as well as those population that have more challenges to resilience. To review the indicators included in this index, please refer to Chapter 2, section FEMA Community Resilience Index. Population centers are further highlighted below with purple circles. As can be seen in the map below, the severe heat areas fall in areas of Howard County with medium to medium-high challenges to resilience.

FIGURE 29: CRCI INDICATORS & HEAT SEVERITY

CRCI indicators and Heat Severity

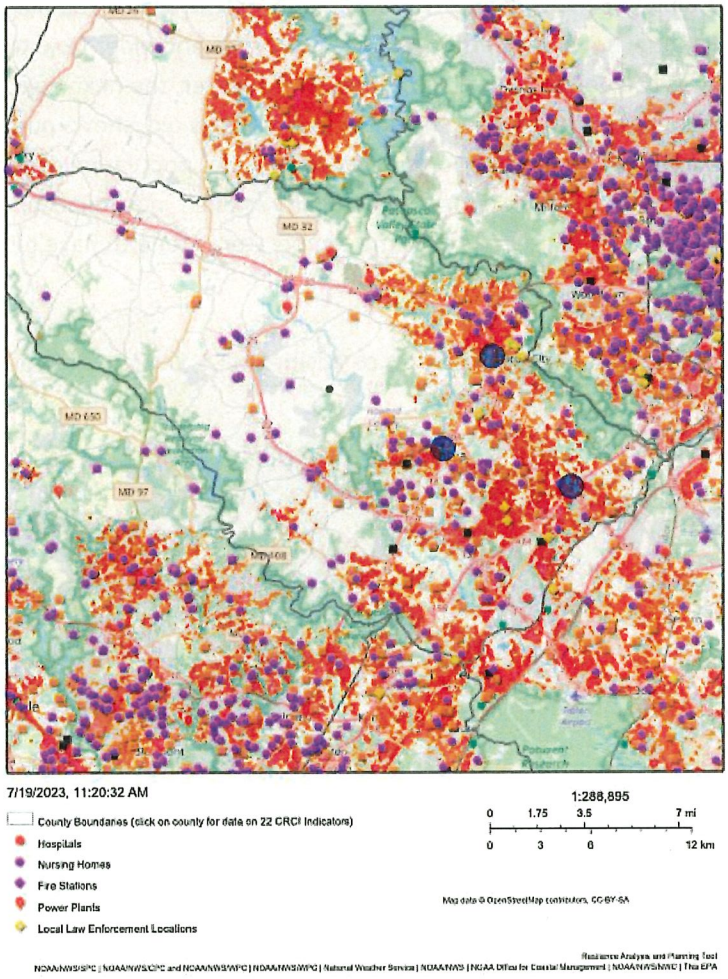


[21] *Heat Severity – USA 2021, Imagery Layer from The Trust for Public Land, https://fema.maps.arcgis.com/home/item.html?id=cdd2ffd5a2fc414ca1a5e676f5fce3e3. (last accessed July 19, 2023).*

Structures

- All residential and commercial structures are vulnerable to severe heat and cold; and,
- Most County structural assets, such as nursing homes, hospitals, fire stations, power plants, law enforcement, universities, public and private schools, and utilities fall in severe heat areas as well. The map below demonstrates the general clusters of locations in these severe heat areas.

FIGURE 30: HEAT SEVERITY AND STRUCTURAL ASSETS



For extreme cold, a map similar to the one above was not available.

Systems

- Water Infrastructure (extreme cold will likely have more impacts on more densely populated areas due to water pipes bursting and affecting multiple areas).
- Communications (ice on cell towers or wires can bring communications lines down).
- Economy (extreme temperatures can kill important crops and plants that people rely on for their livelihoods).

Natural, Historic, and Cultural Resources

- Historic buildings throughout the County are all vulnerable to extreme heat and cold (Historic Ellicott City and Lawyers Hill).

- Extreme temperatures can cause outdoor cultural events to be canceled.

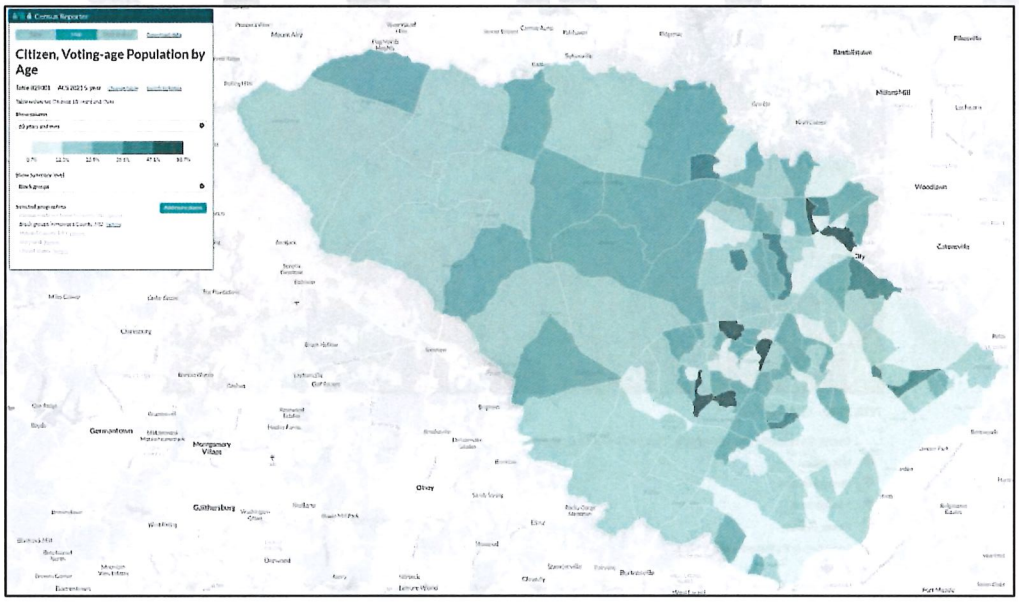
Activities that Have Value to the Community

- Camping and outdoor recreation (fish and wildlife can be harmed by extreme temperatures).

Effects of Population Change and Development in Hazard-Prone Areas

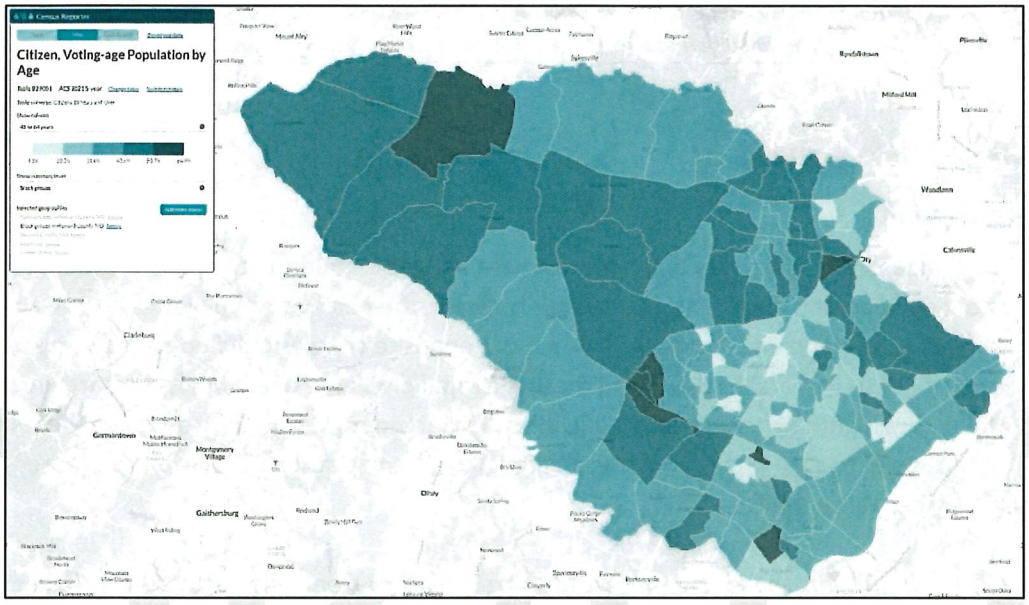
As noted in Chapter 2, population density is not expected to change significantly by 2035. Densities will continue to stay in the Columbia and Ellicott City areas. However, the age of populations in those areas are likely to change. Currently, populations that are 65 years of age and older tend to live in more densely populated areas as can be shown in the map below. However, the next map that shows population densities for residents currently between 45 and 64 years old, shows population densities in more rural areas of the County. This observation suggests that older populations might be located in more rural areas in the next 20 years. Therefore, vulnerability of older individuals to extreme temperatures could decrease in the future as extreme temperatures tend to have more negative impacts on densely populated areas.

FIGURE 31: POPULATION DENSITIES OF RESIDENTS 65 YEARS AND OLDER



**Source: Department of Planning and Zoning, Research Division*

FIGURE 32: RESIDENTS 45 TO 64 YEARS OLD



**Source: Department of Planning and Zoning, Research Division*

Hazard Occurrences

Between 2017 and 2022, the NCDC has 16 recorded instances of extreme temperature hazards in Howard County. This includes three instances of extreme cold hazards and 13 instances of extreme heat hazards.[22]

Hazard Future Likelihood- High

The following table anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This high probability will likely continue as climate change has resulted in a greater occurrence of extreme weather events. A greater than 30% chance of annual occurrence corresponds to a hazard event occurring every one to three years.

Future Likelihood of an Extreme Temperature Hazard in Howard County	
Historical Average (time period)	13 extreme heat events (2017-2022) and 3 extreme cold events (2017-2022)
Historical Annual Probability	30%+ chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No
Future Annual Probability	30% + chance of annual occurrence

[22] *Storm Events Database: Search Results for Howard County, Maryland*, NOAA NAT'L CTRS. FOR ENVTL. INFO., https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+Cold%2FWind+Chill&eventType=%28Z%29+Excessive+Heat&eventType=%28Z%29+Extreme+Cold%2FWind+Chill&eventType=%28Z%29+Heat&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=2017&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 Feb. 27, 2023).

Future Likelihood Score	4.0 (Very Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

Lightning (Risk Score 2.6)

Hazard Description

Lightning is a giant spark of electricity in the atmosphere between clouds, the air, or the ground. In the early stages of development, air acts as an insulator between the positive and negative charges in the cloud and between the cloud and the ground. When the opposite charges build up enough, this insulating capacity of the air brakes down and there is a rapid discharge of electricity that we know as lightning. The flash of lightning temporarily equalizes the charged regions in the atmosphere until the opposite charges build up again. The air in the channel of a lightning strike reaches temperatures higher than 50,000 degrees Fahrenheit.[23]

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

Lightning Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	4.0 Very Likely		50%
CONSEQUENCE	**Impact**	1 Limited	2 Significant	40%
	Warning Time	2 Long	2 Long	5%
	Duration	1 Short	1 Short	5%
TOTAL RISK SCORE		**2.6**	**2.9**	

Hazard Location

Although individual lightning strikes affect a relatively small geographic area, lightning has the potential to impact the entire County equally, particularly during the warmer months of the year. People and property are exposed to damage, injury, and loss of life from lightning in virtually the entire United

[23] *Lightning Safety Tips and Resources*, NOAA https://www.weather.gov/safety/lightning (last visited October 4, 2022); *see also National Weather Service's Glossary*, NOAA, http://www.weather.gov/glossary/index.php?letter=l (last visited October 4, 2022).

States. The United States has had 4,136 lightning fatalities from 1959-2017.[24] Of those fatalities, 126 occurred in Maryland, ranking tied for 10th for the greatest number of lightning fatalities within that time period in the United States.[25]

Most lightning-related deaths and injuries occur when people are outdoors during summer afternoons and evenings. Lightning strikes occur when there are thunderstorms. Thunderstorms occur more often in the afternoon and evening "because in order for there to be high amounts of moisture in the air along with warm rising air, there must be instability in the atmosphere. During the warmer months the humidity is much higher."[26]

Hazard Extent

Lightning can occur anywhere within the planning area and reach around 50,000 degrees Fahrenheit. The lightning current can branch off to strike a person from a tree, pole, building, or other tall object. In addition, electrical currents may be conducted through the ground to a person after lightning strikes a nearby tree, antenna, or another tall object. The current also may travel through power lines, telephone lines, or plumbing pipes to a person who is in contact with an electric appliance, telephone, or plumbing fixture inside of a building. Lightning may damage property and can cause fires using similar processes as outlined above.

Lightning can cause a range of damages to property. The following damages from lightning reported for a range of years can provide an idea of the extent of the lightning hazard[27].

Year	Damages Reported
1996	$750,000
2000	$100,000
2001	$100,000
2002	$500,000
2004	$55,000
2006	$100,000

Hazard Impacts

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

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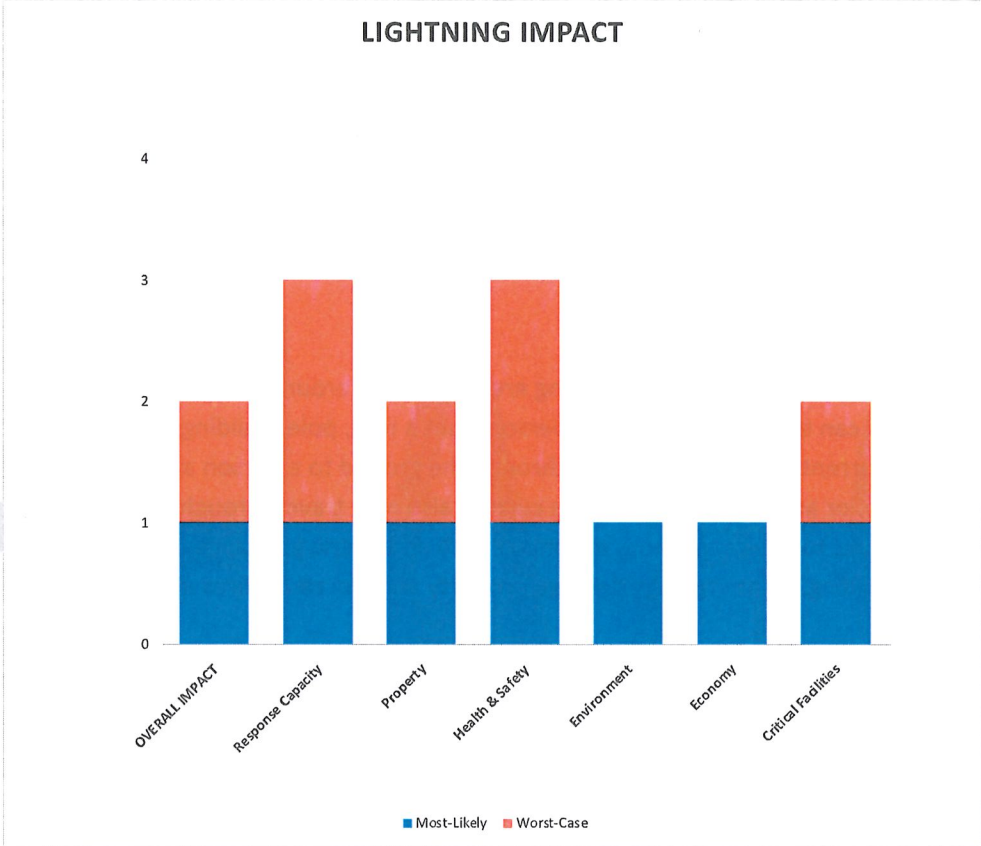
[24] *Number of Lightning Deaths by State from 1959 to 2017*, VAISALA, https://www.weather.gov/media/safety/59-17_State_Ltg_Fatality_Maps_lists.pdf (last visited Feb. 27, 2023).

[25] *Id.*

[26] *Why Do Thunderstorms Often Occur On Summer Afternoons?*, ALABAMAWX (Aug. 4, 2019), https://www.alabamawx.com/?p=196429.

[27] *NCDC, Storm Events Database, https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28C%29+Lightning&beginDate_mm=01&beginDate_dd=01&beginDate_yyyy=1980&endDate_mm=04&endDate_dd=30&endDate_yyyy=2023&county=HOWARD%3A27&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=24%2CMARYLAND, (last accessed July 26, 2023).*



Lightning - Consequence Analysis Likely		
CATEGORY	**RANKING**	**DESCRIPTION**
PROPERTY DAMAGE	*Limited*	▪ Up to 0.2% of critical and non-critical infrastructure will be damaged. ▪ Some electrical equipment and panel boxes burned, and some structural issues related to fires caused by lightning expected. ▪ Damaged trees and some traffic signals are expected. ▪ Electrical surge damage will be expected. ▪ Possible fires and possible damage to trees and structures are expected.
HEALTH AND SAFETY	*Limited*	▪ Zero to three deaths are expected depending on the time of year. Electrocution is the most common cause of death. ▪ Zero to ten injuries are expected. Electrical shock, burns, or seizures are the most common causes of injuries.
CRITICAL FACILITIES	*Limited*	▪ *Utilities* – Shutdown or interruption of service is unlikely. ▪ *Information/Communications* – Shutdown or out of service is unlikely. Localized power outages. ▪ *Transportation* – Shutdown unlikely.
RESPONSE CAPACITY	*Limited*	▪ *Police* – Local resources adequate. No impact to response capability or continuity of operations. ▪ *Fire and Rescue* – Local resources adequate. Limited impact to response capability and continuity of operations. There may be additional small wildfire and limited structure fires as a result of lightning strikes.

		▪ *Health* – Local resources adequate. Clinical and administrative operations can be performed normally as long as the auxiliary power is properly maintained or will be moved to another location. ▪ *Public Works* – Local resources adequate. Minor impact on the response capability and continuity of operations.
ENVIRONMENTAL IMPACT	*Limited*	▪ Minimal impact.
ECONOMIC IMPACT	*Limited*	▪ Limited amount 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*

Vulnerability of County Assets

According to the National Risk Index Annualized Frequency of Lighting by County[28], Howard County has between 24 and 52 lightning events per year. This number represents the "average number of recorded lightning hazard occurrences (events) per year over a period of 22 years"[29]. Data that shows all lightning occurrences in specific areas of Howard County are unavailable. However, lightning tends to occur more often during months with more instability in the atmosphere, such as the warmer months of late spring into summer and then in the early months of fall. All areas of Howard County are similarly susceptible to lightning strikes. In general, lightning strikes are more likely to strike taller objects, such as skyscrapers and trees[30], so areas of the County with taller buildings and trees could be more at risk. Assets that are vulnerable are the following:

People

- All people outdoors during summer afternoons and evenings during a thunderstorm are vulnerable.
- People more at risk could be unhoused populations, those without cell phones to receive weather alerts, those with occupations that mainly work outside, and those without a vehicle to quickly get to safety.

Structures

- All residential and commercial structures, especially taller structures, are vulnerable to lightning strikes.
- Utilities/Electric (Substations have been struck in the past by lightning, but they tend to be back in operation within a few hours).

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[28] *National Risk Index Annualized Frequency Lightning, FEMA National Risk Index, https://fema.maps.arcgis.com/home/item.html?id=8dc5ab3181cd4ed5a6534ea3ffaff8bf, (last accessed July 19, 2023).*

[29] *Lightning, National Risk Index, FEMA, https://hazards.fema.gov/nri/lightning, (last accessed July 19, 2023).*

[30] *Severe Weather 101- Lightning, NOAA National Severe Storms Laboratory, https://www.nssl.noaa.gov/education/svrwx101/lightning/, (last accessed July 19, 2023).*

Systems

- Communication Systems (If lightning strikes cell towers or other antennae, it could affect communications of citizens and emergency services).

Natural, Historic, and Cultural Resources

- Historic buildings largely made of wood could be more at risk due to the risk of being set on fire by lightning (Historic Ellicott City, Lawyers Hill Historic District).

Activities that Have Value to the Community

- Outdoor events held during the summer months are more vulnerable to the effects of lightning.

Effects of Population Change and Development in Hazard-Prone Areas

Howard County's vulnerability to lightning will increase as the population grows and intensity of storms increases due to climate change. This population growth and density change can be seen primarily within the regions of Central and South-eastern portions of Howard County, as identified within Chapter 2, Growth and Development section of this Plan. Higher population density areas may see a greater concentration of individuals exposed to lightning risks, particularly during outdoor events and activities. Vulnerable populations, such as unhoused individuals, those without access to weather alerts, outdoor workers, and those lacking rapid access to shelter, could be more at risk in densely populated areas. Higher population density areas often require more robust utility and communication infrastructure. Substations and communication systems, critical for serving densely populated regions, are vulnerable to lightning strikes. A lightning strike on a substation can lead to temporary power outages, affecting both residential and commercial areas. Communication systems, including cell towers, could be compromised by lightning strikes, impacting emergency services and community connectivity.

With ongoing urbanization and population growth, densely populated areas in Howard County may witness an increase in the number of tall structures, such as buildings, communication towers, and utility poles. These structures can attract lightning strikes due to their height and metal components. As a result, the potential for lightning-related incidents, including fires, electrical surges, and structural damage, could rise in these urbanized zones. Changes in land use, such as the conversion of open spaces into residential, commercial, or industrial areas, can influence the county's vulnerability to lightning. Urban sprawl may introduce more concrete and asphalt surfaces, reducing natural lightning dissipation pathways. Moreover, alterations to the landscape can impact the local microclimate and atmospheric conditions, potentially influencing lightning formation and discharge patterns. Please refer to Chapter 2, Growth and Development, and subsection Future Development to identify where these current and future development areas reside.

Hazard Occurrences

The NCDC database identified five lightning events in Howard County between 2000 and 2022. Like other hazards, the list appears to only account for events from 1950 onwards. The five events in the database listed occurred between 2000 and 2006. This indicates additional events outside this period are unlikely captured in the database. Although many more lightning events may have occurred, they were not reported to the NCDC. The table below summarizes the significant lighting events that have occurred in Howard County between 2000 and 2022. Dollar amounts have been adjusted for inflation and are detailed in 2022-dollar values.

Lightning Events, Howard County, 2000 – 2022

(Source: NOAA/NCDC)

Event ID	Location	Date	Event Type	Deaths	Injuries	Property Damage ($)	Crop Damage ($)
5173739	Columbia	8/7/2000	Lightning	0	0	$172,886	0
5265439	Clarksville	8/11/2001	Lightning	0	0	$168,198	0
5314399	Clarksville	8/3/2002	Lightning	0	0	$827,434	0
5421712	Hanover	8/10/2004	Lightning	0	0	$86,681	0
5515110	Ellicott City	6/1/2006	Lightning	0	0	$147,674	0

Notable Incidents in Howard County

July 2019	Shortly In July 2019, a man was seriously injured by lightning strike on the Howard County/Baltimore County line while hiking in the Patapsco Valley State Park. That same day, a lightning strike caused damage to a home.
August 2022	A On August 3, 2002, a lightning strike destroyed a home in Clarksville along Talon Court. This event caused approximately $827,434 in property damage.

Hazard Future Likelihood - High

The future likelihood of lightning has increased from the historical average from likely, to very likely. The future probability of lightning is 11-30%+ chance of annual occurrence or, one event every 3-9 years. This is partially because SMEs have deemed that patterns of storms are changing, storms are occurring more frequently, and are more intense. Based on historical data, the future probability of lightning strikes is reasonably high with a severe strike impacting the planning area every couple of years. However, the damage associated with these events is usually minor and not widespread. The following table anticipates the future occurrence rate of the hazard based on historical likelihood and future trends.

Future Likelihood of a Lightning in Howard County	
Historical Average (time period)	5 events (2000- 2022)
Historical Annual Probability	11-30% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes
Future Annual Probability	11-30%+ chance of annual occurrence
Future Likelihood Score	3.875 (Likely- Very Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

Severe Winter Weather (Risk Score 2.3)

Hazard Description

Severe Winter Weather refers to a weather event that produces forms of precipitation caused by cold temperatures, such as snow, sleet, ice, and freezing rain, while ground temperatures are cold enough to cause precipitation to freeze. Windy conditions may also be present during a winter weather event. The accumulation of these forms of precipitation can immobilize the entire region, leaving roads impassable, triggering utility outages, causing flooding and storm surge, and may lead to the loss of lives. These impacts may be enhanced with the presence of windy conditions, which can lead to blizzard, whiteout conditions, and drifting of snow.[31] Additionally, these conditions have the potential to cause transportation hazards.

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

Severe Winter Weather Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	3.75 Likely-Very Likely		50%
CONSEQUENCE	**Impact**	1.1 Limited	2.3 Significant-Critical	40%
	Warning Time	2 Long	1 Very Long	5%
	Duration	1 Short	2 Moderate	5%
TOTAL RISK SCORE		**2.4**	**2.9**	

Hazard Location

Severe winter weather, including snowstorms, ice storms, and extreme cold, may affect any part of Howard County during winter. The annual snowfall for the County is approximately 24 inches, which is relatively moderate.[32] Within Howard County, the risk to people and property from winter weather cannot be distinguished by area because of its central location. Counties in western Maryland experience significantly more annual snowfall, while counties closer to Maryland's eastern shore generally have a smaller annual snowfall total.

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[31] *Weather Prediction Center*, NOAA, https://www.wpc.ncep.noaa.gov/#page=ovw (last visited Feb. 27, 2023); *Severe Weather 101 – Winter Weather*, NOAA NAT'L SEVERE STORMS LAB., https://www.nssl.noaa.gov/education/svrwx101/winter/ (last visited Feb. 27, 2023).

[32] *Climate & Geography*, HOWARD CTY. ECON. DEV. AUTH., http://www.hceda.org/why-howard-county/living/climate-geography/ (last visited Feb. 27, 2023).

Hazard Extent

When it comes to winter storms, the National Weather Service (NWS) uses the Winter Storm Severity Index (WSSI) to provide the "general public with an indication of the level of winter precipitation (snow and ice) severity and its potential related societal impacts"[33]. The Index shows severity by estimating damages that can be done to a community. The relative conditions of the area are considered, such as population, location, and storm characteristics. The WSSI classifies incoming storms using the impact levels shown below.

Potential Winter Storm Impacts	
	No Impacts Impacts not expected.
	Limited Impacts Rarely a direct threat to life and property. Typically results in little inconveniences.
	Minor Impacts Rarely a direct threat to life and property. Typically results in an inconvenience to daily life.
	Moderate Impacts Often threatening to life and property, some damage unavoidable. Typically results in disruptions to daily life.
	Major Impacts Extensive property damage likely, life saving actions needed. Will likely result in major disruptions to daily life.
	Extreme Impacts Extensive and widespread severe property damage, life saving actions will be needed. Results in extreme disruptions to daily life.

Typically, Howard County remains cool during the winter months. Heavy snow events can be common during certain years, with snow fall totals surpassing 12 to 18 inches. During other years, snowfall events could be considerably less. Generally, January is the coldest month, with an average temperature slightly above freezing at 33.3 degrees Fahrenheit. February commonly has the highest snow fall, with 9.61 inches of average snow fall.

It is possible for an occasional ice storm, freezing rain event, or sleet to impact the County. Winter storms along the Atlantic Coast can bring a wintery mix of precipitation—where the event may start out

[33] *Winter Storm Severity Index (WSSI), National Weather Service, https://www.weather.gov/ict/WSSI_Overview, (last accessed July 27, 2023).*

as rain and switch over to snow (or vice versa). A wintery mix event may cause more sustained damage than a single-precipitation winter event. For example, if a wintery mix started as snow and then switches over to rain, the weight of the fallen snow may bring down trees and electrical lines. Another possible characteristic of severe winter storms is extreme cold temperatures, where single digit temperatures and wind chills below zero are possible.

Snow events such as winter storms, heavy snow fall, ice, wind, and cold temperatures have the potential to create hazardous situations. Over the years, Howard County has sustained varying degrees of damages from winter storms. These storms affected the entire County by restricting travel, downing trees, interrupting electrical power, and causing water main breakages. The 2009-2010 winter season had the highest recorded snowfall on record, with 77 inches of snow falling across the area. Several other snow events brought over 12 inches of snow to the County during that period. These smaller snow events, along with sleet, freezing rain, and cold temperatures, caused physical damage to the environment.

Hazard Impacts

Howard County's vulnerabilities include the prevalence of old buildings with roof structures that are not up to current standards. There are also many barns in Howard County which do not require permits and thus may be more susceptible to damage from winter weather events.

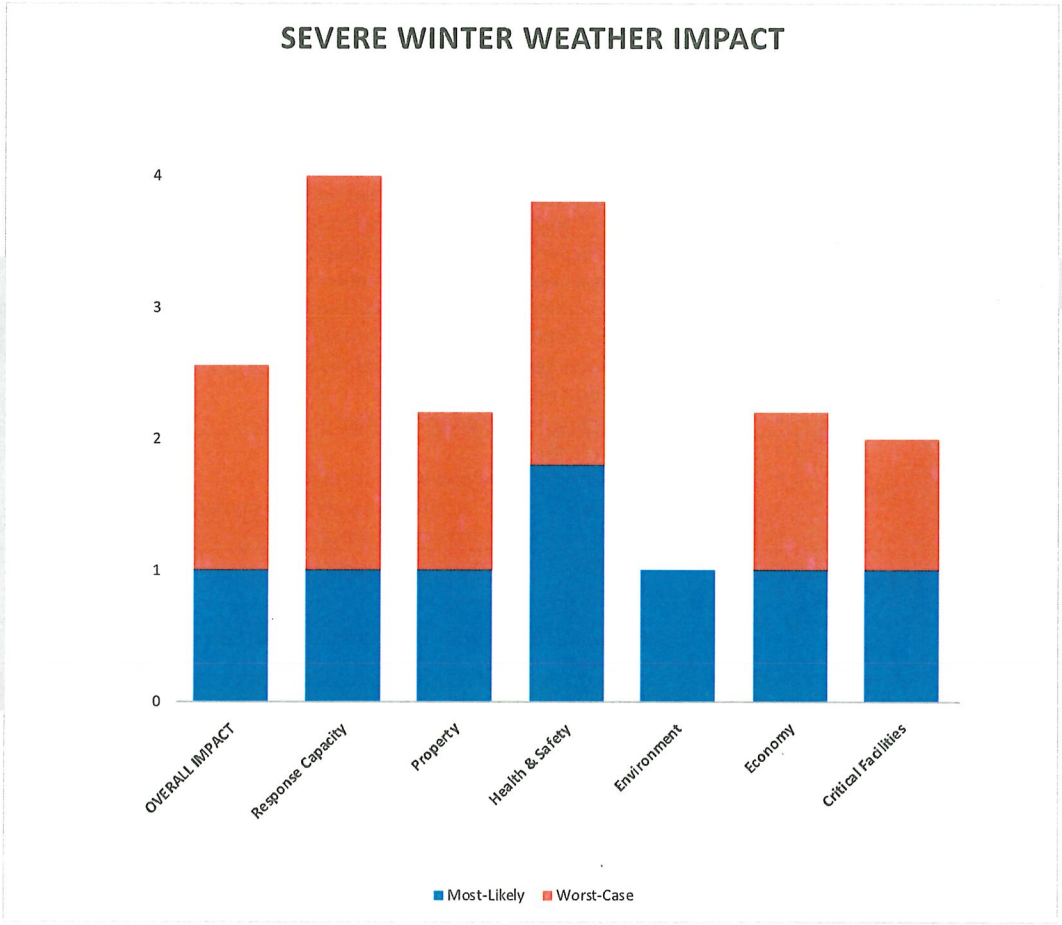
Winter weather events occur on an annual basis in the County, but significant improvements to building codes, maintenance to structures, and weather forecasting has dramatically decreased the threat to people and property. Even with these improvements, a risk of injury or death to individuals during a winter event may still exist, particularly with elderly persons, small children, infants and/or the chronically ill. These groups may be more susceptible and vulnerable to injury or death if they are exposed to the winter weather event or if they do not have adequate heating in their homes. Also, heavy snow loads on roofs may cause structural failure or structural damage to buildings and infrastructure.

Severe winter weather events could also result in increased traffic accidents, impassable roads, and loss of income. On roadways, snow and ice can reduce visibility and affect automobile traction as bridges may freeze prior to the majority of the roadways. It is important to note that this is not the only cause for this occurrence. Disruption of roadways and other transportation methods is a threat to the County's economic well-being because individuals may not be able to travel to work and the shipment of goods could come to a standstill.

County residents may also be affected physically by severe winter weather events. Individuals may injure themselves while walking on ice and snow or suffer heart attacks as a result of overexertion from shoveling snow. Although rare, carbon monoxide poisoning can occur during winter weather events

when heaters, automobile mufflers, or generators are not vented properly.[34] Frostbite and hypothermia may also lead to death or injury.

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



[34] *See, e.g., 1 Dead, 2 Critical in Carbon Monoxide Poisoning*, CBS BALTIMORE (Aug. 30, 2011), https://www.cbsnews.com/baltimore/news/1-dead-2-critical-in-carbon-monoxide-poisoning/.

Severe Winter Weather - Consequence Analysis Likely				
CATEGORY	**RANKING**	**DESCRIPTION**		
PROPERTY DAMAGE	*Limited*	▪ Critical and non-critical infrastructure will not be damaged. ▪ No damage anticipated except icing on some roadways and bridges are expected. ▪ Downed power lines, vehicle accidents, and falling tree limbs are expected.		
HEALTH AND SAFETY	*Limited-Significant*	▪ Zero deaths are expected. Automobile accidents and hypothermia are the most common causes of death. ▪ Zero to five injuries are expected. Automobile accidents and cold weather injuries are the most common cause of injuries.		
CRITICAL FACILITIES	*Limited*	▪ *Utilities* – Minor disruption, shutdown unlikely. ▪ *Information/Communications* – minor power disruption, shutdown unlikely. ▪ *Transportation* – Transportation issues will occur and there will be vehicle accidents.		
RESPONSE CAPACITY	*Limited*	▪ *Police* – Emergency service disruption however, local resources adequate. No impact to response capability and continuity of operations. ▪ *Fire and Rescue* – Emergency service disruption however, local resources adequate. Limited impact to response capability. Increased call volume for vehicle accidents. ▪ *Health* – Local resources adequate. HD operations will not be affected. ▪ *Public Works* – Local resources adequate. ▪ Government Services –Reduced government services.		
ENVIRONMENTAL IMPACT	*Limited*	▪ Minimal immediate impact. ▪ Repeated use of road salt impacts water resources. ▪ Increased Chloride levels are harmful to aquatic and human life. ▪ Loss of tree limbs and downed trees are likely.		
ECONOMIC IMPACT	*Limited*	▪ Traffic delays impact in economic consequences. ▪ Workforce reduction.		
TOTAL IMPACT	***Limited***	▪ **Total Impact Score: 1.0 on a scale of 1 (Limited) to 4 (Catastrophic).**		
Limited		*Significant*	*Critical*	*Catastrophic*

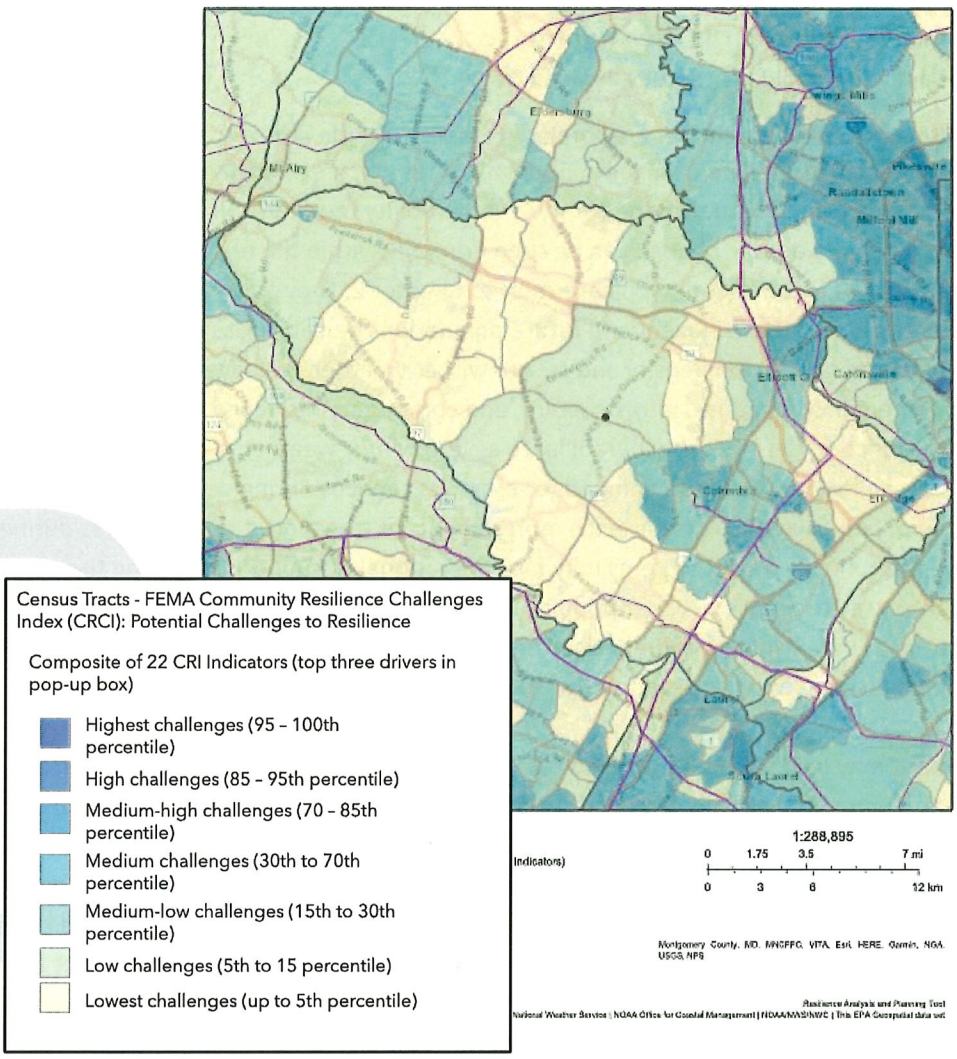
Vulnerability of County Assets

People

- Unhoused populations, people who live in lesser developed areas of the County due to slower snow plowing times, households without vehicles, and populations that might have trouble affording heating bills.
- People who rely on electricity for medical equipment.
- People who commute in and out of the County for work due to icy conditions.

As noted in Chapter 2, Howard County has a large population of individuals who commute outside of the County for work (72,574) and into the County for work (74,590); therefore, many cars will continue to be on the roads, especially during rush hour. Populations with lower resilience (Census tract areas with less resilience will have limited means to respond and recover from this threat. These areas, shaded in darker blue, can be seen below in the map depicting FEMA's Community Resilience Index. Please refer to Chapter 2, in the section named FEMA Community Resilience Index to read more about the specific indicators for the County. This map also depicts County electrical transmission lines in purple and major roadways in red).

FIGURE 33: COMMUNITY RESILIENCE INDEX, MAJOR ROADWAYS, & TRANSMISSION LINES



Structures

- All residential and commercial buildings are vulnerable to severe winter weather.
- Electrical Infrastructure (buildup of ice on electrical transmission lines can also cause breakage and disruption of electricity to homes and businesses).

Systems

- Transportation (icy roads).
- Communications (ice buildup or strong winds could hinder cell tower communication).
- Economy (ice buildup on important roadways, such as Interstate 95, Interstate 70, U.S. Route 40, and U.S. Route 29 could slow down commerce).

Natural, Historic, and Cultural Resources

- Historic buildings in Historic Ellicott City, Lawyers Hill, and throughout the County are vulnerable to severe winter weather, especially if made of wood.

- Outdoor cultural events.

Activities that Have Value to the Community

- Outdoor activities, holiday activities, holiday travel.

Effects of Population Change and Development in Hazard-Prone Areas

As Howard County anticipates future changes in population density, it's important to consider how these demographic shifts could influence the county's vulnerability to severe winter weather hazards. This population growth and density change can be seen primarily within the regions of Central and South-eastern portions of Howard County, please refer to Chapter 2, Growth and Development section of this Plan to identify where these current and future populations density areas are/expected to be. The interaction between population density and severe winter weather can have significant implications for public safety, emergency response, infrastructure, and community resilience. Analyzing the potential impact of future population density on vulnerability to severe winter weather is essential. Higher population density can lead to increased demand for essential services during severe winter weather events. Densely populated areas may experience more significant transportation challenges during severe winter weather. Public transit systems may face operational disruptions, affecting the mobility of residents who rely on these services. Higher population density areas could experience greater strain on infrastructure during severe winter weather, potentially leading to more frequent utility disruptions, road closures, and increased wear and tear on transportation systems.

Future development may lead to changes in land use patterns, such as increased urbanization and expansion of impervious surfaces like roads and parking lots. These changes can affect local drainage systems and water runoff, potentially leading to more rapid accumulation of snow and ice during winter storms. Areas with increased impervious surfaces may experience more localized flooding as snow and ice melt. Future development could influence building codes and standards for insulation and energy efficiency. While these improvements are positive for energy conservation, they might impact a building's ability to retain heat during extreme cold events. Additionally, increased urbanization can contribute to the urban heat island effect, where developed areas experience higher temperatures due to heat-absorbing surfaces. This can affect the onset and duration of snow and ice accumulation. Expansion of utility networks to serve growing populations might increase vulnerability to severe winter weather. Power lines, substations, and communication infrastructure could be exposed to ice accumulation and falling tree limbs during winter storms, leading to power outages and disruptions in essential services. According to Chapter 2, Growth and Development, and subsection Future Development, future development, Growth and Revitalization areas are not going to expand much further west and north. Areas already surrounded by established community will receive more development and improvement. Overall, future development can make the County more vulnerable to severe winter weather simply because there will be more roads, pipe infrastructure, and power lines that will be vulnerable to this hazard.

Hazard Occurrences

Generally, the winter storm season for the eastern portion of Maryland runs from November to mid-March, while the western counties experience longer winters. Severe winter weather has occurred as early as October and as late as May in eastern portions of the State.

The NCDC database reports Howard County has experienced 66 severe winter weather hazard events between 2014 and 2022.[35] This includes 11 occurrences of winter storms and 55 occurrences of winter weather.

Notable Incidents in Howard County

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

February 1899	In February 1899, a storm produced approximately 20 inches of snow across the region. Also known as the "Great Eastern Blizzard of 1899," it is one of the earliest documented severe winter storm events in the area.
January-February 1912	Between January 5, 1912 – February 12th, 1912, extreme cold was recorded across the region. In Howard County, reports showed that temperatures fell close to 20 degrees below zero and resulted in freeze across the area. This was referred to as the "Great Cold Wave" of January 1912.
January 1922	Between January 27th, 1922 – January 28th, 1922, a nor'easter brought between 30-32 inches of snow across the County. Its high winds also brought blizzard and whiteout conditions across the region. It is also known as the Knickerbocker Storm".
March 1942	Between March 29th, 1942 – March 30th, 1942, the "Palm Sunday Snowstorm" was the heaviest March snowstorm on record in Maryland. The storm dropped over 20 inches of heavy, wet snow in Howard County.
February 1979	On February 18th, 1979, the "Presidents' Day Storm" brought the second greatest amount of snow fall in Howard County, bringing snow of up to 20 inches over the Northern Virginia and Maryland region. At times, snow was falling two to three inches an hour, and temperatures fell to the single digits.
February 1983	Between February 11th, 1983 – February 12th,1983, the "Blizzard of 1983" was the second greatest snow fall in the region. Over two feet of snow covered the County. During certain periods, snow fell at a rate of 3.5 inches per hour.
January 1996	The snowstorm of January 7th, 1996 – January 13th, 1996, commonly known as the "Blizzard of '96'" brought between 18-30 inches of snow to Howard County on January 8th. On the 9th, an "Alberta Clipper" left an additional three to five inches of snow throughout the region. A third storm brought another four to six inches of snow. The County had two to three feet of snow by the end of the week.
January 1999	On January 14th, 1999, an arctic cold front moved over Central Maryland and brought snow and freezing rain to the region. The snow turned to freezing rain while the ground remained below freezing, which, in turn, created hazardous conditions. Ice accumulations ranged from ¼ to ½ inch with winds gusting over 40 mph, resulting in fallen trees and power outages across the County. At one point, as many as 39,000

[35] *Storm Events Database*, NOAA NAT'L CTRS. FOR ENVTL. INFO., https://www.ncdc.noaa.gov/stormevents/ (last visited Feb. 27, 2023).

	households were without power. The Governor of Maryland declared a State of Emergency for Howard County and the surrounding counties.
December 2000	On December 11th, 2000, a low-pressure system produced between one to two inches of rain. However, the rain then turned to ice as temperatures dropped below freezing. In some locations, ice accumulated to ¼ of an inch thick. In Howard County, 22 people were treated for slip and fall injures related to the ice accumulation.
February 2003	The NCDC database indicates that one of the most severe winter storms resulting in property damage and loss of life occurred on February 14th, 2003, and lasted until February 18th, 2003. The system brought three waves of wintery precipitation to the region. The first line of precipitation started to fall on the evening of the 14th as a mix of light to moderate snow or rain. The next round, on the 16th and 17th, took the form of heavy wet snow and sleet. The event ended with snow showers tapering off on the 18th. When the winter storm ended, snowfall totals ranged from 20 to 32 inches across the Baltimore Metropolitan area. Estimated regional property damages from the storm were $9.7 million. In Howard County, a barn, warehouse, store awning, tennis bubble dome, greenhouse, and shed collapsed under the weight of the snow.
February 2006	Between February 11th, 2006 – February 12th, 2006, approximately 14-22.5 inches of snow fell across the Washington, D.C., and Baltimore Metropolitan regions, with Howard County suffering a direct hit from the storm. The highest snowfall total occurred in Columbia Hills, which is in the north-east part of the County. In that region, snowfall of up to 22.5 inches was recorded. There were numerous reports of downed trees and power outages in the County. NCDC database estimated property damage to be $334,015 for the entire storm.
February 2008	On February 12th, 2008, a wintery mix of snow and ice produced roughly an inch of snow and between 0.1-0.3 inches of ice. The central and eastern portions of Maryland saw a quick change from snow to ice, which froze just before the evening commute. As road conditions deteriorated, several accidents were reported across the region.
Winter 2009-2010	The 2009-2010 winter season brought the highest snowfall on record in the region. Several waves of severe snow events dropped over a foot of snow each in the County. The first low pressure system arrived on the night of December 18th, 2009. The system strengthened on the 19th, as moisture from the south pushed northward while the cold air remained in place. Snowfall totals ranged from 14-17 inches across the County. As a result of this event, a Presidential Disaster Declaration (DR-1875) was issued for the State of Maryland on February 19th, 2010, for the December storms. Before the Presidential Disaster Declaration was even issued for the December storms, the State was hammered yet again by a line of severe winter storms from February 5th-11th, 2010 and produced a snowfall of 10-20 inches across the County. Certain parts of the County had even higher localized amounts. As a result of this event, another Statewide Presidential Disaster Declaration (FEMA DR-1910) was declared on May 6th, 2010, for the February storms.
January 2011	Between January 26th, 2011 – January 27th, 2011, a snowfall event produced between eight to thirteen inches of snow across the County. The heavy, wet snow brought trees and power lines down and left thousands without power. Unfortunately, the storm

	coincided with the evening rush hour which resulted in numerous car accidents and roadway shutdowns. There were also several reports of tractor trailers jackknifing due the slick road conditions.
January 2016	On January 22nd, 2016, then County Executive Kittleman declared a State of Emergency in Howard County. The blizzard caused "snow totals ranging from 24 inches near Columbia to more than 30 inches in western parts of the county. Snow drifts in some areas reached five to six feet high. Additionally, the National Guard deployed to the County to complete 56 missions. This storm resulted in a Presidential Disaster Declaration.

Hazard Future Likelihood - High

The future annual probability of the hazard is 11-30%+ chance of annual occurrence, or one event every 3-9 years. An expected increase in extreme storms may result in a slight increase in the likelihood of severe winter weather in Howard County.[36] Other considerations include the impact climate change will have on the severity and frequency of these storms. The following table anticipates the future occurrence rate of the hazard based on historical likelihood and future trends.

Future Likelihood of a Severe Winter Weather in Howard County	
Historical Average (time period)	66 events (2014-2022)
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	3.5 (Likely- Very Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

Flood (Risk Score 2.3)

Hazard Description

A flood is defined as an accumulation of water that exceeds a physical barrier or collects in a low-lying area that leads to the inundation of an area. Flooding typically results from large scale weather systems that generate prolonged or highly impactful rainfall. Other conditions such as winter snow thaws, over-saturated soil, ice jams breaking apart, and urbanization can cause flooding as well. Floods can happen during heavy rains, when the ocean or tidal waters rise over shoreline communities, when snow melts quickly, or when dams or levees break. Damaging flooding may happen with only a few inches of water, or it may cover a house to the rooftop. Floods can occur within minutes or over a long period, and may last days, weeks, or longer. The flow of floodwaters can be rapid whitewater, or a more tranquil, but still damaging, inundation. Floods are the most common and widespread of all weather-related natural disasters.

[36] *Third National Climate Assessment,* U.S. GLOB. CHANGE RESEARCH PROGRAM, https://nca2014.globalchange.gov/ (last visited Feb. 27, 2023).

Widespread flooding typically results from large-scale weather systems that generate prolonged rainfall. But more localized but still often deadly flooding can happen from individual slow-moving thunderstorms. Other conditions such as rapid winter snow thaws, over-saturated soil, ice jams on rivers that break apart, and urbanization can cause flooding. In Howard County, flooding can follow weather events, including, but not limited to, tropical systems, thunderstorms (individual storms, or lines of storms), heavy rain events, winter storms, spring thaws, or a combination of these events.

Flooding is a natural event for rivers and streams. Howard County can be impacted by two different types of flooding; Flooding and Flash Flooding

Flooding, in its most common form, occurs when the land and embedded small rivers, creeks, streams, reservoirs, and drainage systems receive too much water in a short time span. This leads to the excess flow of water over river/stream/drainage banks onto the adjacent floodplains. It also leads to water over roadways in low areas, as well as flooding of structures and residences. The flow of water in more typical flooding is less rapid, but it can be very damaging, especially if over a widespread populated area.

Flash flooding is one of the County's greatest weather threats to life safety. It can be caused by several things, including dam or levee breaks and mudslides, but is most often due to extremely heavy rainfall from thunderstorms. Flash Flooding is also defined by the timeframe in which it occurs: beginning within six hours, though often within three hours, of heavy rainfall or other cause. "The intensity of the rainfall, the location and distribution of the rainfall, the land use and topography, vegetation types and growth/density, soil type, and soil water-content all determine just how quickly the flash flooding may occur, and influence where it may occur."[37] Urbanized areas are usually more prone to flooding in short timespans. Often, rainfall over an urbanized area will cause flooding faster and more severe than in the suburbs or countryside. The impervious surfaces in the urbanized areas do not allow water to infiltrate the ground, and the water runs off to the low spots very quickly.

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

Flood - Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	3.1 Likely-Very Likely		50%
CON	**Impact**	1.4 Limited-Significant	2.9 Significant-Critical	40%

[37] *Flash Flooding Definition*, NAT'L WEATHER SERV., https://www.weather.gov/phi/FlashFloodingDefinition (last visited Feb. 27, 2023).

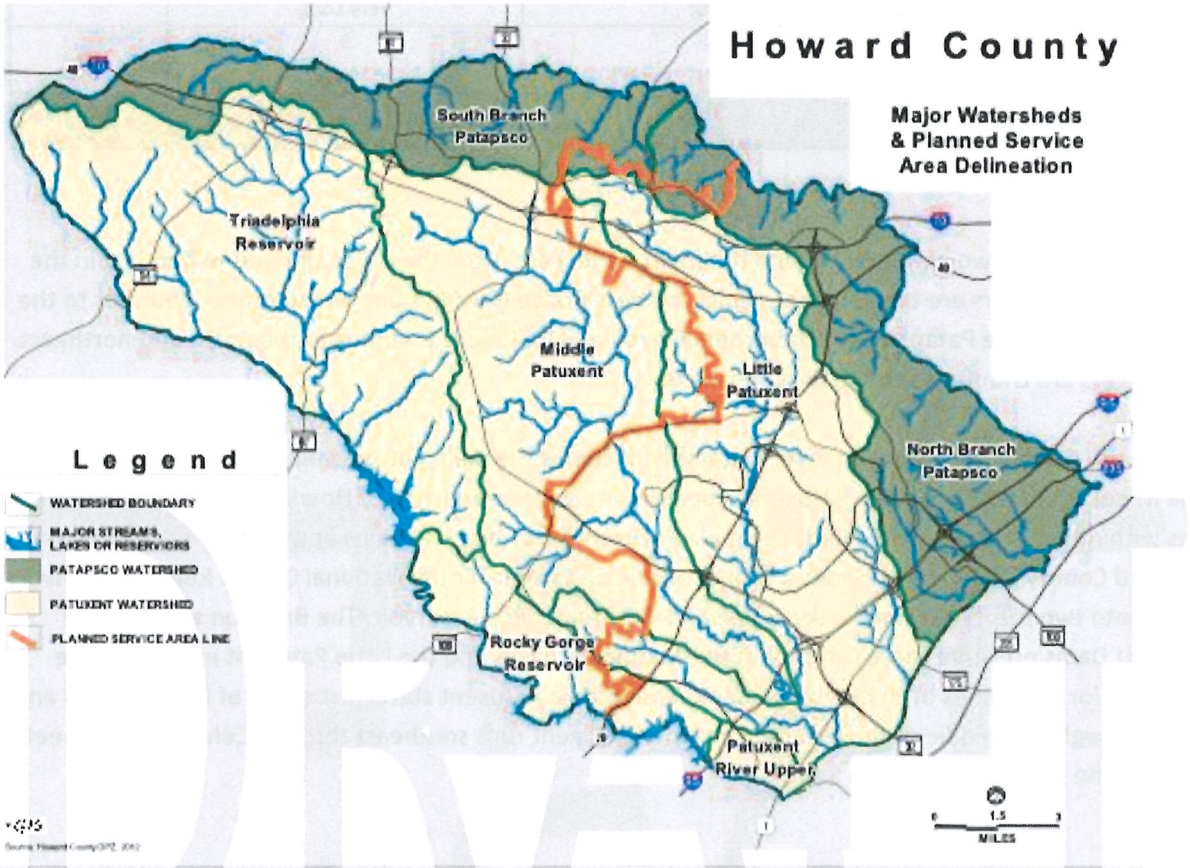
	Warning Time	2 Long	1 Very Long	5%
	Duration	1 Short	3 Long	5%
TOTAL RISK SCORE		**2.3**	**2.9**	

Hazard Location

Howard County's two major rivers (and their tributaries) are often the origin of riverine flooding in the County. These rivers are the Patuxent, which borders Prince George's and Montgomery Counties to the Southwest, and the Patapsco, which borders Carroll and Baltimore Counties to the north and northeast. Both rivers are tributaries to the Chesapeake Bay.

In Howard County, the Patuxent River watershed includes the main Patuxent River and two branches, the Middle Patuxent and Little Patuxent. Approximately three-quarters of Howard County's land area lies within the Patuxent watershed. The main Patuxent River branch begins at the most western point of Howard County. This river provides a source of drinking water for the National Capital Region. The river feeds into two reservoirs, the Rocky Gorge and the Triadelphia Reservoir. The Brighton and Howard Duckett Dams preserve these reservoirs. The Middle Patuxent and the Little Patuxent are two of the three major tributaries of the Patuxent River. The Middle Patuxent starts just south of Interstate 70 and runs through the middle of the County. The Little Patuxent runs southeast through Columbia and meets up with the Middle Patuxent in Savage.

FIGURE 34: HOWARD COUNTY MAJOR WATERSHEDS



*Source: Howard County, Planning and Zoning Department

The Patapsco River watershed makes up the remaining quarter of the County's land area. The watershed is located to the extreme north and northwest of the County. The river splits into two branches, which serve as the borders for Carroll, Baltimore, and Howard Counties.

The Patuxent, Middle Patuxent, Little Patuxent, and Patapsco River watersheds can be divided even further to include Cattail Creek, Deep Run, Dorsey Run, and Hammond Branch watersheds. In addition, the County has several other smaller tributaries. These include Bonnie Branch, Clyde's Branch, Guilford Branch, Plumtree Branch, and the Tiber-Hudson Branch. All these tributaries are susceptible to riverine flooding.

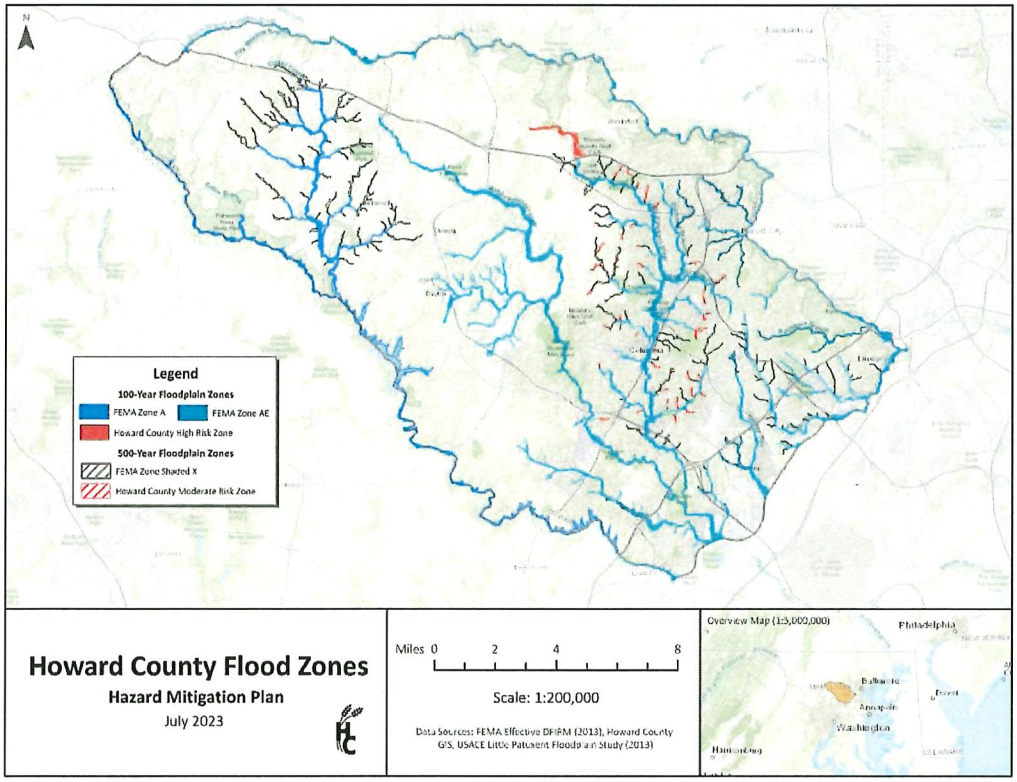
Hazard Extent

Flood severity is measured in various ways, including frequency, depth, velocity, duration, and contamination. In Howard County, the severity of the flood hazard depends on the part of the County considered, but severity issues are generally correlated with frequency of occurrence. Flooding along the three major rivers of the County usually occurs during the summer and early fall, mainly as a result of severe thunderstorms and tropical cyclones. These events force smaller tributaries of the County to overflow and flood from the top down. The events of the 2016 Ellicott City flood caused over $10 million

in damages and claimed two lives, and the 2018 Ellicott City flood caused around $20 million in damages[38].

As the figure below illustrates, the majority of flood-prone areas are located in the eastern, and more urbanized, portion of the County. The Howard County Flood Mitigation Plan (FMP) states that 5.1% of the County's land area is susceptible to riverine, flash, and urban flooding.[39] Howard County has vulnerabilities to floods; some of the major cities in the County, such as Ellicott City, Elkridge, and the Allview neighborhood in Columbia are in low-lying areas. The aforementioned dams, low-lying roads, and railways also present another challenge in the County.

FIGURE 35: HOWARD COUNTY FLOOD ZONES



[38] *Howard Announces $8.1M Grant to Repair Damage from 2018 Flash Flood, 2019, Maryland Association of Counties, https://conduitstreet.mdcounties.org/2019/08/08/howard-announces-8-1m-grant-to-repair-damage-from-2018-flash-flood/, (last accessed July 26, 2023).*

[39] 2024 FLOOD MITIGATION PLAN UPDATE, HOWARD CTY., MD., (February 16, 2023).

[40] Howard County Department of Public Works Storm Water Management Division. For detailed maps of local areas and their flood zones, please visit https://data.howardcountymd.gov/gdfirm/main_Web.aspx.

Howard County Flood Zone Definitions[41]	
FEMA Zone A	The flood insurance rate zone that corresponds to the 100-year floodplain that is determined in the Flood Insurance Study by approximate methods. Mandatory flood insurance purchase requirements apply here, as well. Because detailed hydraulic analyses are not performed for these areas, no Base Flood Elevations or depths are shown within this zone on FEMA's FIRMs.
FEMA Zone AE	The flood insurance rate zone that corresponds to the 100-year floodplain that is determined in the Flood Insurance Study by detailed methods. Mandatory flood insurance purchase requirements apply. In most instances, the Base Flood Elevations derived from the detailed hydraulic analyses at selected intervals within this zone (the cross sections) are shown on FEMA's Flood Insurance Rate Maps (FIRMs).
Howard County High Risk Zone	The 100-year floodplain for drainage areas of 30 acres or greater as defined in Chapter 6 of the Howard County Design Manual, Volume 1. Mandatory flood insurance purchase requirements do not apply here. County development restrictions apply. If overlaps occur with the DFIRM, the FEMA DFIRM applies.
FEMA Zone Shaded X	The areas of 0.2% annual chance flood (the 500-year floodplain); areas of 1% chance of flood with average depths of less than 1 foot; or with drainage areas less than 1 square mile and areas protected by levees from 1% annual chance flood. Mandatory flood insurance purchase requirements do not apply here. County development restrictions apply.
Howard County Moderate Risk Zone	The 500-year floodplains for drainage areas of 30 acres or greater as defined in Chapter 6 of the Howard County Design Manual, Volume 1. Mandatory flood insurance purchase requirements do not apply here. County development restrictions apply. If overlaps occur with the DFIRM, the FEMA DFIRM applies.

[41] https://data.howardcountymd.gov/gdfirm/Floodplain%20Website%20Updates%20-%20flood%20zones_v3.pdf

According to the 2024 Howard County Flood Mitigation Plan, 548 out of 82,102 (0.6%) structures in the County are vulnerable to flooding. The map below depicts the 100-year Floodplain Special Hazard Zone, which are areas with special flood, mudflow, or flood-related erosion hazards.[42] The following figure provide statistics regarding estimated building exposure and estimated building losses for a 100-year flood hazard, a magnitude flood event that has a 1% annual probability of occurring, if all exposed buildings were damaged.[43]

Study Area	Exposed and Damaged Buildings	Exposed and Damaged Residential Buildings	Exposed and Damaged Commercial Buildings
Columbia	144	134	10
Elkridge	76	56	20
Ellicott City	214	143	71
Other Areas	114	37	77
County Total	548	370	178

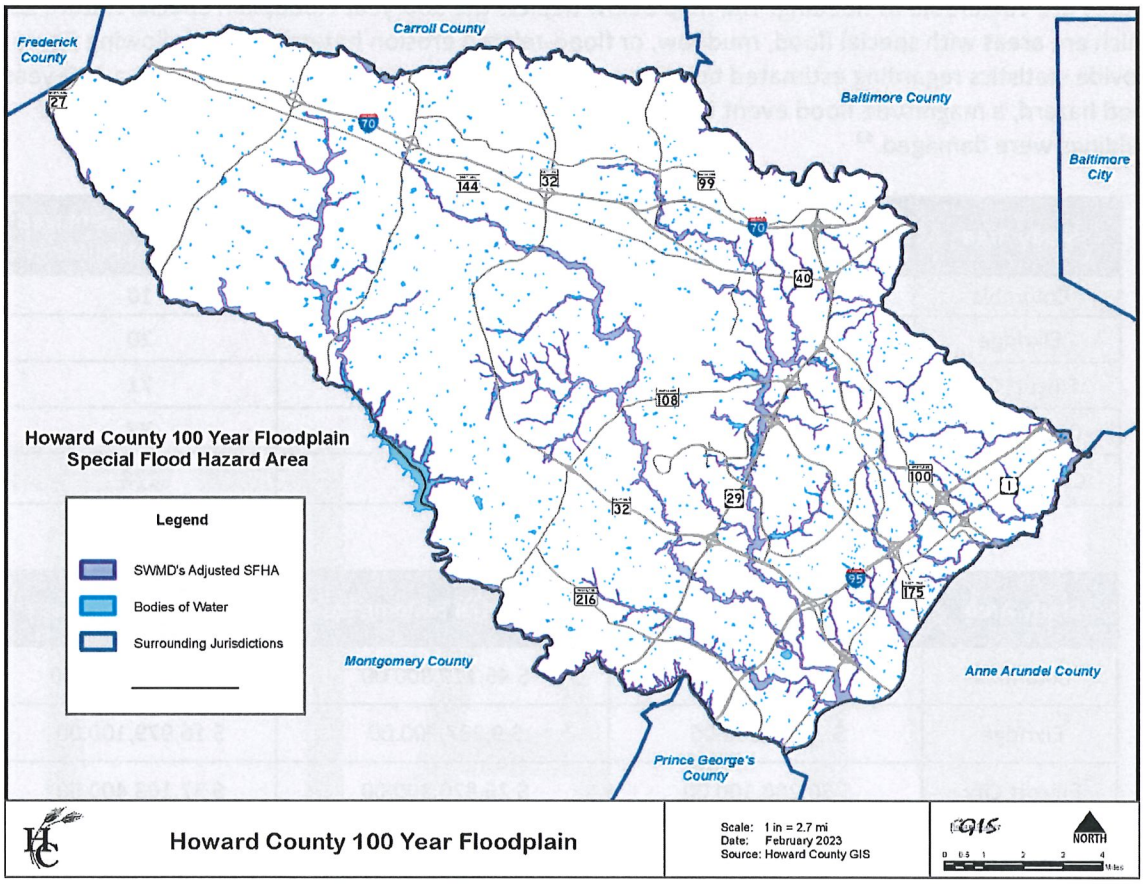
Study Area	Residential Building Loss	Commercial Building Loss	Total Building Loss
Columbia	$ 289,020,100.00	$ 45,119,800.00	$ 334,139,900.00
Elkridge	$ 7,741,200.00	$ 9,237,900.00	$ 16,979,100.00
Ellicott City	$ 30,288,100.00	$ 26,820,300.00	$ 57,108,400.00
Other Areas	$ 37,649,800.00	$ 386,273,000.00	$ 423,922,800.00
County Total	$ 364,699,200.00	$ 467,451,000.00	$ 832,150,200.00

In the 2024 Howard County FMP, a flood vulnerability assessment was executed that examined critical facilities and their locations in the 100-year flood zone. The following facilities were included in this analysis: fire stations, police stations, schools, government buildings, wastewater treatment facilities, and other utilities infrastructure, senior centers, assisted housing, hospitals, and nursing homes. Only five critical facilities were determined to be in the modeled flooded area as can be seen below.

[42] See Hazard Definitions Appendix G for all definitions.

[43] See Hazard Definitions Appendix G for all definitions.

FIGURE 36: HOWARD COUNTY 100 YEAR FLOODPLAIN SPECIAL FLOOD HAZARD AREA



*Source: Howard County Department of Technology and Communication Services, GIS Division

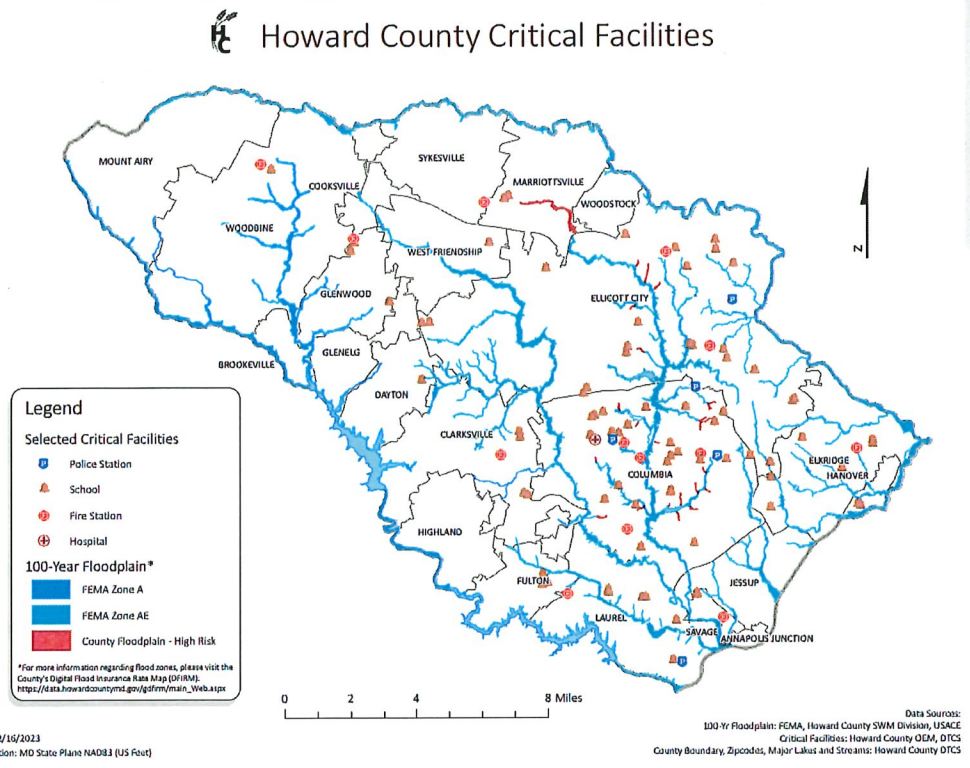
Critical Facilities in the 100-Year Flood Zone

Facility Type	Name
Wastewater Treatment Plant (WWTP)	Little Patuxent Water Reclamation Plant
School	Clemens Crossing Elementary School
Pumping Station – Sewer	NLRL
Pumping Station – Sewer	RT40
Pumping Station – Sewer	R108

Hazard Impacts

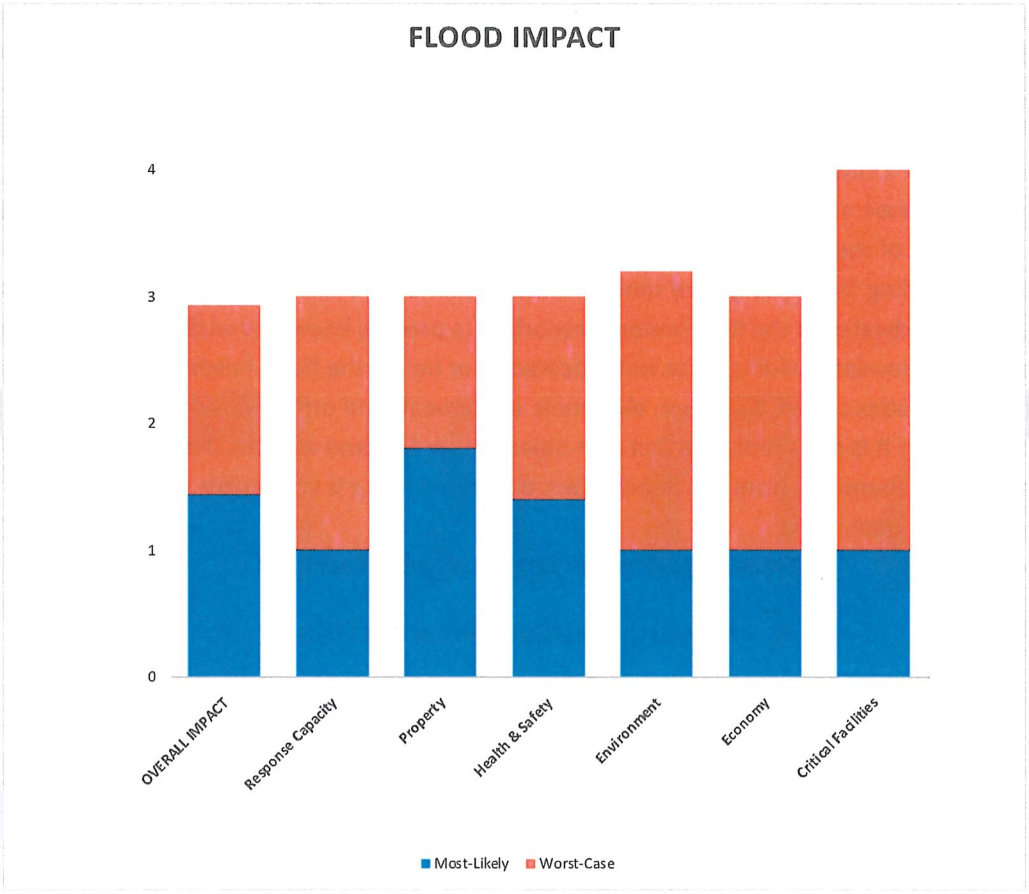
Due to the tremendous power of moving water, flash flooding can easily cause loss of life and significant damage, including uprooting of trees, undermining of buildings and bridges, and scouring new channels. According to the 2024 Howard County FMP, although the number of people killed or injured nationally during floods each year is relatively small, Howard County suffered three flood-related deaths between 2016 and 2018. It is the built environment within the floodplain, however, which is most likely to bear the brunt of a flood's impact. Whether the water is moving or standing, the exposure of buildings to floodwater could cause a great deal of damage. If the water is moving, the hydraulic pressure variation between the inside of the building and the outside can cause the walls and foundation to buckle and fail. If the water is standing for any length of time, even materials above the flood height could become saturated with floodwater as the floodwater is absorbed (a process known as wicking). Certainly, most of the contents of flooded buildings that were located at or below the flood height will need to be discarded. This includes carpet, furniture, electronic equipment, and other household or commercial items. In most cases it is not simply the fact that objects have become wet but the sediment, contaminants, and chemicals from the floodwaters that could make it impossible to recover all but the most precious/heirloom items.

FIGURE 37: HOWARD COUNTY CRITICAL FACILITIES



In Figure 37, the High-Risk County Floodplain is part of the 100-year floodplain for drainage areas of 30 acres or greater.

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



Flood - Consequence Analysis Likely		
CATEGORY	**RANKING**	**DESCRIPTION**
PROPERTY DAMAGE	*Limited-Significant*	▪ Limited critical and non-critical infrastructure damage. ▪ Debris on the roadway is expected. ▪ Limited washouts at road edges and around some culverts are expected to be damaged.
HEALTH AND SAFETY	*Limited-Significant*	▪ Zero deaths are expected. Vehicle in water and attempting to escape, walking near water, or electrocution are the most common causes of death. ▪ Two injuries are expected. Vehicle collisions and stranded drivers trying to escape are the most common causes of injuries.
CRITICAL FACILITIES	*Limited*	▪ *Utilities* – shutdown unlikely. ▪ *Information/Communications* – Outage unlikely. ▪ *Transportation* –Minor flooding on roadways, blocking traffic and causing the need for rescue of a few individuals who became stranded while trying to cross through the flood waters. Several flooded roadways, fast moving water, impact traffic, and law enforcement and public works required to block roads and recover.

RESPONSE CAPACITY	*Limited*	▪ *Police* – Local resources adequate. ▪ *Fire and Rescue* – Local resources adequate. Limited impact to response capability. Additional personnel will be necessary to assist with stranded motorists. ▪ *Health* – Local resources adequate. HD has COOP plans in place to ensure essential functions continue either on site (if possible) or at an alternate location. ▪ *Public Works* – Local resources adequate. Minimal Impact on response capability and continuity of operations.
ENVIRONMENTAL IMPACT	*Limited*	▪ Minimal impact with a possible short-term spike in water pollution. ▪ Mudslides or fallen trees can cause serious erosion or sediment pollution to the local water resource.
ECONOMIC IMPACT	*Limited*	▪ Millions of losses in dollar value in low lying areas. ▪ Structural and business loss and disruption of transportation network in economic consequences.
TOTAL IMPACT	***Limited-Significant***	▪ **Total Impact Score: 1.4 on a scale of 1 (Limited) to 4 (Catastrophic).**

Limited	*Significant*	*Critical*	*Catastrophic*

Vulnerability of County Assets

Howard County's 2024-2029 Flood Mitigation Plan conducted a flood vulnerability assessment and included examining the Equity Emphasis Area Index (EEAI) score in flood-prone areas[44]. This section includes the results of this assessment.

The EEAI score is determined based on the Baltimore Metropolitan Council's Vulnerable Population Index (VPI) methodology[45], which considers the following vulnerable population groups:

- Poverty;
- Non-Hispanic, Non-White;
- Hispanic;
- Limited English Proficiency (LEP);
- Disabled;
- Elderly ; and,
- Carless.

Census tracts receive scores from zero to eleven, and the higher the score, the more vulnerable the population. The maps below show the EEAI score for each census tract in Howard County and a comparison of the distribution of buildings in flood hazard areas (100-year floodplain) and EEAI scores. Columbia, Ellicott City, and parts of Elkridge and Laurel appear to have areas with both higher EEAI scores (more vulnerable populations) and higher densities of buildings in flood hazard areas. The western side of the County generally has lower EEAI scores (less vulnerable populations) and sporadic instances of buildings in the floodplain.

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[44] *Howard County 2024-2029 Flood Mitigation Plan Update, Howard County Department of Public Works, (Draft form)*

[45] *Vulnerable Population Index: Considering the Transportation Needs of Vulnerable Populations, 2018, Baltimore Metropolitan Council, https://www.baltometro.org/sites/default/files/bmc_documents/data%26maps/transportation/vpi/VPI-white-paper-2018_web.pdf, (last accessed July 24, 2023).*

FIGURE 38: HOWARD COUNTY EEAI BY CENSUS TRACK

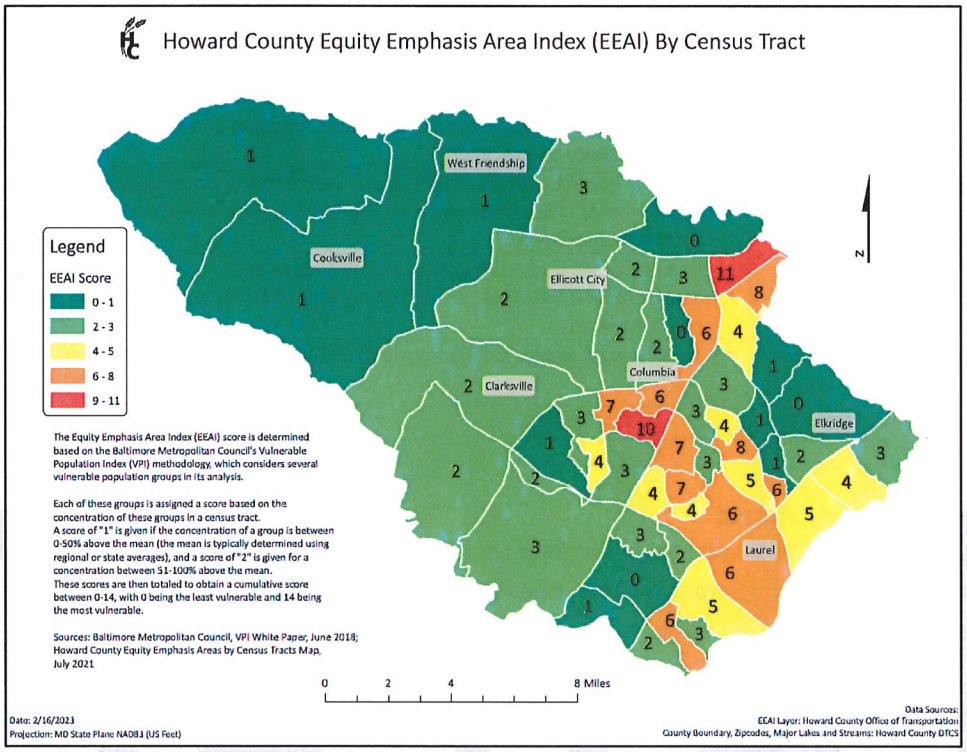
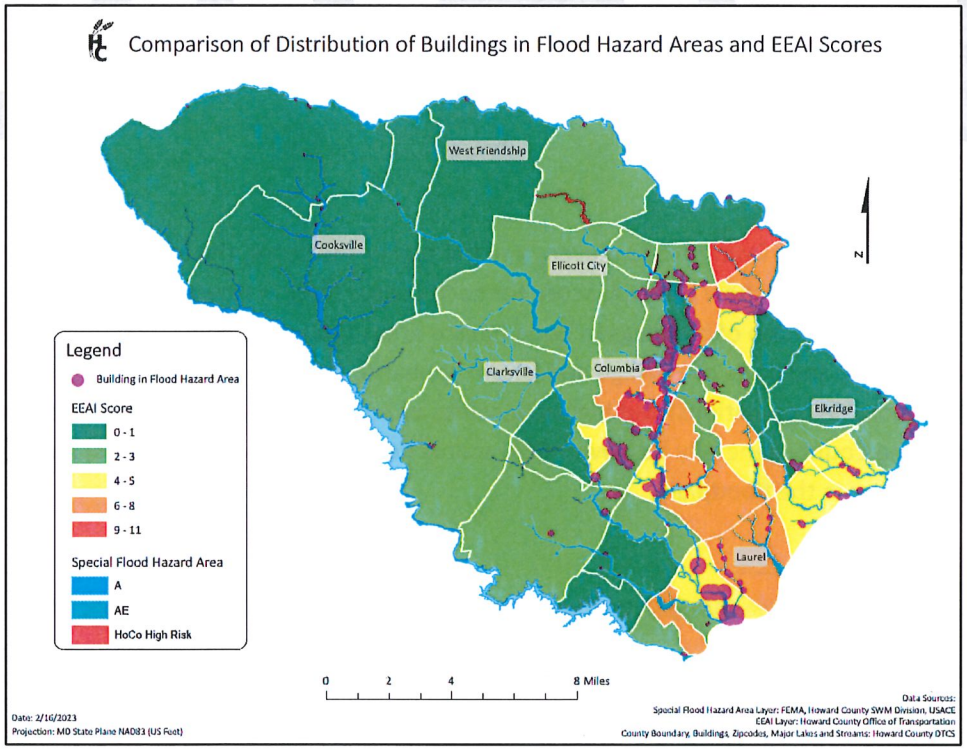


FIGURE 39: COMPARISON OF DISTRIBUTION OF BUILDINGS IN FLOOD HAZARD AREAS & EEAI SCORES



Effects of Population Change and Development in Hazard-Prone Areas

More information on how Howard County is enforcing strict development regulations on mapped floodplains and other mitigation flood mitigation activities, please refer to Chapter 2, section Development in Hazard-Prone Areas.

High population density areas may experience faster urban runoff during intense rainfall events, leading to quicker onset of flash floods. The combination of impervious surfaces and insufficient drainage can result in rapid and dangerous flooding. While the risk of flash flooding might be lower in low population density areas, it's important to note that even rural or less developed regions can still experience flash floods, especially if topography, soil type, or other factors contribute to rapid runoff. High population density areas may require more extensive infrastructure development, such as roads, bridges, and stormwater management systems. Inadequate or outdated infrastructure can contribute to localized flooding by restricting water flow and causing backups.

As Howard County, Maryland, looks towards the future and experiences continued development and urbanization, it is imperative to assess how these changes may influence the county's vulnerability to flooding. This assessment is particularly critical in areas that are inherently prone to flooding due to their geographical and hydrological characteristics. Future development is likely to introduce additional impervious surfaces such as roads, parking lots, and buildings. These surfaces hinder the natural infiltration of rainwater into the soil, leading to increased surface runoff during precipitation events. In areas already susceptible to flooding, this heightened runoff can exacerbate flood risks by overwhelming drainage systems and watercourses. Coastal and waterfront development introduces an additional layer of flood vulnerability due to sea-level rise, storm surges, and tidal fluctuations. As these areas are exposed to both riverine and coastal flooding, development without proper consideration of these factors can escalate flood risks. While development contributes to economic growth, rapid expansion can strain existing infrastructure such as drainage systems, culverts, and sewage networks. Inadequate infrastructure can hinder efficient water management and escalate flooding concerns, particularly during heavy rainfall events. Both population growth, density, and future development can be seen primarily within the regions of Central and South-eastern portions of Howard County, please refer to Chapter 2, Growth and Development section, and subsection Future Development of this Plan to identify where these current and future populations density areas are/expected to be and where future development is expected to be.

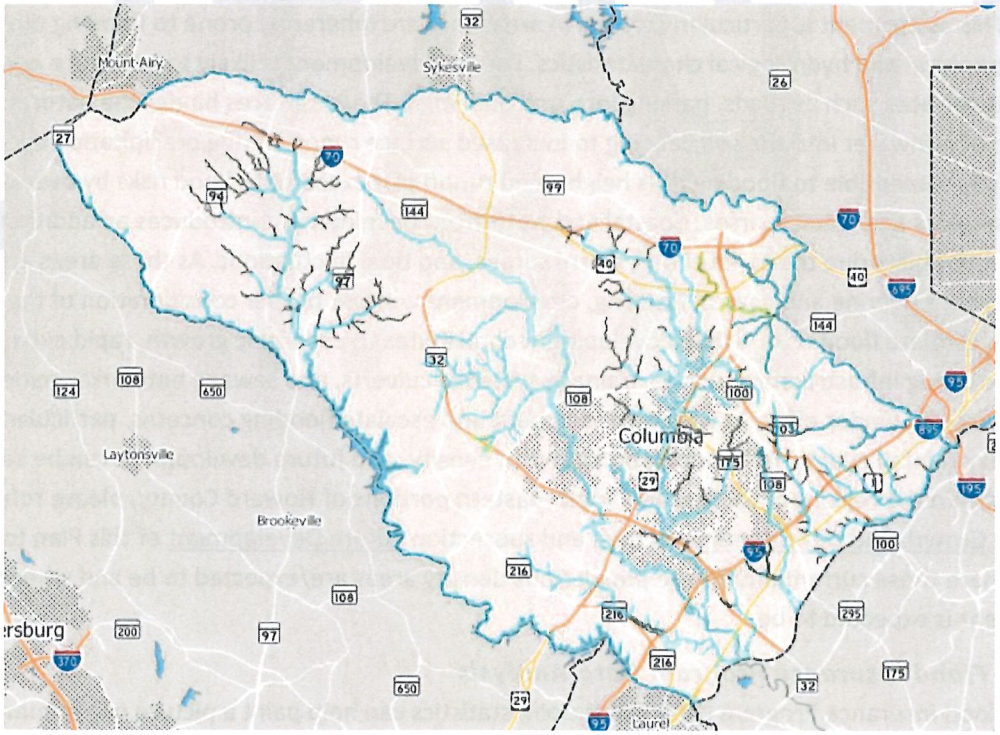
National Flood Insurance Program Data Analysis

National Flood Insurance Program (NFIP) data claim statistics can help paint a picture of a community's flood vulnerability and risk. The NFIP is a federal program that enables property owners in participating communities to purchase insurance to protect against flood losses. To participate, communities must develop and continuously implement floodplain management regulations that will reduce future flood damages. If a community adopts and enforces floodplain management ordinances, the federal government will ensure flood insurance is available to those in the community.

FEMA prepares and makes available to the public Flood Insurance Rate Maps (FIRMs), which provide an overview of flood risk and identify County land that is vulnerable to flooding. FIRMs are used to regulate new development and control the substantial improvement or repair of substantially damaged buildings. Flood Insurance Studies (FIS), often developed in conjunction with FIRMs, contain a narrative of the flood history of a community and discuss the engineering methods used to develop the FIRMs. The study also contains flood profiles for studied flooding sources and can be used to determine Base Flood Elevations (BFE) for some areas.[46]

The most recent, Volume three, Howard County FIS is dated November 6th, 2013, and compiles previous flood information and data on numerous waterways.[47] The 2024 updated FMP for Howard County states that Preliminary Digital Flood Insurance Rate Maps (DFIRMs) were updated. These updates include incorporating the results of any new flood studies into the new DFIRMs and reconciling the new DFIRM data with the flood data in the FMP. These DFIRMs are made in response to the changing conditions affecting the County, including changes in land use, weather events, and improved techniques for assessing floodplains.

FIGURE 40: DIGITAL FLOOD INSURANCE RATE MAP AS OF AUGUST 26, 2022



*Source: https://data.howardcountymd.gov/gdfirm/main_Web.aspx

[46] *Base Flood Elevation (BFE)*, FEMA, https://www.fema.gov/base-flood-elevation (last visited Feb. 27, 2023) (defining BFE as "[t]he elevation of surface water resulting from a flood that has a 1% chance of equaling or exceeding that level in any given year." The BFE serves as the regulatory requirement for the elevation or flood-proofing of structures, which determines the flood insurance premium.).

[47] FLOOD INSURANCE STUDY, HOWARD CTY., MD. AND INCORPORATED AREAS (Vol. 3 of 3, Nov. 6, 2013), https://data.howardcountymd.gov/scannedpdf/Environmental_Services/EffectiveFirmDocs/24027CV003A.pdf.

According to the 2024 Howard County Flood Mitigation Plan, as of May 2022, FEMA reports that there are 53 Repetitive Loss (RL) properties in Howard County, four of which are Severe Repetitive Loss (SRL) properties. A RL property is defined as any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978. A SRL property is defined as a residential property that is covered under an NFIP flood insurance policy and:

- Has at least four NFIP claim payments (including building and contents) over $5,000 each; or,
- At least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.

Five of the RL properties are mitigated RL properties, which were acquired by the County, and their buildings were demolished. Mitigation for two of the demolished buildings used FEMA funds. The five lots are now open space. The County has filed the proper paperwork to update the RL list to remove these five mitigated properties. FEMA produces loss and claim statistics for all National Flood Insurance Program communities throughout the Country. The three following tables provide data on the loss and policy statistics respectively for Howard County between 1977 and December 1, 2022, as well as land use types for the RL and SRL Properties.

RL and SRL Land Use Counts	
Low-Density Residential	18, 1 of which is SRL
Commercial	16 total, 2 of which are SRL
Mixed-Use	5
Parks & Open Space	12, 1 of which is SRL
Medium-Density Residential	2

Howard County Loss Statistics[48]

Area	Losses	Total Payments
Howard County	394	$15,717,563

Howard County NFIP Policy Statistics[49]

Area	Policies in Force	Insurance in Force	Whole Written Premiums in Force
Howard County	960	$ 287,289,000	$ 891,524

[48] Source: https://bsa.nfipstat.fema.gov/reports/1040.htm#24 as of 6/30/2018.

[49] Source: https://bsa.nfipstat.fema.gov/reports/1011.htm#MDT as of 6/30/2018.

Hazard Occurrences

The NCDC indicates there have been 36 flooding events in Howard County from 2002 to 2022.[50] The NCDC separately categorized flash flooding events. Between 2002 and 2022, the NCDC reports that there were 32 flash flood events.[51]

Howard County has had numerous flooding incidents, including major events such as Tropical Storm Agnes in 1972, Hurricane Eloise in 1975, Hurricane Floyd in 1999, Tropical Storm Lee in 2011, and most recently, the Ellicott City flash flooding events on July 30th, 2016, and May 27th, 2018. Most incidents are the result of tropical systems, nor'easters, or flash flooding from sudden, short-lived rainstorms. To develop the following flood history narratives, information was pulled from FIS for Howard County and the NCDC database. Detailed descriptions of these events can be found below.

Notable Incidents in Howard County

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

July 1868	On July 24th, 1868, 18 inches of rain fell in Howard County, causing the Patapsco River to overflow. Witnesses noted that the river rose approximately 30 feet in 30 minutes. The flood resulted in 37 fatalities and caused an estimated $5.6 million in damage.
May 1894	The Patapsco River flooded, causing extensive property damage. The flood resulted in approximately $203,740 in damage.
September 1952	On Labor Day weekend, Hurricane Able's heavy rains swept through Howard County. A destructive flash flood caused a log jam in the mouth of the Tiber River and resulted in approximately $5.4 million worth of damage.
August 1971	August 1st – 4th, 1971, heavy rain and flooding caused numerous road closures and damaged several homes. The Patuxent River rose 25 feet in 30 minutes and mud slides damaged roads and bridges. Roads that were flooded and/or damaged included: Owen Brown Road, Morgan Road, Carroll's Mill Road, River Road, Mullinix Mill Road, Howard Chapel Road, Furnace Avenue, Mink Hollow Road, Route 108, Route 32, Centennial Lane, Bethany Lane, and Old Annapolis Road. An estimated $799,244 in County property damage was reported.
June 1972	Another notorious and destructive flooding event in Howard County was caused by Tropical Storm Agnes from June 21st – 23rd, 1972. The Howard County FIS estimates the total property damage from the storm to be as high as $56.2 million. The majority of the damage occurred along the Patapsco River in the Ellicott City and Elkridge areas. The total damage along the Patapsco River was estimated to be approximately $49.1 million. Property damages along the Little Patuxent River totaled about $3.2 million and damages along the Patuxent and Middle Patuxent totaled roughly $699,031. An estimated $1.5 million worth of damages occurred to roads and bridges throughout the County. Meanwhile, the Spatial Hazard Events and Losses Database for the United States (SHEDLUS) database estimates the total property damage from Tropical Storm Agnes to be

[50] *Storm Events Database*, NOAA NAT'L CTRS. FOR ENV'T INFO., https://www.ncdc.noaa.gov/stormevents/ (last visited Feb. 27, 2023).

[51] *Id.*

	roughly $15.2 million. This massive flood caused at least three fatalities. The photograph below shows the flooding that occurred along Main Street in downtown Ellicott City.
September 1975	September 22nd – 26th, 1975, the remnants of Hurricane Eloise, 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 Hurricane Agnes. Mud and debris covered the landscape, and homes and businesses were declared unsafe.
June 1996	On June 19th, 1996, storms poured 5.5 inches of rain into Howard County and flooded roads, bridges, and properties. Seneca Creek and Bennett Creek overflowed their banks, causing several roads to be temporarily closed. Two fatalities occurred when a couple rafting in the Patapsco River was swept over a dam in the raging current. $112,636 in property damage was reported.
September 1996	On September 6th, 1996, the remnants of Hurricane Fran dropped up to five inches of rain in parts of the County and caused physical damage to the County with 40 mph sustained winds. Minor flooding occurred, 36,300 residents of Howard County lost power, and $46,829 of property damage was recorded.
September 1999	On September 9th, 1999, a thunderstorm moved through the County, producing damaging winds and heavy rainfall across the area. Flooding occurred in Ellicott City, Dorsey, Columbia, and Elkridge. Portions of Route 1 flooded, and cars became trapped by the surrounding water. Water infiltrated homes near Columbia and Dorsey. Precipitation measurements showed 7.39 inches of rain near Columbia and 5.98 inches near Elkridge.
September 1999	On September 16th, 1999, the remnants of Hurricane Floyd produced high winds and heavy rains that closed 200 roads and streets countywide. 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 were damaged, 350 basements were flooded, two people were rescued, and the Howard Country Fair was shut down for the first time in its 47-year history.
Floods of 2003	Howard County experienced several floods in 2003. First, on February 22nd, widespread flooding was caused by both melting snow from the snowstorm of February 14th – 18th, 2003 combined with one and a half to three inches of rain. Several roads closed, including Route 108, Race Road, Furnace Avenue, Triadelphia Mill Road, and Toll House Road and 30 basements flooded. A few months later, from June 7th-20th, 2003, storm systems moved across the region, causing roads and waterways repeatedly to flood for nearly two weeks. River and stream levels remained high throughout this period, fed by up to five inches of rain per day. Several roads were closed multiple times including Furnace Avenue, South Entrance Road, Carris Mill Road, Warfield Road, Route 108, and Lime Kiln Road. On September 23rd, a few days after Hurricane Isabel brought rain to the region, a heavy rainstorm brought two and a half inches of rain in one day and flooded parts of the County. On November 19th, a strong line of thunderstorms brought two to four inches of rainfall, which resulted in the closure of several roads. Finally, on December 11th, a heavy overnight rainfall averaging two to three inches fell on snow-covered grounds, melting the snow. This led to the heightening of rivers and streams as well as the closure of several roads due to rising water.

October 2005	On October 8th, 2005, remnants of Tropical Strom Tammy caused prolonged heavy rainfall that measured seven inches in two days. 10 roads in the County flooded, two homes were damaged by the influx of mud, and a water rescue was conducted in Ellicott City.
June 2006	On June 23rd – 26th, 2006, a storm system moving from the south caused torrential rain that continued for four days. The ground was saturated, and low-lying areas flooded as the area accumulated more than 10 inches of rain. A two-to-three-foot storm surge, coupled with flood water, washed away part of the Vollmerhausen Road bridge and forced the closing of minor roads. Main Street in Ellicott City flooded, causing a broken sewer line.
July 2008	On July 23rd, 2008, a slow-moving cold front produced a wave of heavy showers in the afternoon and evening. Flash flooding occurred, closing several roads including I-95, the nation's main thoroughfare on the East Coast, near Elkridge.
July 2016	On July 30th, 2016, a significant flooding event occurred when a strong storm dropped six inches of rain over Ellicott City over a span of two hours. Significant flash flooding caused extensive damage to businesses and homes on Main Street and in the West End neighborhood of Historic Ellicott City. The storm took two lives and caused at least $27.7 million in estimated damages. The storm caused extensive damage to 90 businesses and 107 homes. The images below are from the July 2016 flooding.
May 2018	On May 27th, 2018, a series of heavy thunderstorms caused excessive rainfall in short period of time, resulting in flash flooding. This event occurred just 22 months after the 2016 flooding in Ellicott City and Catonsville. According to the NOAA, "The heavy rainfall, between six to 12 inches in the heaviest band, caused catastrophic damage, especially in Historic Ellicott City." There was flood damage to buildings, infrastructure, and vehicles. Roads washed out, land eroded, and there were localized landslides. Emergency swift-water rescue operations were performed. There was one fatality during the flood. The graphs below show the rainfall totals through the evening and associated water levels.

Hazard Future Likelihood – Medium-High

The future annual probability of a Flood is 11-30% + chance of annual occurrence, or one event every 1-9 years. There is an increased risk of flood events going forward based on the National Climate Assessment, which projects increased frequency of severe storms and rain. An expected increase in rainfall levels and extreme storms may result in a slight increase in the likelihood of flooding.[52] Aging dam infrastructure may also contribute to a slight increase in the likelihood of flooding in the future. Other considerations include existing buildings in the floodplain and continued development.

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

Future Likelihood of a Flood in Howard County	
Historical Average (time period)	36 flood events between (2002-2022) and 32 flash flood events between (2002-2022)
Historical Annual Probability	30%+ chance of annual occurrence

[52] *Fourth National Climate Assessment,* U.S. GLOB. CHANGE RESEARCH PROGRAM, https://nca2018.globalchange.gov (last visited Feb. 27, 2023).

Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No
Future Annual Probability	11-30% + chance of annual occurrence
Future Likelihood Score	3.1 (Likely- Very Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

Tornado/Windstorm (Risk Score 2.1)

Hazard Description

Windstorms and Tornadoes are grouped together as one hazard but are defined separately. Windstorms fall within two categories: thunderstorm winds, and high wind events. These types of events will be discussed separately within this hazard profile. A tornado is "a violently rotating column of air, pendant from a cumuliform cloud or underneath a cumuliform cloud, and often (but not always) visible as a funnel cloud."[53] Tornadoes are related to larger vortex formations, and therefore often form in convective cells such as thunderstorms or in the right forward quadrant of a hurricane, far from the hurricane eye.

Damaging winds are often called "straight-line" winds to differentiate the damage they cause from tornado damage. Strong thunderstorm winds can come from several different processes. Most thunderstorm winds that cause damage at the ground are a result of outflow generated by a thunderstorm downdraft. Damaging winds are classified as those exceeding 50-60 mph.

Windstorms are categorized in the NCDC database as thunderstorm winds and high wind events. Within these windstorm events are two basic types of winds that may affect Howard County: Mesoscale and Microscale winds. Either type of windstorm event may result in property damage and loss of life. Mesoscale winds are high winds that are long-lasting and occur over a large area. They are typically associated with a cold frontal passage or a nor'easter. Microscale winds last a short time period and are confided to a small area. Microscale winds are commonly associated with thunderstorms. When a thunderstorm produces winds over 50 kts (roughly 58 mph), that thunderstorm is considered severe.

A downburst is "the general term used to broadly describe macro and microbursts."[54] Downbursts result from a sudden descent of cold air hitting the ground and spreading outward, thus creating a high wind event. A downburst can have devastating effects. According to NOAA, there are two types of downbursts; a microburst and a macroburst. A microburst is a small downburst that brings damaging winds up to 168 mph, over an area of two and a half miles, and lasts five to fifteen minutes. A

[53] *Glossary of Meteorology*, AM. METEOROLOGICAL SOC'Y (2000), http://www.spc.noaa.gov/faq/tornado/ (last visited Feb. 27, 2023).
[54] *Severe Weather 101 – Damaging Winds*, NOAA NAT'L SEVERE STORMS LAB., https://www.nssl.noaa.gov/education/svrwx101/wind/ (last visited Feb. 27, 2023).

macroburst is a large downburst that causes tornado-like damage, where winds can reach 134 mph, over an area of two and a half miles, and lasts five to thirty minutes.

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

Tornado/Windstorm Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	3.0 Likely		50%
CONSEQUENCE	**Impact**	1.0 Limited	2.8 Significant-Critical	40%
	Warning Time	3 Moderate	4 Short	5%
	Duration	1 Short	1 Short	5%
TOTAL RISK SCORE		**2.1**	**2.9**	

Hazard Location

Tornadoes can form at any time, in any location with the Nation's season of greatest activity running from March to August. The peak of tornado activity usually occurs in April, May, and June in the United States. Tornadoes can occur at any time of the day, although they are more likely to occur between 4 p.m. and 9 p.m.[55] This is because "by this time the sun has heated the ground and the atmosphere enough to produce thunderstorms."[56]

Within Howard County, the risk to people and property from tornadoes cannot be distinguished by area; the hazard has a uniform probability of occurrence across the County. Although the impact of a tornado event will be different in different parts of the County, all people and assets are considered to have the same degree of exposure. This is the same for mesoscale and microscale wind events. The figures below show how the frequency and strength of extreme windstorms can vary across the United States.

[55] *Severe Weather 101 – Tornadoes*, NOAA NAT'L SEVERE STORMS LAB., https://www.nssl.noaa.gov/education/svrwx101/tornadoes/ (last visited Feb. 27, 2023).

[56] *Tornadoes, explained*, NAT'L GEOGRAPHIC (Aug. 28, 2019), https://www.nationalgeographic.com/environment/natural-disasters/tornadoes/.

FIGURE 41: UNITED STATES WIND ZONES MAP

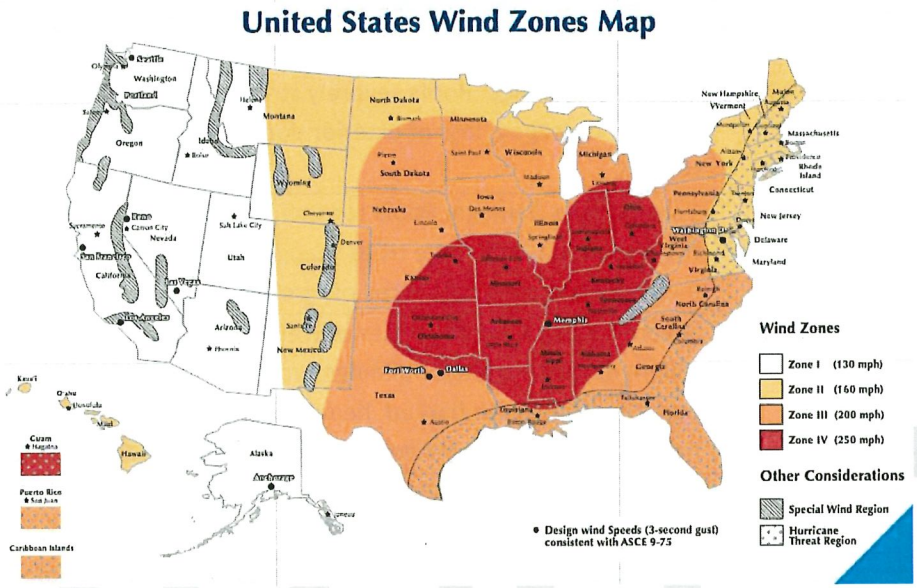


FIGURE 42: UNITED STATES WIND ZONES ZOOMED-IN IMAGE OF MARYLAND[57]

Hazard Extent

Tornado damage severity is measured by the Enhanced Fujita Tornado Scale (EF-Scale), named after Dr. T. Theodore Fujita, who introduced the scale in 1971. This scale is a set of wind estimates based on observed damages after a tornado. It uses three-second gusts estimated at the point of damage. It is also based on a judgment of eight levels of damage and 28 indicators that include various commercial and residential building types, transmission towers, poles, and trees. Similar to the original scale, the new EF-Scale includes five classes ranging from EF0 to EF5. The table below displays the wind speed ranges of the EF-Scale that has been in use since February 2007.

[57] *Chapter 5 – Risk Assessment Maps - United-States – Seismic and Wind Zones*, ONTARIO CNTY., NY, https://www.co.ontario.ny.us/DocumentCenter/View/3445/Chapter-5---Risk-Assessment-Maps---United-States---Seismic-and-Wind-Zones (last visited Apr. 6, 2023).

EF-Scale Number	3 Second Gust (MPH)	Type of Damage Done
EF0	65-85	Light Damage.
EF1	86-110	Moderate Damage: Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	Considerable Damage: Roofs torn off well-constructed houses; mobile homes demolished; large trees snapped or uprooted; light object missiles generated; cars lifted off ground.
EF3	136-165	Severe Damage: Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	Devastating Damage: Whole frame houses, well-constructed houses completely leveled; cars thrown, and small missiles generated.
EF5	>200	Incredible Damage: Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100m (109 yd); high-rise buildings have significant structural deformation; incredible phenomena will occur.

Within the planning area, it is possible for a tornado of any magnitude to occur, with the probability decreasing as the intensity scale increases. Tornadoes can impact all part of Howard County equally and uniformly. Although the NCDC indicates the strongest historical tornado in Howard County was rated F2 on the F-Scale, the potential for extreme atmospheric instability, especially with climate change, allows for the possibility that tornadoes in the planning area could reach EF-4 or EF-5 severity. For example, on April 28, 2022, an F4 tornado struck La Plata in Charles County, which killed three, injured 122 people, and caused over $100 million in damages[58]. Charles County's proximity suggests that a similar tornado may occur within the County. A tornado of similar magnitude could potentially cause catastrophic damages to the affected area in Howard County. Later in this section, a list of tornado occurrences in Howard County appears in the "Occurrences" section along with the magnitude or F/EF Scale rating of each.

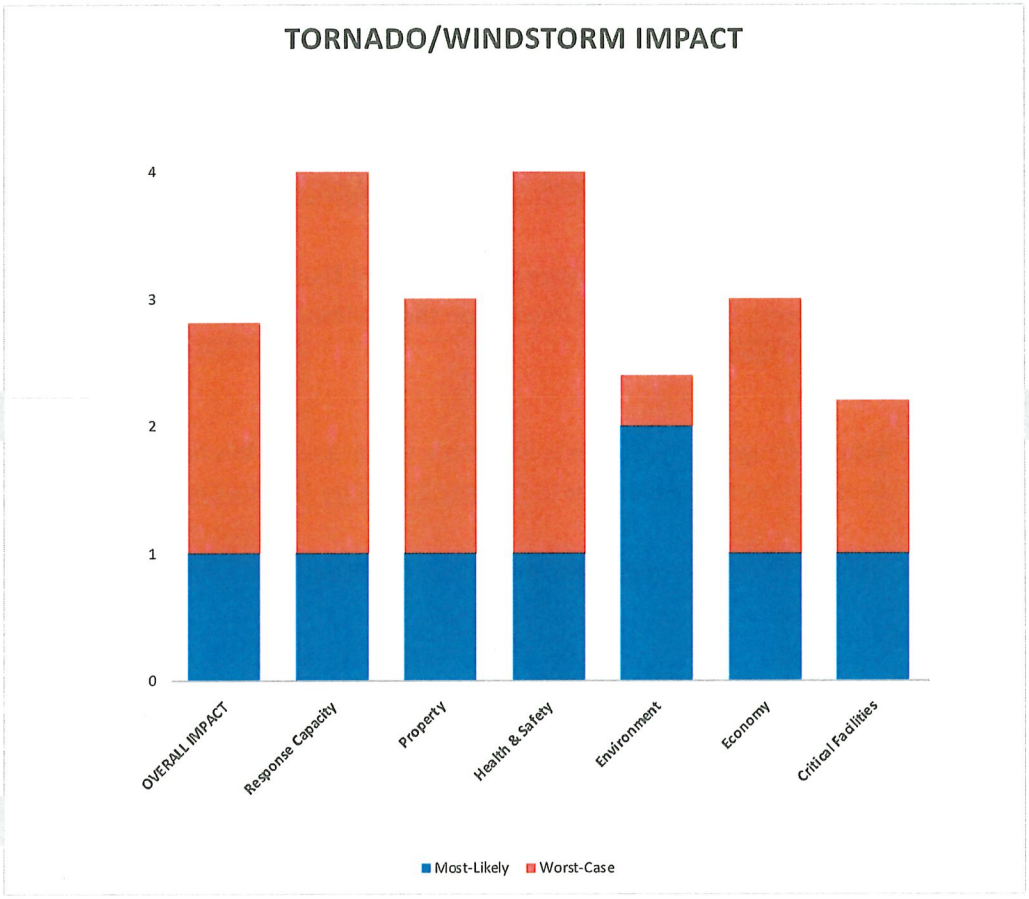
Hazard Impacts

Damage from severe thunderstorm winds account for half of all severe reports in the lower 48 states and is more common than damage from tornadoes. Wind speeds can reach up to 100 mph and can produce a damage path extending for hundreds of miles.[59] As mentioned above, although the impact of a tornado event will be different in different parts of the County, all people and assets are considered to

[58] *La Plata MD F4 Tornado—20 Years Later, 2022, National Weather Service, https://www.weather.gov/lwx/events_20020428, (last accessed July 26, 2023).*

[59] *Severe Weather 101 – Damaging Winds*, NOAA NAT'L SEVERE STORMS LAB., https://www.nssl.noaa.gov/education/svrwx101/wind/ (last visited Apr. 3, 2023).

have the same degree of exposure. This is the same for mesoscale and microscale wind events. The figure and table below characterize extreme temperature impacts to property, health and safety, critical facilities, response capacity, the environment, and the economy.



Tornado/Windstorm - Consequence Analysis Likely		
CATEGORY	**RANKING**	**DESCRIPTION**
PROPERTY DAMAGE	*Limited*	▪ Up to 1% of critical and non-critical infrastructure will be damaged. ▪ Some roof shingles and downed trees expected- some roads impassable. ▪ There is a need for temporary shelter.
HEALTH AND SAFETY	*Limited*	▪ Zero deaths are expected. Automobile accidents, flying debris, or sheltering in an unsafe location are the most common causes of death. ▪ Zero to five injuries are expected. Automobile accidents, flying debris, or sheltering in an unsafe location are the most common causes of injuries.
CRITICAL FACILITIES	*Limited*	▪ *Utilities* – No critical facilities or essential functions will be out of service. ▪ *Information/Communications* – No critical facilities or essential functions will be out of service. Minor disruption to power. ▪ *Transportation* – Possible temporary road closures due to downed trees. Minor disruption to transportation.

RESPONSE CAPACITY	*Limited*	▪ *Police* – Local resources adequate. Low impact to response capability or COOP. ▪ *Fire and Rescue* – Local resources adequate. ▪ *Health* – Local resources adequate. HD operations will not be affected. ▪ *Public Works* – Local resources adequate. No impact response capability and continuity of operations.
ENVIRONMENTAL IMPACT	*Significant*	▪ Downed trees throughout area expected.
ECONOMIC IMPACT	*Limited*	▪ Limited amount loss in dollar value.
TOTAL IMPACT	***Limited***	▪ **Total Impact Score: 1.0 on a scale of 1 (Limited) to 4 (Catastrophic).**

Limited	*Significant*	*Critical*	*Catastrophic*

Vulnerability of County Assets

According to the table above, the Tornado/Windstorm hazard event that is most likely to occur has limited impacts on County assets, except for the impacts on the environment, which are significant. Assets that are vulnerable are the following:

People

- Populations with challenges to resilience will be more vulnerable to this hazard. To review this map as well as its indicators, please refer to Chapter 2, section FEMA's Community Resilience Index.
- Populations without home, car, and health insurance to recover from tornado/windstorm damages.

Structures

- All residential and commercial buildings are vulnerable to this hazard.
- Mobile homes (there are eight mobile home parks in southeastern Howard County ranging in size from small (51-100) to large (>100)). The map below depicts the locations of these mobile parks.
- Roadways (strong winds could cause trees to block important roadways).
- Critical Facilities (strong winds can level buildings, cause trees to fall on important facilities, or cause projectiles to damage buildings).
    - Areas with more vulnerability would include those important roads or structures with tree canopies over them. Taken from an assessment of Howard County's tree canopy in April 2022[60], the below map depicts these areas with bright red portions being structures with tree canopy and dark red being roads with a tree canopy covering them. The health and stability of the trees in these locations must be monitored by owners to prevent the downing or breaking of unhealthy or overgrown trees.

Systems

- Economy (fallen trees or buildings could block important roadways, such as Interstate 70 and Interstate 95).

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[60] *Assessment of Howard County, Maryland's Tree Canopy and Forest Cover, University of Maryland Baltimore County, Dr. Matthew Baker, April 2022, https://livegreenhoward.com/wp-content/uploads/2022/10/2018-HC-Tree-Canopy-Report_OCS_UMBC-4.22.22.pdf, (last accessed July 24, 2023).*

- Communications (strong winds could knock over cell towers/radio antennae).
- Emergency Services (strong winds can hinder the travel of emergency vehicles, such as ambulances and fire engines).

Natural, Historic, and Cultural Resources

- Tree Canopy (strong winds can knock down trees).
- Historic buildings in historic districts (Ellicott City and Lawyers Hill).

Activities that Have Value to the Community

- Outdoor activities, such as concerts, festivals, sports events.

This hazard causes downed trees that can damage power lines, block roads, damage homes and vehicles, and harm individuals.

FIGURE 43: MOBILE HOME PARKS IN HOWARD COUNTY

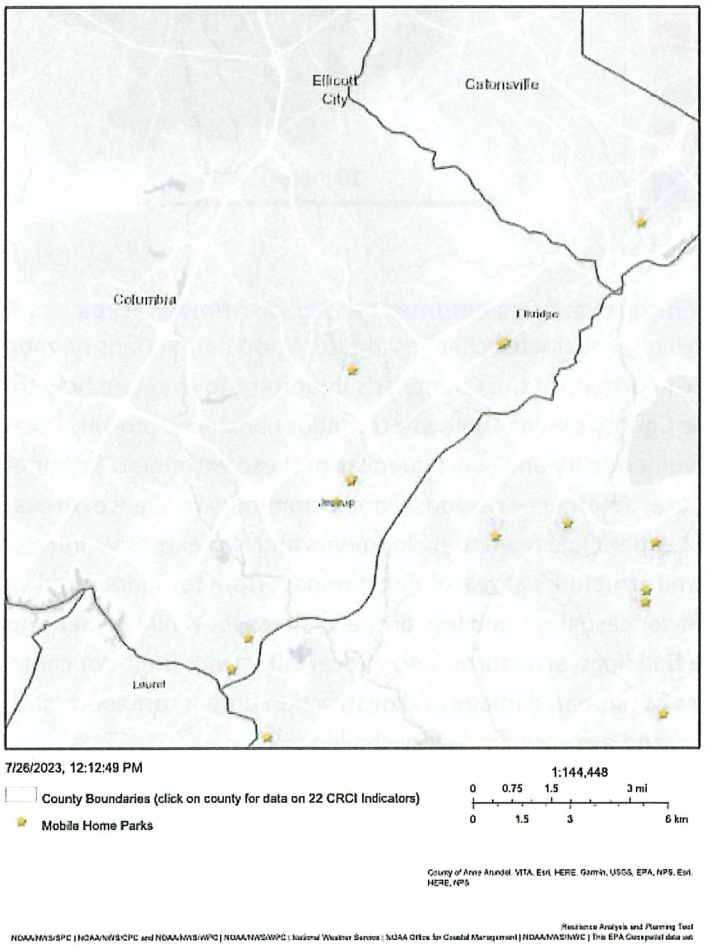
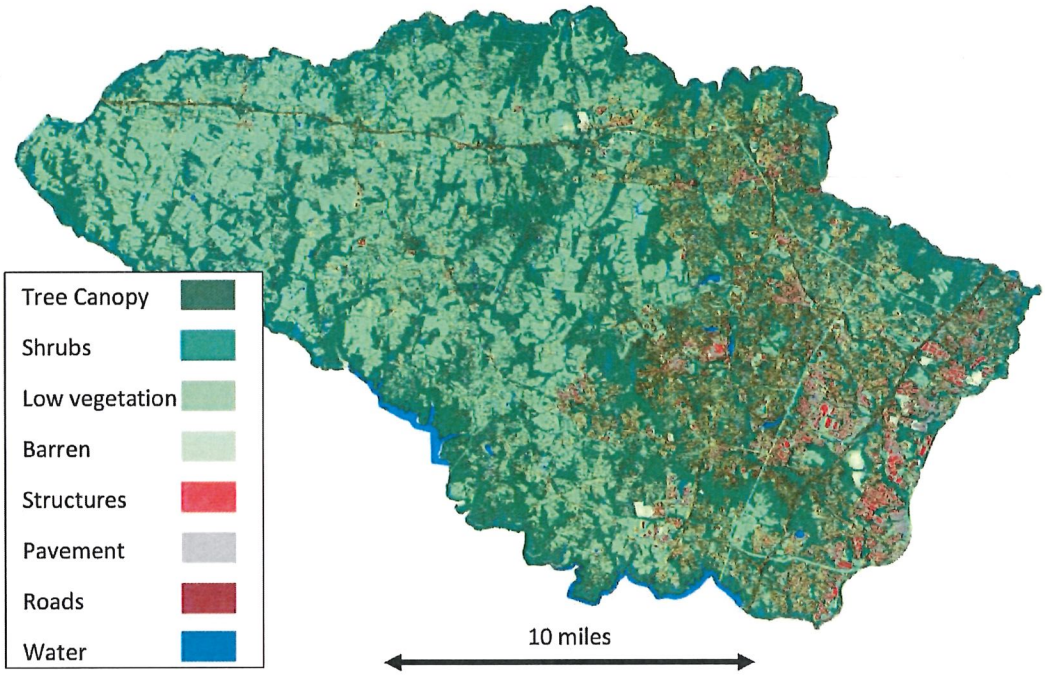


FIGURE 44: TREE CANOPIES, VEGETATION, STRUCTURES, ROADS, WATER, AND PAVEMENT MAP



Effects of Population Change and Development in Hazard-Prone Areas

As Howard County, Maryland, anticipates changes in future population density, more specifically in the Central and South-eastern portions of the County, it's important to evaluate how these demographic shifts could influence the County's vulnerability to tornadoes and wind storms. Population density can significantly impact the vulnerability and consequences of these extreme weather events, affecting public safety, infrastructure, emergency response, and community resilience. Areas with lower population density might experience fewer developments and less extensive infrastructure. This could lead to fewer buildings and structures at risk of direct impact from tornadoes and windstorms, potentially resulting in fewer casualties and less property damage. While higher population density often translates to more buildings, structures, and critical infrastructure in concentrated areas. This can elevate the potential for widespread damage and destruction during tornadoes and windstorms, leading to higher economic losses and increased recovery challenges.

Anticipating future development, particularly in areas prone to tornadoes and wind storms, requires careful consideration of how demographic shifts and urban growth could influence the County's vulnerability to these extreme weather events. Future development can lead to increased exposure of people and assets to tornadoes and wind storms. As more residential and commercial structures are built, the potential for casualties, property damage, and economic losses due to tornado impacts rises. This heightened exposure amplifies the risk posed by severe weather events. 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. The maps in Chapter 2 of this Plan show where existing high population densities are located and where future developmental activities are anticipated.

Hazard Occurrences

Tornado Events

The NCDC database reports that 18 tornadoes have occurred in Howard County between 1975 and 2022.[61] The table below summarizes the 18 tornadoes that have occurred within Howard County. With a total of 18 tornado events between 1975 and 2019 Howard County experiences, on average, 1.5 tornadoes every four years. Based on this information, it is possible to infer an approximate 38% annual probability of occurrence countywide. Depending on atmospheric conditions, it is possible for any number of tornadoes to occur in any given year.

Howard County Tornado Events 1975-2022
(Source: NOAA/NCDC)

Location	County/Zone	St.	Date	Time	T.Z.	Type	Mag	Dth	Inj	PrD	CrD
Totals:								0	3	4.048M	0.00K
HOWARD CO.	HOWARD CO.	MD	07/03/1975	15:35	CST	Tornado	F0	0	0	0.00K	0.00K
HOWARD CO.	HOWARD CO.	MD	07/31/1978	19:15	CST	Tornado	F2	0	0	250.00K	0.00K
HOWARD CO.	HOWARD CO.	MD	08/28/1992	15:00	CST	Tornado	F1	0	2	2.500M	0.00K
HOWARD CO.	HOWARD CO.	MD	08/28/1992	15:20	CST	Tornado	F0	0	0	2.50K	0.00K
West Friendship	HOWARD CO.	MD	07/06/1995	16:07	EST	Tornado	F0	0	0	75.00K	0.00K
COLUMBIA	HOWARD CO.	MD	08/27/1996	13:50	EST	Tornado	F0	0	0	15.00K	0.00K
SAVAGE	HOWARD CO.	MD	07/10/2000	16:30	EST	Tornado	F1	0	0	50.00K	0.00K
NORTH LAUREL	HOWARD CO.	MD	09/24/2001	16:41	EST	Tornado	F2	0	0	1.000M	0.00K
ALPHA	HOWARD CO.	MD	07/31/2009	13:42	EST-5	Tornado	EF1	0	0	0.00K	0.00K
WATERSVILLE JCT	HOWARD CO.	MD	06/01/2012	13:52	EST-5	Tornado	EF1	0	0	5.00K	0.00K
SCAGGSVILLE	HOWARD CO.	MD	06/01/2012	15:29	EST-5	Tornado	EF0	0	0	100.00K	0.00K
SAVAGE	HOWARD CO.	MD	10/15/2014	12:13	EST-5	Tornado	EF0	0	0	0.00K	0.00K
SAVAGE	HOWARD CO.	MD	09/29/2015	21:05	EST-5	Tornado	EF0	0	0	0.00K	0.00K
FLORENCE	HOWARD CO.	MD	06/21/2016	12:29	EST-5	Tornado	EF0	0	0	0.00K	0.00K
LONG CORNER	HOWARD CO.	MD	11/02/2018	19:19	EST-5	Tornado	EF1	0	0	0.00K	0.00K
HIGHLAND	HOWARD CO.	MD	05/23/2019	14:27	EST-5	Tornado	EF1	0	1	0.00K	0.00K
KNOLLWOOD	HOWARD CO.	MD	05/30/2019	14:20	EST-5	Tornado	EF1	0	0	0.00K	0.00K
GUILFORD	HOWARD CO.	MD	07/29/2021	16:07	EST-5	Tornado	EF0	0	0	50.00K	0.00K
Totals:								0	3	4.048M	0.00K

[61] *Storm Events Database*. NOAA NAT'L CTRS. FOR ENV'T INFO., https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28C%29+Tornado&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. 3, 2023).