Hazard Mitigation Plan

Anne Arundel County

2025

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EXECUTIVE SUMMARY

Hazard mitigation is commonly defined as any sustained action taken to reduce or eliminate long-term risk to people and property from hazards and their effects.

The Hazard Mitigation Plan (2025 HMP update) serves as a blueprint for coordinating and implementing hazard mitigation policies, programs, and projects. It identifies mitigation goals, objectives, and related mitigation actions that may assist in reducing risk and preventing loss from future natural hazard events. The impacts of hazards can be lessened and sometimes avoided if appropriate mitigation actions are taken before during and after hazard events. These actions are aimed at saving lives, preserving property, and minimizing the social, economic, and environmental disruptions that commonly follow hazard events.

Previous HMPs were developed in 2006, 2012, and 2018. The 2025 HMP update aims to:

- Provide a blueprint to protect life and property from the impacts of a future disasters by reducing the potential for future damages and economic losses.
- Qualify the County for grant funding, in both pre-disaster and post-disaster environments.
- Build community resiliency through effective response and recovery efforts following future disaster events.

The 2025 HMP update serves as a tool for all stakeholders by identifying hazards and risks and providing a listing of mitigation actions and projects that can be taken to reduce those risks. Educating the public about hazards affecting the community will build community resilience and help to save lives and preserve property. The 2025 HMP update was developed by members of a Hazard Mitigation Planning Committee (HMPC) that consisted of County agencies, partners, and the Town of Highland Beach. The HMPC members used the results of the Hazard Identification and Risk Assessment (HIRA) as well as the Capability Assessment to develop mitigation goals, strategies, actions, and projects.

The 2025 HMP update is organized as follows, with detailed table and figure lists provided, by Sections in the Table of Contents.

Section 1 – Community Profile provides a physical and demographic profile of the County, examining characteristics such as geography, hydrography, development, people, and land uses.

Section 2 – Planning Process summarizes the planning history behind the Disaster Mitigation Act of 2000, its regulatory requirements, the planning process used by Anne Arundel County during the plan update, and a description of stakeholder involvement and outreach.

Section 3 – Risk Assessment evaluates the hazards likely to affect or impact the County, quantifying whom, what, where, and how the area might be affected by hazards.

Section 4 – Capability Assessment describes available programs and resources that can support plan implementation.

Section 5 – Mitigation Strategy includes a range of updated mitigation actions, and projects to support achievement of the plan's goals and objectives.

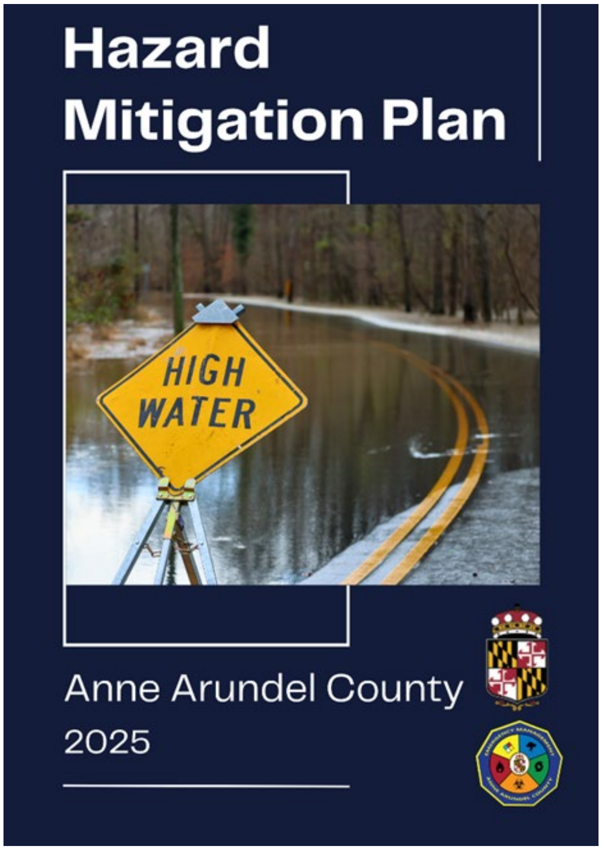
Section 6 - Plan Maintenance describes how the plan will be monitored, evaluated, and updated, including a process for continuing stakeholder involvement after the plan is completed.

Section 7 – Approval and Adoption provides details on steps that are needed to gain FEMA approval and adopt the plan.

Appendices are included at the end of the plan and contain supplemental reference materials and more detailed calculations and methodologies used in the planning process.

County Profile

Contents of this Section



1.0 County Profile

The purpose of the County Profile is to describe the characteristics of Anne Arundel County to better understand the context for the hazards assessed in the 2025 HMP update. County characteristics highlighted in this section include basic information about Anne Arundel County's geography, population, demographics, economy, and development patterns.

Anne Arundel County was founded in 1650 and named after Lady Anne Arundell (1615-1649), daughter of Thomas Arundell of Wardour, and wife of Cecilius Calvert, 2nd Lord Baltimore and founder of the Maryland colony. The County is located in Central Maryland and is bounded by the Patapsco River to the north, the Chesapeake Bay to the east, and the Patuxent River to the west and is linked across the bay to Kent Island in Queen Anne's County by the William Preston Lane, Jr., Memorial Bridge (completed 1952). The low-lying coast is lined with tidal estuaries such as those of the Magothy, Severn, South, and West rivers.

Annapolis, the Maryland state capital and County seat, has long been associated with maritime activities, especially trade and tourism; it is the home of the United States Naval Academy (founded 1845), St. John's College (chartered 1784), and the Maryland State House (built 1772–79), the nation's oldest state capitol in legislative use. The northern and northwestern regions of the County contain south suburban Baltimore and Fort George G. Meade (established 1917). In addition to governmental activities and tourism, the County's economy rests on the manufacture of search and navigation equipment and on printing, fishing, and agriculture.

Anne Arundel County Facts

Founded: 1650
Land Area: 414.8 square miles
Population (2023): 594,582
Population Change (2010-2022): +10%
Households: 221,704
County Seat: Annapolis
Largest Community: Glen Burnie

Sources: U.S. Census Bureau 2010, and 2023; USGS, 2013.

Anne Arundel County is located in the heart of the nation's fourth largest market, the Baltimore/Washington D.C. corridor. It is home to the state capital, Annapolis, and the U.S. Naval Academy, both major visitor destinations. With over 500 miles of shoreline along the Chesapeake Bay and its tributaries, Anne Arundel combines natural beauty, rural charm, and metropolitan sophistication.

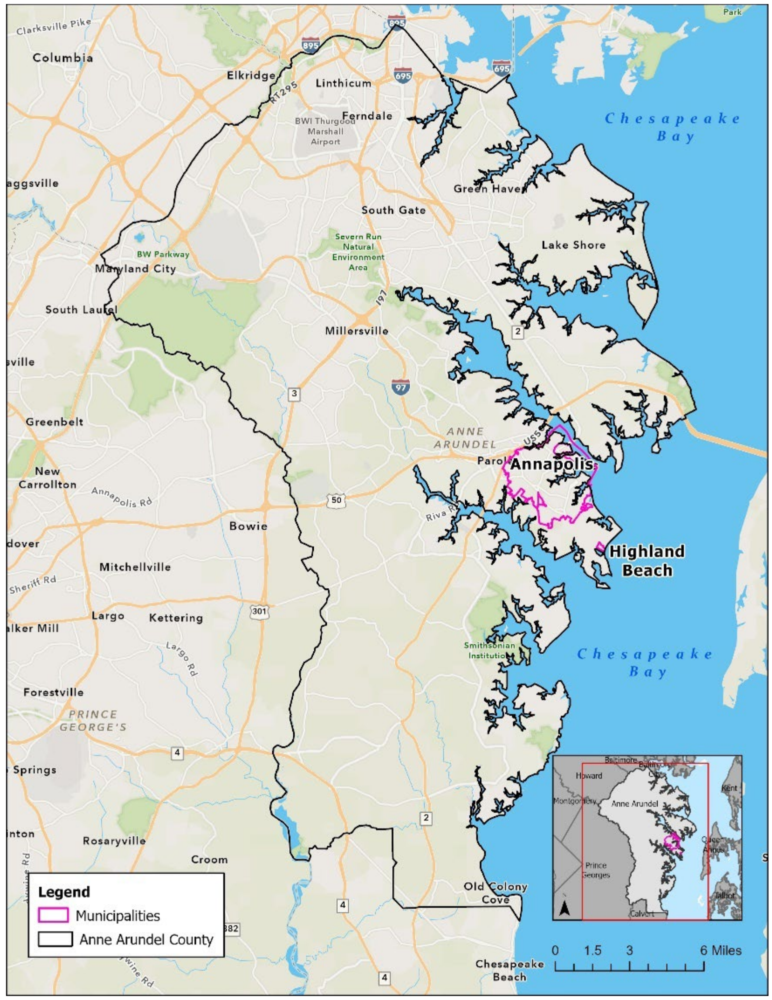
The County's economy is supported by a diverse set of economic drivers such as BWI Marshall Airport, the defense industry, world-class private sector employers, telecommunications, retail, and distribution operations. Its rapidly expanding defense industry is fueled by the presence of multiple federal agencies located at Fort George G. Meade. Ft. Meade is the center for cyber operations in the nation with the presence of U.S. Cyber Command, National Security Administration (NSA), and Defense Information Systems Agency (DISA).

Warehousing continues to be a very active sector for Anne Arundel County's economy. Along the I-95 corridor, four warehouses are being constructed that will add over 650,000 square feet to the market. In the tech sector, Eclipse Technologies recently opened a new 31,000 square-foot facility in Annapolis Junction. Key private sector employers include Northrop Grumman, Southwest Airlines, Luminis Health, UM Baltimore Washington Medical Center, Live! Casino and Hotel, and Amazon. The County's private sector industries generate $40.9 billion in economic output.

1.1 Geography and Environment

Anne Arundel County is located on the western shore of the Chesapeake Bay. The County's 533 miles of shoreline constitute more coastline than any other part of Maryland. According to the U.S. Census Bureau, the County has a total area of 588 square miles. Of that, 416 square miles is land, and 172 square miles is water.

Figure 1.1-1 Anne Arundel County, Maryland
Source: ESRI



The elevation of the County ranges from sea level in the eastern portion of the County to 317 feet in the western part. Over thousands of years, a series of peninsulas fanning out from the higher elevations in the west has formed due to deposition from numerous creeks and rivers.

Because of the County's location adjacent to the Chesapeake Bay, it has developed over time into an enclave of development and commercial activities. Commercial seafood harvesting, recreational fishing, and recreational boating provide a host of economic opportunities. The traditional watermen of the area are slowly disappearing because of a general decline in the water quality and available seafood in the Chesapeake Bay. However, the area is thriving economically as the loss of traditional watermen is being offset by a dramatic increase in sport fishing, recreational motor, and sail boating activities. In addition, numerous world-class boat yards and sailing centers draw visitors from a wide area. The population of the County tripled in the decades between 1940 and 1960 from 68,375 to 206,634 with approximately 70% of the population living north of the South River.

The geologic formations of the County and surrounding Maryland were formed during the tertiary period, resulting in landscapes comprised of sand, clay, silt, greensand, and diatomaceous earth. The rivers, streams, marshland, shoreline, and forests which make up the County's natural resources also support a wide range of plant and wildlife communities. The County's mineral resources include sand and gravel, used to aggregate materials for the construction industry (Maryland Geological Survey, 2018). Clay, for example, is often used in the production of brick and ceramics, while other resources include iron ore deposits and groundwater (Maryland Geological Survey, 2018). These same environments contribute to the County's overall quality of life, rural character, and unique aesthetic, while providing a foundation for its built environment. In return, natural resource lands also support opportunities to maintain clean water and air quality, promote eco-tourism, and enhance property values in developed areas.

1.2 Climate

Anne Arundel County's climate is generally moderate. In the summer, the temperatures vary from mild to hot. In the winter, the temperatures are relatively moderate. The highest average temperatures occur in July, averaging in the mid-to-upper 80s. Low temperatures tend to occur in January, the coldest month, averaging in the 20s (US Climate Data).

Table 1.1-1 Anne Arundel County Temperature and Precipitation by Month

Month	Normal Maximum Temperature	Normal Minimum Temperature	Normal Monthly Precipitation (inches)
January	44	29	3.32
February	48	31	2.94
March	57	38	4.53
April	68	47	3.66
May	77	57	4.20
June	86	67	4.17
July	89	71	4.56
August	87	71	3.88
September	81	64	4.76
October	69	52	3.89
November	59	42	3.82
December	48	33	3.56
Annual	68	50	3.94

Source: US Climate Data, https://www.usclimatedata.com/climate/annapolis/maryland/united-states/usmd0585

1.3 Transportation

Anne Arundel County is a suburban jurisdiction with identified town centers, extended commercial districts along its major arterial highways such as MD 2 and MD 3, and low- and medium-density residential uses in other areas. As a suburban jurisdiction located between the two major urban centers of Washington, D.C. and Baltimore, transportation investments (both highways and transit) have been made to support travel between those areas through the County.

Highway facilities that carry traffic within the County experience significant travel demand in part because of existing development patterns and densities. The relatively low residential densities over much of the County make it difficult to support mass transit opportunities and tend to result in longer vehicle trips. The County's highway network consists of approximately 4,850 lane miles of roads and is the predominant mode of travel used by residents and employees in the County.

Baltimore/Washington Marshall International Airport (BWI) accommodates over 21 million passengers annually and is the largest airport in the state. Owned by the State of Maryland and operated by the Maryland Aviation Administration (MAA), the airport is located in Linthicum, approximately 10 miles south of Baltimore and 30 miles north of Washington, D.C. Close proximity to the Baltimore/Washington Parkway, Fort Meade, and NSA have helped make the airport one of the biggest economic engines in Maryland, serving the federal government, technical, hospitality and tourism industries.

1.4 County Assets - Critical Facilities & Infrastructure

During the 2025 plan update, OEM staff reviewed their existing critical facility listing and made updates. The OEM met with MDEM staff during the plan update to review the critical facility listing.

Critical facilities provide essential services to the County and must be functional after a hazard event. Anne Arundel County considers the following facilities to be essential: hospitals, fire stations, police stations, and public shelters. Table 1.1-2 is a list of 46 facilities that the County has designated as critical, current as of August 2024. There are no critical facilities in Highland Beach.

Table 1.1-2 Anne Arundel County Critical Facilities

Facility Name	Address	Jurisdiction	ZIP Code	Community Lifeline
Anne Arundel Medical Center	2001 Medical Parkway	Annapolis	21401	Health and Medical
Baltimore Washington Medical Ctr.	301 Hospital Drive	Glenn Burnie	21061	Health and Medical
Fire Station 1	4680 Muddy Creek Rd	Galesville	20675	Safety and Security
Fire Station 10	3725 Mountain Road	Pasadena	21122	Safety and Security
Fire Station 11	7549 Solley Road	Glenn Burnie	21060	Safety and Security
Fire Station 12	161 Ritchie Highway	Severna Park	21146	Safety and Security
Fire Station 13	8506 Ft. Smallwood Road	Pasadena	21123	Safety and Security
Fire Station 17	1505 Ritchie Highway	Arnold	21012	Safety and Security
Fire Station 18	7726 Baltimore Annapolis Blvd.	Glenn Burnie	21060	Safety and Security
Fire Station 19	1411 Cape St. Claire Road	Annapolis	21401	Safety and Security
Fire Station 2	529 Londontown Road	Edgewater	21037	Safety and Security
Fire Station 20	4642 Mountain Road	Pasadena	21122	Safety and

Table 1.1-2 Anne Arundel County Critical Facilities

Facility Name	Address	Jurisdiction	ZIP Code	Community Lifeline
				Security
Fire Station 21	1367 Dorsey Road	Hanover	21076	Safety and Security
Fire Station 23	960 Ritchie Highway	Arnold	21146	Safety and Security
Fire Station 26	7880 South Crain Highway	Glenn Burnie	21061	Safety and Security
Fire Station 27	3498 Laurel Ft. Meade Road	Laurel	20724	Safety and Security
Fire Station 28	1425 Annapolis Road	Odenton	21113	Safety and Security
Fire Station 29	7891 Max Blobs Park Road	Jessup	20794	Safety and Security
Fire Station 3	3123 Riva Road	Riva	21140	Safety and Security
Fire Station 30	304 Mountain Road	Pasadena	21122	Safety and Security
Fire Station 31	5100 Ritchie Highway	Brooklyn	21225	Safety and Security
Fire Station 32	309 Camp Meade Road S	Linthicum	21090	Safety and Security
Fire Station 33	15 Central Avenue	Glenn Burnie	21061	Safety and Security
Fire Station 34	4 Broadview Boulevard	Glenn Burnie	21061	Safety and Security
Fire Station 4	7870 Telegraph Road	Severn	21144	Safety and Security
Fire Station 40	121 Jennifer Road	Annapolis	21401	Safety and Security
Fire Station 41	6270 Shady Side Road	Shady Side	20764	Safety and Security
Fire Station 42	6007 Drum Point Road	Deale	20751	Safety and Security

Table 1.1-2 Anne Arundel County Critical Facilities

Facility Name	Address	Jurisdiction	ZIP Code	Community Lifeline
Fire Station 5	1300 Waugh Chapel Road	Gambrills	21054	Safety and Security
Fire Station 6	1029 General's Hwy	Crownsville	21032	Safety and Security
Fire Station 7	2380 Davidsonville Road	Gambrills	21054	Safety and Security
Fire Station 8	991 Bay Ridge Road	Annapolis	21403	Safety and Security
Fire Station 9	6165 Solomons Island Road	Lothian	20711	Safety and Security
Annapolis High School	2700 Riva Road	Annapolis	21401	Safety and Security
Meade High School	1100 Clark Road	Fort Meade	20755	Safety and Security
Northeast High School	1121 Duvall Highway	Pasadena	21122	Safety and Security
Severna Park High School	60 Robinson Road	Severna Park	21146	Safety and Security
Southern High School	4400 Solomon Island Road	Harwood	20776	Safety and Security
Eastern District Police Station	3700 Mountain Road	Pasadena	21122	Safety and Security
Northern District Police Station	939 Hammonds Lane	Baltimore	21225	Safety and Security
Southern District Police Station	35 Stepney's Lane	Edgewater	21037	Safety and Security
Western District Police Station	8273 Telegraph Road	Severn	21113	Safety and Security
Crofton High School	2291 Davidsonville Road	Gambrills	21054	Safety and Security
Severn Run High School	8065 New Cut Road	Severn	21108	Safety and Security
Old Mill High School (Note: Future School 9/2028)	600 Patriot Lane	Millersville	21108	Safety and Security

Table 1.1-2 Anne Arundel County Critical Facilities

Facility Name	Address	Jurisdiction	ZIP Code	Community Lifeline
Emergency Operations Center	Baltimore Annapolis Blvd and Route 2	Glenn Burnie	21061	Safety and Security
Tipton Airport	7515 General Aviation Drive	Fort Meade	20755	Transportation
Fire Department Warehouse	8321 Grover Road	Millersville	21108	Safety and Security

Source: Anne Arundel County Office of Emergency Management (current as of August 2024).

1.5 Demographics

Table 1.1-3 summarizes population, household, and employment statistics for Anne Arundel County, the Baltimore region, and the State of Maryland. These are also discussed briefly in the subsections below.

Table 1.1-3 Population, Household, and Labor Force Statistics and Projections

Population	2015	2020	2025	2030	2035	2040
Anne Arundel Co.	562,870	582,880	595,010	608,990	620,350	632,200
Baltimore Region	2,737,380	2,762,890	2,814,290	2,864,350	2,914,680	2,964,210
Maryland	5,982,810	6,074,750	6,244,980	6,413,690	6,588,760	6,739,410
Households	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Anne Arundel Co.	205,975	216,500	223,950	230,325	235,450	239,575
Baltimore Region	1,019,575	1,045,750	1,071,200	1,098,200	1,120,350	1,137,500
Maryland	2,177,875	2,233,900	2,314,650	2,392,175	2,460,650	2,518,225
Employment	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Anne Arundel Co.	310,710	317,550	319,930	322,490	325,420	329,980
Baltimore Region	1,494,500	1,527,930	1,537,730	1,544,200	1,555,590	1,580,720
Maryland	3,313,390	3,401,820	3,461,470	3,506,500	3,551,430	3,617,270

Source: Maryland Department of Planning, State Data & Analysis Center (December 2020)
https://planning.maryland.gov/MSDC/Pages/projection/projectionsbytopic.aspx

1.5.1 Population

Anne Arundel County has seen steady increases in its population over the past fifteen to twenty years. Between 1990 and 2020, the population grew from 427,239 to 582,880, a 36.4% increase (World Population Review). The County's population increase rate historically exceeded that of the Baltimore region and Maryland.

Current forecasts indicate moderate growth in the County's population will continue over the 30-year forecast period, but that the rate of growth has slowly begun to decline. From 1970 to 2010, the County experienced a 2% annual average population growth and captured the highest share of growth in the region, but the County's growth rate since 2010 has been slowing. With an estimated 2018 population of 576,031, population growth averaged roughly 0.7% annually between 2010 and 2018. That is slower than the 1% annual growth rate achieved during the 2000-2010 period. Due to the County's maturing population, this lower annual growth rate is expected to continue in the future.

Households

Anne Arundel County continues to experience growth in households as well. The County experienced a 19.8% increase in households between 1990 and 2000, a higher rate of growth than in the Baltimore region or the state as a whole. Household growth is expected to continue over the next 30 years, based on County forecasts. Household growth in the Baltimore region is also expected to continue at a moderate pace, with forecasts indicating an 11.5% increase in households from 2015 to 2040. As shown in Table 1.1-4, the number of households in Anne Arundel County is projected to increase by 16.3% over the same period.

1.5.2 Employment

Forecasts indicate County employment will increase by 22.2% between 2015 and 2040, compared to a 4.8% increase in the Baltimore region. Employment in Anne Arundel County is distributed across several general sectors. Major employers are shown in Table 1.1-4.

Table 1.1-4 Major Anne Arundel County Employers

Employer	Sector	Number Employed
Fort George G. Meade	Public/Government	64,455
Anne Arundel County Public Schools	Public/Government	11,946
State of Maryland	Public/Government	11,584
BWI Marshall Airport	Public/Government	10,000
Anne Arundel County Government	Public/Government	8,665
U.S. Naval Academy	Public/Government	3,000
Anne Arundel Community College	Public/Government	1,226
U.S. Postal Service	Public/Government	600
U.S. Coast Guard Yard	Public/Government	598
City of Annapolis Government	Public/Government	550
Northrop Grumman	Private	10,300
Luminis Health Anne Arundel Medical Center	Private	3,400
Southwest Airlines	Private	5,239
Live! Casino and Hotel	Private	2,672
U. of Maryland Balt./Wash. Medical Center	Private	3,170
Amazon	Private	3,000
Booz Allen Hamilton	Private	1,400
Allegis Group	Private	1,900
Johns Hopkins Healthcare	Private	1,500
Microsoft Cororation	Private	1,478
Jacobs	Private	1,397
Raytheon Technologies	Private	1,477

Source: [*Top Employers | Anne Arundel County Profile | AAEEC (aaedc.org)*]

The Maryland Department of Licensing, Labor, and Regulation (DLLR) provides statistics about employment across the state. For 2023, DLLR reporting indicates that Anne Arundel County's average quarterly total employment was 264,961. Of this overall figure, government employment was 36,365 (13.7%), and all private sector employment was 228,596 (86.3%). Within private-sector employment, service-providing employment was 190,880 (83.5% of the County total), and goods-providing business employment was 37,717 (16.5% of the County total) (Office of Workforce Information and Performance).

1.5.3 Age & Gender Profile

Since the 2012 version of the Hazard Mitigation Plan, the U.S. Census modified and simplified the way it reports age and gender statistics. Anne Arundel County currently comprises 5.9% people under the age of five years, 22.2% under the age of 18 years, 16.2% over the age of 65 years, and 50.4% female (US Census).

1.5.4 Race Characteristics

Anne Arundel County is predominantly Caucasian, making up approximately 64% of the total racial composition, according to 2022 survey estimates from the U.S. Census Bureau. The next largest racial group was Black/African American persons, who comprise approximately 18.3% of the population. All other races combined make up less than 7% of the County population (US Census).

1.5.5 Educational Attainment

One of the most beneficial assets to a local jurisdiction is a well-educated population. Census estimates show that approximately 93.5% of Anne Arundel County's population age 25 and over holds a high school diploma or a higher degree (American Community Survey). Table 1.1-5 provides a breakdown of education levels for Anne Arundel County and the State of Maryland.

Table 1.1-5 Education Attainment

Jurisdiction	Less than H.S. Education	H.S. Diploma	Associate Degree	Bachelor's Degree	Graduate Degree
Anne Arundel Co	8,811	85,401	28,087	114,687	83,564
Maryland	166,900	1,000,588	294,875	996,167	882,538

Source: 2022 American Community Survey, U.S. Census Bureau Note: Counts for ages 25 years and older.

1.5.6 Household Income

Anne Arundel County has a uniform distribution in terms of the number of households in each income bracket. Census estimates from 2022 indicate that household incomes are fairly evenly distributed within the six income classes selected. The County's mean household income in 2022 was estimated at $116,009 (Maryland Department of Labor).

1.6 Future Land Use & Development Trends

Plan2040 is the County's current long-range land use plan. Plan2040 sets the policy framework to protect the natural environment, shape development of the built environment, provide public services to promote healthy communities, and support a diverse and resilient economy. The County favors most of these trends in support of preserving their County's character and historical integrity. Effective from June 2021, the Plan includes two volumes. Volume I include the vision and themes, goals, policies and strategies, the planned land use maps, and the implementation plan. Volume II provides supporting background information. Land development regulations will promote redevelopment of underutilized properties while limiting development of farms and forests.

Housing growth will continue in Anne Arundel County but is likely to slow, as is expected in a maturing jurisdiction. Currently, the housing distribution for Anne Arundel County is weighted toward townhomes (single-family attached), followed by single-family detached and multifamily dwellings, based on new construction permits being issued. As shown in Table 1.1-6, between 2020 and 2023 the County issued 6,961 residential permits. Among these permits, 3,232 (46%) were for townhome units, 2,400 (34%) were for single-family detached units, and 790 (11%) were for multi-family units.

In the longer term, the land use planning priorities in the County are likely to gradually shift from a focus on new development to a focus on redevelopment and revitalization, as the County matures, and as vacant land for development becomes scarcer. While the 2019 existing development capacity analysis showed that there is sufficient capacity Countywide to support the expected new growth over the 20-year horizon, much of that depends on the ability to redevelop underutilized land and land currently zoned for commercial uses. Changes to the Code to allow missing middle housing and flexibility in redevelopment are strategies in Plan2040 that have recently been implemented through legislation. Along with shifts in land use policies and changes to the County Code, a priority for both the short and long term is strategic planning for water resource protection and a focus on mitigation to address the impacts of existing and planned land uses on water resources. Additionally, strategic planning to ensure that adequate public facilities (schools, roads, public safety services) will be in place to serve new growth will be focused on in the near term.

Table 1.1-6 Anne Arundel County Residential Permits Issued (2020-2023)

Classification	Permits 2020	Permits 2021	Permits 2022	Permits 2023
Single-family detached	883	783	428	306
Single-family attached	1,061	622	946	603
Two-family	6	0	0	0
Multi-family	24	334	307	125
Mobile homes	2	0	7	10
Other shelter	0	0	0	0
Mixed use	0	6	508	0
TOTAL	**1,976**	**1,745**	**2,196**	**1,044**

Source: Baltimore Metropolitan Council Building Permit Data System.

The Plan2040 Land Use Plan is shown in Figure 1.1-2. Development patterns are well established in most parts of the County. Higher density residential uses and most of the County's industrial and commercial land base is concentrated in the northern parts of the County and in Odenton, Severn, Maryland City, Crofton, and Parole. The rural land base still covers much of the Crownsville area and virtually all of South County with the exception of the Deale, Churchton, Shady Side, and Galesville communities. Low to medium density residential uses are spread throughout but are most predominant on the peninsulas (Lake Shore, Broadneck, Annapolis Neck, Edgewater and Mayo) and in Severna Park, Pasadena, Severn and Jessup. Table 1.1-7 provides general descriptions of the land use categories.

Figure 1.1-2 Planned Land Use
Source: Anne Arundel County General Development Plan, Plan2040

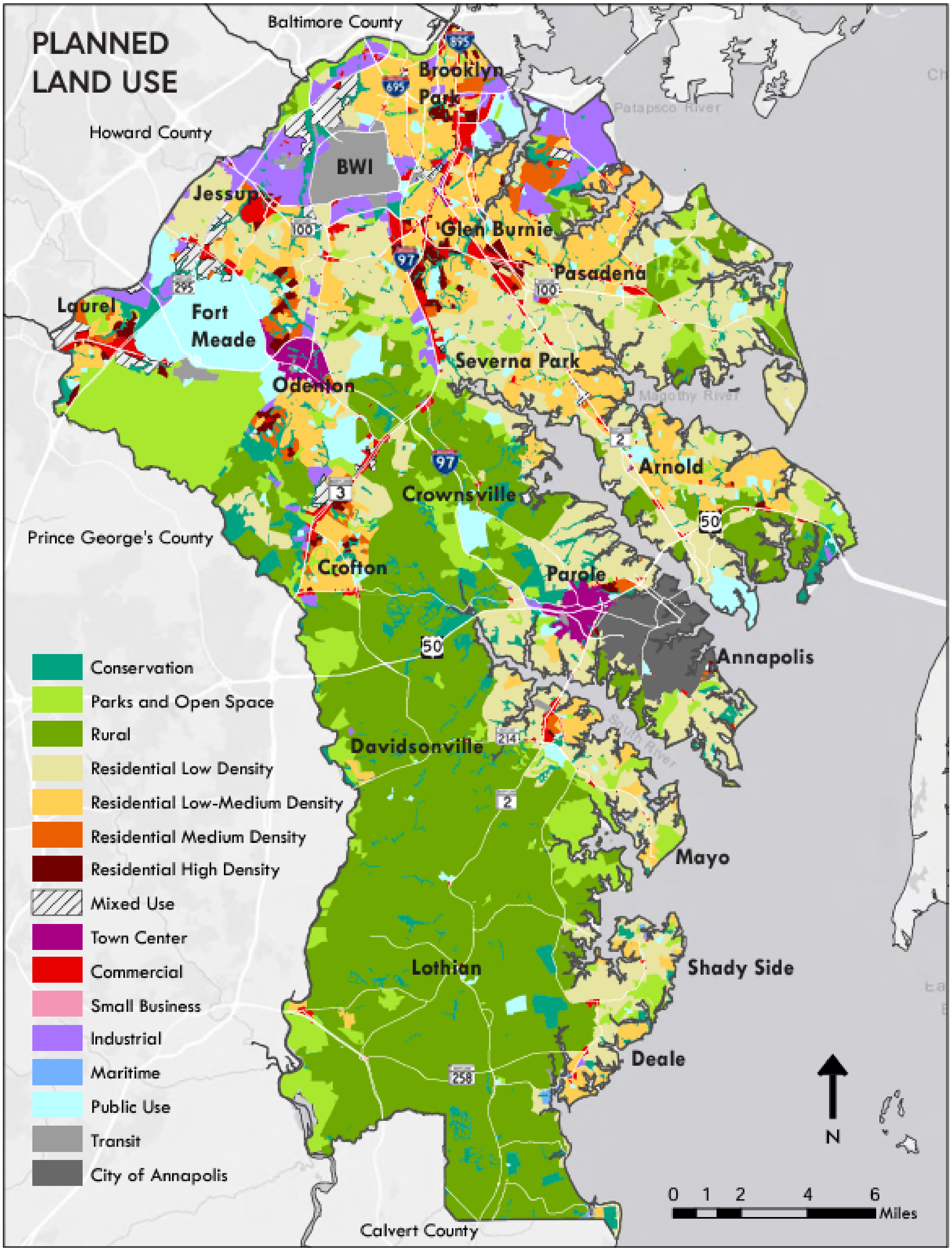


Table 1.1-7 Description of Land Use Plan Categories

Planned (Plan2040) Land Use Designation	Zoning Category Generally Consistent with Land Use Designation	Permitted / Anticipated Uses
High density residential (HDR) - density between 10 to 22 units per acre	R15, R22 (and in TC, MXD zones)	Multifamily Residential, Mobile Home Parks, Private Institutional
Medium density residential (MDR) - density between 5 to 10 units per acre	R10 (and in TC, MXD zones)	Townhomes, Single-Family Semi Detached, Mobile Home Parks, Private Institutional
Low – Medium density residential (LMDR) - density between 2 to 5 units per acre	R5	Single-Family Detached, Single-Family Semi Detached, Mobile Home Parks, Private Institutional
Low density residential (LDR) - density between 1 to 2 units per acre	R1, R2	Single-Family Detached, Mobile Home Parks, Private Institutional
Rural - density averaging or lower than 1 unit per 5 acres	RA, RLD	Single-Family Detached, Mobile Home Parks, Private Institutional. Agricultural
Town Center (TC)	TC - Town Center OTC Districts	Mixed-use
Commercial (COM)	C1 – Local Commercial C2 – Commercial Office C3 – General Commercial C4 – Highway Commercial TC – Town Center	Office: Low, Medium or High Rise Office, Office Park, Residential Office Retail: Local, Major, Residential, Shopping Mall Service: Eating and Drinking, General, Hotel, Self-Storage
Small Business (SB)	SB – Small Business	Office: Residential Office Retail: Local, Minor, Residential Service: Eating and Drinking, General, Bed and Breakfast, private institutions
Mixed use (MU)	MXD-N – Neighborhood Mixed Use MXD-G – General Mixed Use MXD-S – Suburban Center Mixed Use MXD-V – Village Mixed Use	Mixed-use
Industrial (IND)	W1 – Industrial Park W2 – Light Industrial W3 – Heavy Industrial	Industrial: Flex / Tech park, Landfill, Manufacturing, Mining, Warehouse / Distribution
Public Use (PU)	Any	Government-owned facilities and government reuse facilities not designated as Conservation, Parks and Open Space or Transit
Conservation (CON)	OS	Platted floodplains, easements and other preservation areas where primary function is conservation in perpetuity
Parks and Open Space (OS)	OS	Public parks and privately-owned areas that provide active and passive recreational amenities, including, but not limited to, golf courses, hiking trails, bike paths, greenways and other open

Table 1.1-7 Description of Land Use Plan Categories

Planned (Plan2040) Land Use Designation	Zoning Category Generally Consistent with Land Use Designation	Permitted / Anticipated Uses
		spaces, water access facilities, camps, campgrounds, tennis courts, swimming areas and ballfields. This category also includes closed landfills.
Maritime	MA1 – Community Marina MA1B – Neighborhood Marina MA2 – Light Commercial MA3 – Yacht Club MB – General Commercial MC – Heavy Commercial	Marinas and other Maritime Uses
Transit	Any	Public facilities used for rail, bus, water or air such as Light Rail, MARC Stations, airports and Commuter Lots

Source: Anne Arundel County Office of Planning and Zoning

Maryland's growth management law (2009) created 12 Visions which reflect the State's ongoing aspiration to develop and implement sound growth and development policy. Local jurisdictions are required to include the Visions in the local comprehensive plan and implement them through zoning ordinances and regulations. Table 1.1-8 compares the State's Vision statements with the County's Plan2040.

Table 1.1-8 Location of Maryland Visions in Plan2040

State of Maryland Visions	Where Addressed in Plan 2040
Quality of Life and Sustainability: A high quality of life is achieved through universal stewardship of the land, water, and air resulting in sustainable communities and protection of the environment.	Included throughout Plan2040. See especially: Vision, Themes, and Goals NE1, NE2, NE3, NE6, BE1, BE2, and BE3 and their supporting policies.
Public Participation: Citizens are active partners in the planning and implementation of community initiatives and are sensitive to their responsibilities in achieving community goals.	Summary of public participation provided in Our Community, Our Voice section and in the public engagement appendix. Commitment to community engagement in future planning: BE3
Growth Areas: Growth is concentrated in existing population and business centers, growth areas adjacent to these centers, or strategically selected new centers.	Development, Redevelopment and Revitalization are concentrated in areas identified on the Planned Land Use Map, Development Policy Area Map in the Planning for the Built Environment Goals BE5, BE6, BE7, BE8, BE9, BE10 and BE13 and supporting policies.
Community Design: Compact, mixed–use, walkable design consistent with existing community character and located near available or planned transit options is encouraged to ensure efficient use of land and transportation resources and preservation and enhancement of natural systems, open spaces, recreational areas, and historical, cultural, and archeological resources.	Compact, mixed use, walkable design consistent with community character: Goals BE 1, BE 2, BE3, BE5, BE7; Focusing development near transit: Goals BE7, BE9; Preservation and enhancement of nature, open space, and recreation areas: Goals NE 1, NE2, NE3, HC8; Preservation of historical and cultural resources: BE14
Infrastructure: Growth areas have the water resources and infrastructure to accommodate	Water and sewer infrastructure: Goal NE5; Transportation infrastructure: BE1, BE15; Schools, Libraries, Services for Aging

Table 1.1-8 Location of Maryland Visions in Plan2040

State of Maryland Visions	Where Addressed in Plan 2040
population and business expansion in an orderly, efficient, and environmentally sustainable manner.	population and individuals with Disabilities, Park and Recreation Facilities, Waste Management Services, Police, Fire and Emergency Service: BE1, HC1, HC2, HC3, HC4, HC5, HC6, HC8, HC9 and HC10
Transportation: A well–maintained, multimodal transportation system facilitates the safe, convenient, affordable, and efficient movement of people, goods, and services within and between population and business centers.	Goal BE15 and Move Anne Arundel! Transportation Functional Master Plan adopted by County Council and referenced in Plan2040.
Housing: A range of housing densities, types, and sizes provides residential options for citizens of all ages and incomes.	Goals BE11 and BE12
Economic Development: Economic development and natural resource–based businesses that promote employment opportunities for all income levels within the capacity of the State's natural resources, public services, and public facilities are encouraged.	Addressed in Planning for a Healthy Economy Goals HE1, HE2, HE3, HE4, HE5, HE6, and HE7 and their supporting policies.
Environmental Protection: Land and water resources, including the Chesapeake and coastal bays, are carefully managed to restore and maintain healthy air and water, natural systems, and living resources.	Addressed in Planning for the Natural Environment Goals, NE1, NE2, NE3, NE4 and their supporting policies.
Resource Conservation: Waterways, forests, agricultural areas, open space, natural systems, and scenic areas are conserved.	Addressed in Planning for the Natural Environment Goals, NE1, NE2, NE3, NE4 and their supporting policies.
Stewardship: Government, business entities, and residents are responsible for the creation of sustainable communities by collaborating to balance efficient growth with resource protection.	Included throughout Plan2040. See especially: Vision, Themes, and Goals NE1, NE2, NE3, NE6, BE1, BE2, and BE3 and their supporting policies.
Implementation: Strategies, policies, programs, and funding for growth and development, resource conservation, infrastructure, and transportation are integrated across the local, regional, state, and interstate levels to achieve these Visions.	Integrated throughout Plan2040 and addressed specifically in the Implementation Plan appendix.

1.6.1 Region 3 Development Trends Analysis

The following table summarizes development trends in the County. It utilizes the definition of "changes in development" from the FEMA's Local Mitigation Planning Policy Guide (2022c) and provides space for descriptions to briefly explain the reasoning for identified increases and decreases. The key for the table is as follows.

- Changes have resulted in an **Increase** in vulnerability for the jurisdiction (>)
- Changes have resulted in **No Change** in vulnerability for the jurisdiction (I)
- There were no instances of a recognized decrease in vulnerability.

The policy guide definitions appear in the table as follows.

- **Recent Development:** For example, construction completed since the last plan was approved.

- **Potential Development:** For example, development planned or under consideration by the jurisdiction.
- **General Trends:** Conditions that may affect the risks and vulnerabilities of the jurisdictions (for example, climate change, declining populations or projected increases in population, or foreclosures).
- **Social Vulnerability:** Shifts in the needs of underserved communities or gaps in social equity. This can also include changes in local policies, standards, codes, regulations, land use regulations, and other conditions.

Table 1.1-9 Summary of Development Trend Implications for Risk and Vulnerability

Development Change	County	Town of Highland Beach
Riverine Flooding		
Recent Development	>	>
Potential Development	>	>
General Trends	>	>
Social Vulnerability	>	>
Coastal Hazards		
Recent Development	>	>
Potential Development	>	>
General Trends	>	>
Social Vulnerability	>	>
Dam Failure		
Recent Development	Development trends have not caused increases or decreases in vulnerability to dam failure for the County or jurisdictions	
Potential Development		
General Trends		
Social Vulnerability		
Hurricane, Tropical Storm, Nor'easter		
Recent Development	>	>
Potential Development	>	>
General Trends	>	>
Social Vulnerability	>	>
Drought		
Recent Development	Development trends have not caused increases or decreases in vulnerability to drought for the County or jurisdictions	
Potential Development		
General Trends		
Social Vulnerability		
Earthquake		
Recent Development	Development trends have not caused increases or decreases in vulnerability to Earth Disturbance for the County or jurisdictions	
Potential Development		
General Trends		
Social Vulnerability		
Thunderstorm (Lightning, Hail, Thunderstorm, and Wind)		
Recent Development	Development trends have not caused increases or decreases in vulnerability to the Public Health Emergencies for the County or jurisdictions.	
Potential Development		
General Trends		

Table 1.1-9 Summary of Development Trend Implications for Risk and Vulnerability

Development Change	County	Town of Highland Beach
Social Vulnerability		
Severe Winter Storms		
Recent Development	Development trends have not caused increases or decreases in vulnerability to the Severe Winter Weather for the County or jurisdictions.	
Potential Development		
General Trends		
Social Vulnerability		
Tornado		
Recent Development	>	>
Potential Development	>	>
General Trends	>	>
Social Vulnerability	>	>
Wildfire		
Recent Development	I	I
Potential Development	I	I
General Trends	I	I
Social Vulnerability	>	>
Erosion		
Recent Development	>	>
Potential Development	>	>
General Trends	>	>
Social Vulnerability	>	>
Soil Movement (Land Subsidence and Sinkholes)		
Recent Development	Development trends have not caused increases or decreases in vulnerability to Land Subsidence or Sinkholes for the County or jurisdictions	
Potential Development		
General Trends		
Social Vulnerability		
Emerging Infectious Disease		
Recent Development	Development trends have not caused increases or decreases in vulnerability to the Public Health Emergencies for the County or jurisdictions.	
Potential Development		
General Trends		
Social Vulnerability		
Civil Disturbance and Active Assailant		
Recent Development	I	I
Potential Development	I	I
General Trends	>	>
Social Vulnerability	>	>
Transportation Accidents		
Recent Development	Development trends have not caused increases or decreases in vulnerability to the Public Health Emergencies for the County or jurisdictions.	
Potential Development		
General Trends		
Social Vulnerability		
Environmental Hazards (Hazardous Materials & Pipeline)		

Table 1.1-9 Summary of Development Trend Implications for Risk and Vulnerability

Development Change	County	Town of Highland Beach
Recent Development Potential Development General Trends Social Vulnerability	Development trends have not caused increases or decreases in vulnerability to the Public Health Emergencies for the County or jurisdictions.	
Cyber Attacks		
Recent Development	>	>
Potential Development	>	>
General Trends	>	>
Social Vulnerability	>	>

1.7 Town of Highland Beach

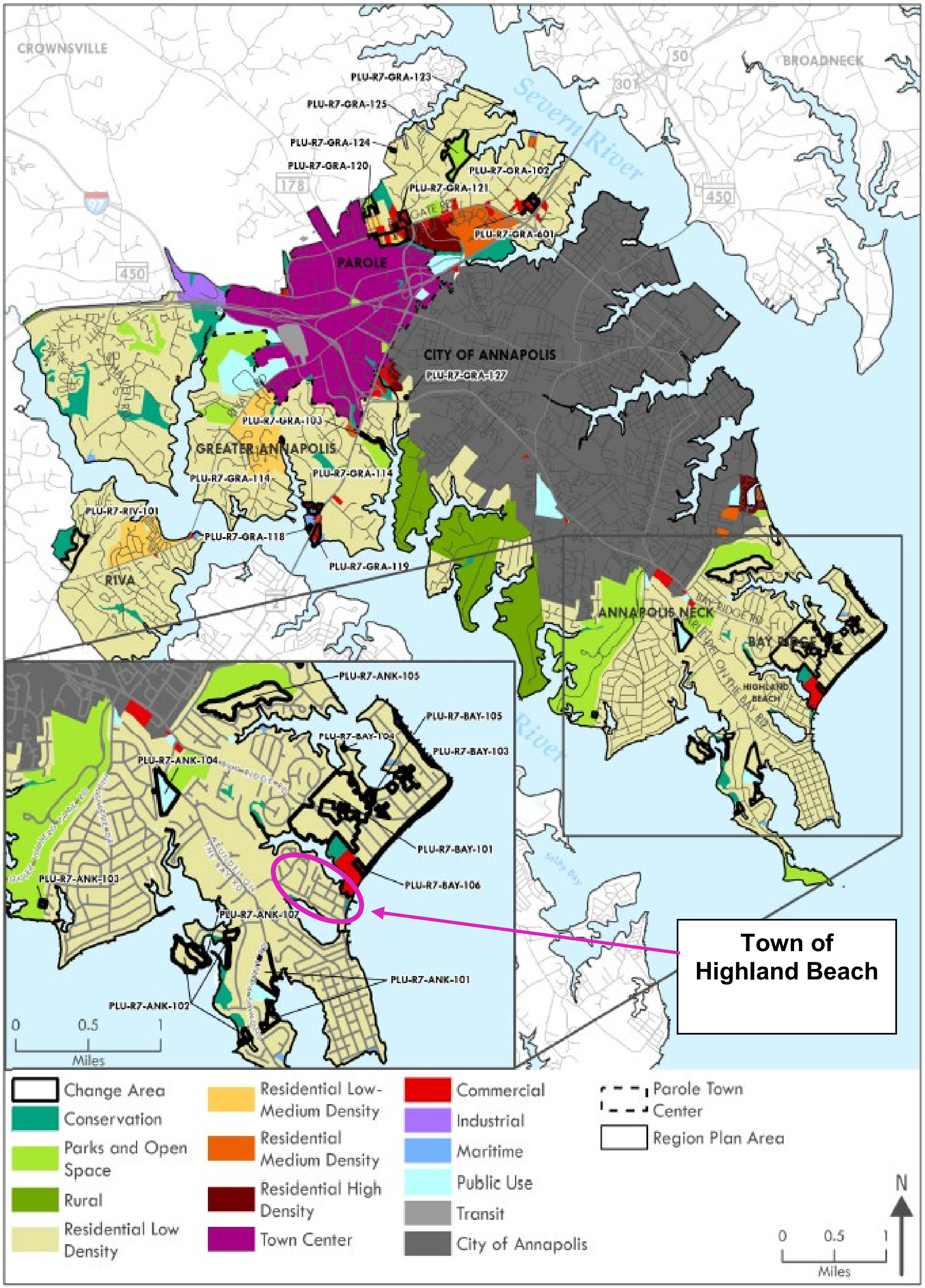
The Town of Highland Beach was incorporated in 1922. A 2018 report indicated that 53.5% of the town's 114-person population identified as Black (Data USA, 2019). Although founded as a summer resort, it is now a town of both summer and year-round residents and is zoned residential only. Highland Beach is the home of the Frederick Douglas Summer House, known as "Twin Oaks," which is listed on the National Register of Historic Places and now serves as the Frederick Douglass Museum and Cultural Center, Inc. Highland Beach is bordered on the north by Black Walnut Creek and the community of Bay Ridge, on the east by the Chesapeake Bay, and on the south by Oyster Creek and the community of Venice Beach.

As of the 2020 census, there were 118 people, 46 households, 34 families living in the town, and there were 79 housing units. The racial makeup of the town was 25.8% White, 56.5% African American, 17.7 Multiracial (Non-Hispanic). The average household size was 2.48 and the average family size was 3.11. The median age in the town was 71.3 years. (U.S. Census Bureau, 2022).

Figure 1-1.3, following, depicts planned future land use for the Town of Highland Beach. It should be noted that the Town is part of the "Peninsula" Development Policy Area. Development in these areas is limited to infill and redevelopment that must be compatible with existing character of the neighborhood and where consideration of salt-water intrusion and vulnerability to sea level rise is given. Future land use indicates that the Town will remain residential low density.

Figure 1.1-3 Planned Land Use Changes, Town of Highland Beach

Source: Anne Arundel County Region 7 Plan



1.8 Equity & Social Vulnerability

The more effectively we plan to mitigate hazards now, the more we reduce impacts on our communities as well as our response and recovery time, increasing our resilience. Socially vulnerable communities are hit hardest during disasters and need the most support to recover (Jerolleman 2019). Anne Arundel County also faces new hazards, as the impacts of climate change place an increasing number of communities at risk and multi-hazard situations are further complicated by the COVID pandemic, requiring new strategies. FEMA is increasingly encouraging jurisdictions to think through inequities in their areas and to support vulnerable communities through more equitable hazard mitigation planning guidance (FEMA 2020).

1.8.1 Equity

There are many approaches to defining and evaluating equity, but at its core, equity is about everyone getting what they need to survive and thrive. According to the World Health Organization (WHO), *equity* is the absence of avoidable or remediable differences among groups of people, whether those groups are defined socially, economically, demographically, or geographically. It is also a process of addressing historic and current inequities to strive for greater equality. There is an extensive field of practice related to equity and planning processes, climate equity and disaster equity. There are increasing efforts focused on Hazard Mitigation and equity including efforts from the National Association for the Advancement of Colored People (NAACP), and the Institute for Diversity and Inclusion in Emergency Management.

FEMA's *Guide to Expanding Mitigation* highlights how local governments can partner with communities to strive for equity in hazard mitigation, including the planning and project development process. The guide recommends taking a "Whole Community" approach and involving historically underserved populations in the planning and decision-making processes, and also recommends the inclusion of those with access and functional needs, businesses, faith-based and community organizations, nonprofit groups, schools, academia, media outlets, and all levels of government, including state, local, tribal, territorial, and federal partners that have a shared responsibility in emergency preparedness and mitigation.

What is Social Vulnerability?

FEMA's National Risk Index defines social vulnerability as the susceptibility of social groups to the adverse impacts of hazards, including disproportionate death, injury, loss, or disruption of livelihood. In addition, FEMA's Guide to Expanding Mitigation adds that social vulnerability can influence an individual's or group's ability to prepare, respond, cope, or recover from an event.

They note that heightened vulnerability may be compounded by deficiencies in infrastructure and conclude that "While not predictive, understanding where populations have increased vulnerability and exposure to natural hazards can help emergency managers take actions to lessen impacts to these communities before an event or distribute needed recovery dollars after an event."

When incorporating equity and inclusion approaches it is optimal to work with leaders of the groups that you are seeking to better include. Particularly with a highly structured planning process like the 2025 HMP update it is important to communicate that your jurisdiction is seeking to *increase* inclusion or *incorporate more* equitable approaches. Equity and inclusion can mean different things to communities and government entities, so it is important both to implement the most inclusive practices possible in your situation while not overpromising and disappointing your partners (San Mateo County, 2021).

FEMA recognizes that the following populations may be disproportionately impacted by disasters:

- Underserved communities with a low socioeconomic status
- People of color
- Tribal and first nation communities
- Women
- Members of the LGBTQ+ community
- Individuals experiencing homelessness or displacement
- Rural communities
- Elderly and youth
- People with limited English proficiency
- Service workers and migrant laborers
- People with limited cognitive or physical abilities
- Institutionalized populations (in prisons and nursing homes)
- Renters

Using an Equity Lens for Hazard Mitigation Community Engagement

Effective outreach and community engagement increases buy-in and support for the 2025 HMP update process. FEMA's Hazard Mitigation Planning Handbook identifies these as key components of successful outreach:

- Informs and learns about hazards, climate impacts, local risk and social vulnerability
- Invites interested parties to contribute their views and ideas for mitigation
- Identifies conflicts and incorporates different perspectives and priorities early in the process
- Secures data and input that improves overall quality and accuracy of the plan
- Ensures transparency and builds trust
- Maximizes opportunities for implementation through greater consensus and acceptance
- Identifies and eliminates barriers to participation and assures hard to reach and traditionally underserved communities can access the process

Many planning processes traditionally have used a set of traditional engagement methods, including English-language surveys, workshops, and presentations. These forms of engagement are often hard to access for the general public and especially so for socially vulnerable communities. Anne Arundel County has populations that are hard to reach, or who have difficulty accessing these engagement methods. Examples include residents that can't access online resources, older adults, youth, people with disabilities, residents with limited education or literacy, residents who face differential treatment due to their race, ethnicity, religion, or other social characteristic, such as having a low income.

Using an equity lens is new for most of us. It can be difficult to identify ways to operationalize equity into a structured public planning process. Table 1.1-10 provides detailed examples of equity considerations and recommended actions tailored for different aspects of the 2025 HMP update process.

Table 1.1-10 Examples Of How To Use An Equity Lens In Hazard Mitigation Planning

Framework	Equity Consideration	Recommended Action
Decision-Making and Solutions	● Who sits at the decision-making table? ● Are there systematic barriers to participation in the planning process? ● How will community and stakeholders be involved, and mutual communication be established? ● Scan for gaps – are needs of key socially vulnerable groups addressed?	● Establish equity principles and objectives to guide the 2025 HMP update process. ● Include community-based leaders on the HMPC including in plan development and review to identify gaps and opportunities for action. ● Establish partnerships with community-based organizations to inform process, identify actions, and foster mutual communication. ● Plan for integrating community feedback into plan update.
Accountability, Communication and Community Engagement	● How to include and deliver outcomes for those underrepresented in decision making or most affected by inequities? ● How will we be accountable to the community from planning process throughout implementation?	● Implement specific engagement for hard to reach, socially vulnerable and traditionally underserved populations. ● Implement mechanisms to report back to community members about how their input was addressed.
Understanding Data: Hazard Analysis & Risk Assessment	● How does inequity increase the impact of the hazard or climate impact? ● How will race, ethnicity, gender identity, income, languages spoken, disability, age, or medically sensitive people be affected by a disaster or climate impact? Are any of these groups concentrated in high-risk areas? ● Did we miss anything because we are not familiar with day-to-day life or what it is like to experience a disaster in a socially vulnerable community?	● Engage with stakeholders to identify socially vulnerable neighborhoods and population groups and assure that locally relevant hazards, risks and social vulnerability are included in the analysis. ● Analyze social vulnerability, hazards, and climate data together. ● Consider race, ethnicity, gender identity, income, languages spoken, disability, age, medically sensitive people, especially regarding the individual or group's ability to prepare for, survive and recover from a disaster or climate impact. ● Assess long-standing and multi-generational inequities, e.g. redlining, underinvestment, hazardous waste sites. ● Consider ways to measure cost of risks and hazards beyond property value, which undervalues the impact of asset loss to socially vulnerable communities.
Burdens and Benefits	● Would low-income households or communities of color experience a disproportionate burden? Will affluent communities receive disproportionate benefits? ● Have historical inequities led to	● Evaluate past mitigation measures and adjust or add to them to be more equitable and address gaps and new risks affecting vulnerable populations. ● Incorporate previously developed

Table 1.1-10 Examples Of How To Use An Equity Lens In Hazard Mitigation Planning

Framework	Equity Consideration	Recommended Action
	more substantial infrastructure needs in some communities? • Will the proposed measures result in displacement of vulnerable community members?	community solutions when possible. • Update approach to hazards which have increased in severity and are hitting socially vulnerable community members hard. • Identify physical barriers and old/lack-of infrastructure in vulnerable and underserved communities. • Involve community-based organizations in evaluation of benefits and burdens.
Next Steps	• How can barriers to inclusion be addressed so the process can be more thorough and inclusive now and in the future?	• Leverage existing and build new relationships with community leaders and stakeholders to support equity and inclusion efforts. • Act responsively when equity considerations are identified.

Source: San Mateo County, 2021

1.8.2 National Risk Perspective

FEMA's National Risk Index (NRI) defines risk as the potential for negative impacts from natural hazards. The NRI provides risk index scores for natural hazards for counties and census tracts across the United States. Risk index scores are calculated utilizing the following components and formula:

Expected Annual Loss		Social Vulnerability		Community Resilience		Risk Index
Is a natural hazard's component that represents the average economic loss in dollars resulting from natural hazards each year.	x	Is a consequence enhancing risk component and community risk factor that represents the susceptibility of social groups to the adverse impacts of natural hazards.	÷	Is a consequence reduction risk component and community risk factor that represents the ability of a community to prepare for anticipated natural hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions.	=	Represents the potential for negative impacts resulting from natural hazards.

More information regarding the method used to calculate risk index scores can be found at https://hazards.fema.gov/nri/determining-risk.

According to the NRI, the overall risk index rating for Anne Arundel County is considered "Relatively Moderate" (risk index score = 83.3 out of 100) compared to other counties. Other highlights for the County include:

- Expected Annual Loss: Relatively Moderate (93.4 out of 100)
- Social Vulnerability: Very Low (19.0 out of 100)
- Community Resilience: Very High (90.0 out of 100)

National Risk Index – Scoring: A community's score describes its relative position among all other communities at the same level for a given component. All scores are constrained to range of 0 (lowest possible value) to 100 (highest possible value).

Ratings: For every score there is a qualitative rating that describes the nature of a community's score in comparison to all other communities at the same level, ranging from "Very Low" to "Very High." Because all ratings are relative, there are no specific numeric values that determine the rating.

The NRI includes a risk index rating for the following comparable natural hazards included within this plan:

- Riverine Flooding (Relatively Low)
- Coastal Flooding (Relatively Moderate)
- Hurricane (Relatively Moderate)
- Drought (Relatively Low)
- Earthquake (Relatively Low)
- Extreme Temperatures
  - Heat Wave (Relatively High)
- Thunderstorm
  - Lightning (Relatively High)
  - Hail (Very Low)
  - Strong Wind/High Wind (Relatively Moderate)
- Severe Winter Weather (Relatively High)
- Tornado (Relatively Moderate)
- Wildfire (Very Low)
- Soil Movement
  - Landslide (Relatively Moderate)

1.8.3 Social Vulnerability

The NRI includes social vulnerability as a component of the overall risk index. For purposes of the NRI, social vulnerability is defined as the susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood. Social vulnerability to natural hazards is determined at the census tract level for Anne Arundel County via the NRI. The NRI utilizes the 16 variables included within the Centers for Disease Control and Prevention (CDC) Social Vulnerability Index (SVI). These variables make up the following larger groups: socioeconomic status, household characteristics, racial and ethnic minority status, and housing type & transportation.

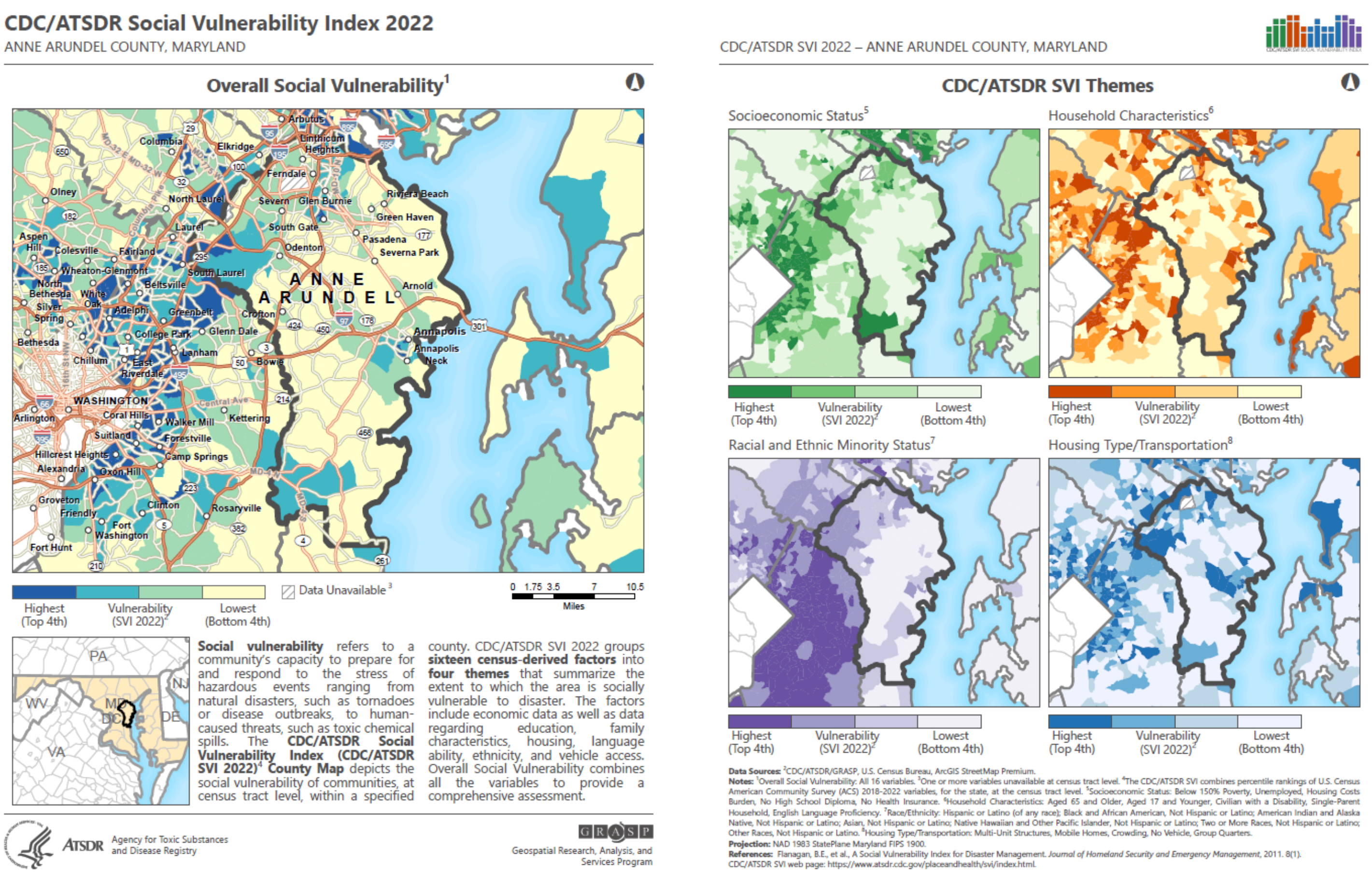
The index concludes that Anne Arundel County has a "very low" susceptibility to the adverse impacts of natural hazards when compared to other counties in the United States. The highest areas of social vulnerability within the County include the tract in Maryland City, Linthicum Heights, and Brooklyn Park. Figure 1.1-4 shows social vulnerability mapped for each census tract within the County. Darker blue areas indicate the census tracts with the highest level of social vulnerability.

Social vulnerability can increase risk from hazards in the following ways.

- Undocumented immigrants may not feel safe accessing shelters or relief.
- Transgender people may be refused shelter appropriate to their gender.

- Communities of color and/or transgender people may not feel safe seeking help from police.
- Members of the Muslim and/or Jewish community who follow strict prayer and dietary practices and may not feel comfortable accessing shelters or emergency food supplies.
- Low-income people may not be able to afford air filtration devices, generators, air conditioners, or to replace spoiled food resulting from power outages.
- Informal workforce and outdoor workers may not be included if sheltering in place is necessary while they are working at an employer’s workplace or home.
- Transit dependent populations will need assistance to evacuate rapidly.
- Community members who depend on food from formal and informal food banks may not be able to access adequate food if a disaster or hazard disrupts food distribution.
- Community members may be unable to access their go to resources such as their faith community and community organizations with cultural, linguistic and accessibility competencies.

Figure 1.1-4 Social Vulnerability Index 2022 Results for Anne Arundel County
Source: CDC/ATSDR Social Vulnerability Index 2022



1.9 Resiliency, Climate Change & Sea Level Rise

Anne Arundel County remains prepared and stands ready to work with local, State, and Federal partners, support agencies, and other organizations to address the current and future needs of our communities. The resiliency of the County depends upon effective leadership, implementation of local and regional Plans, coordination of resources and assets with our State, Federal, and local partners, and our ability to adapt to the changing environment and conditions affecting our communities.

Anne Arundel County embraces an all-hazards approach to comprehensive planning aimed at protecting life, property, and reducing the potential for future losses and damage from natural hazards. Anne Arundel County will utilize the Emergency Operations Center (EOC) to assist with response and recovery efforts. Once activated, the Incident Commander will remain abreast of the hazards and changing conditions affecting our communities. The Incident Commander and our partner agencies will be responsible for collecting and assessing current information on the risks and hazards affecting the County and taking steps to mitigate potential loss and damage to life, property, and critical infrastructure. The Office of Emergency Management maintains the capability of warning the public of hazards affecting our communities through mass notification systems and Integrated Public Awareness & Warning System (IPAWS). The County will use these systems and implement mutual aid agreements with neighboring jurisdictions to protect life, property, and critical infrastructure from all hazards affecting our communities.

Climate change increases the frequency, duration, and intensity of natural hazards; communities are feeling the impacts of a changing climate now. Many of these trends will likely continue for decades. These variations create new risks to state and local governments and challenge pre-existing mitigation plans. They also pose a unique threat to the nation's most at-risk populations by exacerbating the impacts of disasters on underserved and socially vulnerable populations who already experience the greatest losses from natural hazards.

While climate adaptation efforts may be undertaken separately or in addition to the all-hazards mitigation planning process, hazard mitigation and climate adaptation are complementary efforts that have the same goal: long-term risk reduction for people and increased safety for communities. The key difference between hazard mitigation and climate adaptation is that hazard mitigation encompasses all natural hazards, including short-term, episodic events that may or may not be connected to climate change. Climate adaptation efforts and plans are focused on reducing risk and mitigating impacts from actual or expected causes of climate change. As natural disasters cross geographic boundaries and increase in frequency and intensity, the need to support intersecting plans is greater than ever. Adapting to the expected impacts of climate change is a form of hazard mitigation. A hazard mitigation plan that addresses climate change in its risk assessment and includes adaptation actions in its mitigation strategy may reduce risk to current and future events (FEMA 2023).

On May 3, 2021, the Anne Arundel County Council adopted a set of climate change and sea level rise policies in the latest update of the County-wide General Development Plan, Plan2040. Plan2040 supports efforts to incorporate considerations of vulnerability to sea level rise, coastal flooding, and nuisance flooding into community development plans.

Plan2040 establishes a vision, goals, policies, and strategies to guide development of Anne Arundel County over the next twenty years. It lays out a policy framework that informs many of the County’s future decisions on land use, environmental protection, transportation, open space, agriculture, community facilities, historic preservation, housing, economic development, and quality of life. Plan2040 will be implemented through Region Plans, functional plans, design manuals, regulations, the capital budget, and the work programs of County departments. The policies and strategies presented in Plan2040 will ensure a cohesive approach to addressing climate change and resilience planning within the County.

Since coastal communities are most vulnerable to climate change and sea level rise, the 2025 HMP update will focus on mitigation strategies and actions that assess the vulnerability of coastal communities to sea-level rise, coastal flooding, and nuisance flooding.

Plan2040: The following goals and policies provide a framework for County plans, regulations and programs related to Climate Change

GOAL BE16: Increase the County's resilience to future changes in climate and reduce emissions of greenhouse gases.

Policy BE16.1: *Establish systems in the County government to integrate climate change considerations across County functions.*

Policy BE 16.2: *Reduce greenhouse gas emissions (GHG) to support achievement of State of Maryland goal of reducing emissions by 40% by 2030.*

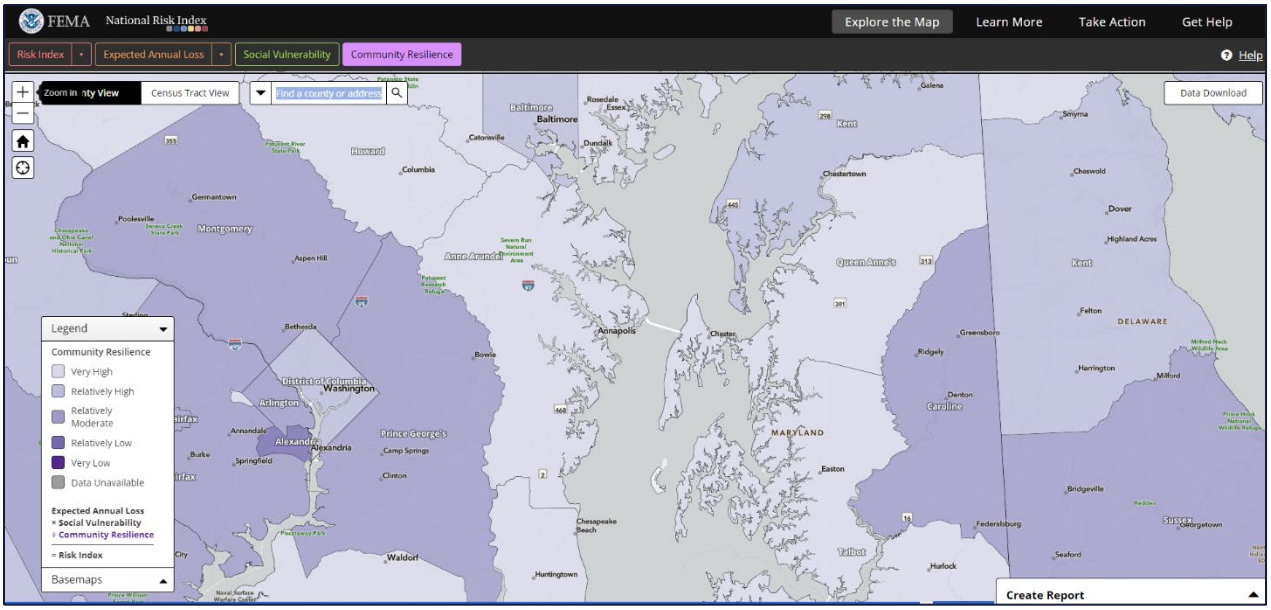
Policy BE16.3: *Support transition to renewable energy sources.*

Implementation of the mitigation actions identified in Section 5 will assist in building more resilient communities that have the ability to adapt to the changing hazards and conditions affecting the County. Partners and stakeholders of the HMP will be responsible for incorporating the policies, and strategies of Resilience, Climate Change, or Sea Level Rise into their respective local plans, programs, and initiatives. The vision for Resiliency, Climate Change, and Sea Level Rise outlined in this section are under consideration by the County for local plan integration.

1.9.1 Resiliency

Community resilience is the ability of a community to prepare for anticipated natural hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions. As a consequence, reduction risk component of the National Risk Index, a Community Resilience score and rating represent the relative level of a community's resilience compared to all other communities at the same level. A community's Community Resilience score measures its national rank and is inversely proportional to a community's risk. A higher Community Resilience score results in a lower Risk Index score.

Figure 1.1-5 FEMA Community Resilience Score for Anne Arundel County and Adjacent Counties
Source: FEMA National Risk Index



While there are many competing definitions of resiliency, most incorporate a few important concepts that can inform efforts to build resilient communities. One is the concept of adaptability to change: a resilient community is one that can thrive under changing conditions, whether those changes are rapid or more gradual. Diversity and redundancy can foster resiliency. For example, a community with a diverse economy may be better able to weather an economic shock, especially if that shock adversely affects one or several sectors more than others. The electrical grid, which efficiently and effectively builds in redundancy, can smoothly handle shift, changes, and spikes in load.

Another important concept to resiliency is that of systems and feedback. Resiliency acknowledges that economic, social, and environmental systems are tightly interconnected. For example, drought can lead to crop failure, thereby impacting the agricultural economy. Simultaneously, drought can exacerbate the conditions for wildfires, which threaten life, property, and ecological communities. These relationships and feedback processes are central to understanding what creates (or undermines) resiliency.

Finally, resiliency addresses vulnerability arising from both acute shocks and latent stresses. A resilient community is one that thrives in good times and bad. Hence, resiliency planning necessarily addresses a broader array of issues than traditional hazard mitigation planning. For example, hazard mitigation may help reduce the flood exposure of a neighborhood while resiliency planning recognizes that disparate conditions in that neighborhood, whether due to poverty, illness, language barriers, or other underlying factors, create and exacerbate negative outcomes before, during, and after a hazard event occurs.

Created in 2021, the Resilience Authority of Annapolis and Anne Arundel County is a multi-jurisdictional authority that works with the County and city to identify and fund infrastructure projects that help communities withstand the effects of climate change. These projects include those that mitigate storm events, sea level rise, and extreme heat. The authority has also partnered with the Annapolis Department of Recreation and Parks to develop a Park Master Plan for Carrs and Elktonia Beach Heritage Park., The State of Maryland Smart, Green and Growing Act of 2009 modernized the State's eight existing planning visions with 12 visions that reflect the State's aspiration to develop and implement sound growth and development policy. Eight of the twelve visions set forth in the Act speak directly to the preservation of natural resources and the environment:

1. Quality of Life and Sustainability: A high quality of life is achieved through universal stewardship of the land, water, and air resulting in sustainable communities and protection of the environment.
2. Community Design: Compact, mixed-use, walkable design consistent with existing character and located near available or planned transit options is encouraged to ensure efficient use of land and transportation resources and preservation and enhancement of natural systems, open spaces, recreational areas, and historical, cultural, and archeological resources.
3. Infrastructure: Growth areas have the water resources and infrastructure to accommodate population and business expansion in an orderly, efficient, and environmentally sustainable manner.
4. Economic Development: Economic development and natural resource-based businesses that promote employment opportunities for all income levels within the capacity of the State's natural resources, public services, and public facilities are encouraged.
5. Environmental Protection: Land and water resources, including the Chesapeake and coastal bays, are carefully managed to restore and maintain healthy air and water, natural systems, and living resources.
6. Resource Conservation: Waterways, forests, agricultural areas, open space, natural systems, and scenic areas are conversed.
7. Stewardship: Government, business entities, and residents are responsible for the creation of sustainable communities by collaborating to balance efficient growth with resource protection.
8. Implementation: Strategies, policies, programs, and funding for growth and development, resource conservation, infrastructure, and transportation.

Maryland has over 3,000 miles of shoreline that are highly susceptible to coastal storms, sea level rise, high tide flooding, erosion, hurricanes and vulnerable to the long-term impacts of a changing climate. The Maryland Department of Natural Resources has implemented a Climate Resilience Program that aims to mitigate these natural hazards. The Department has three main focuses which include coastal resilience, relative sea level rise (RSLR) and high tide flooding.

Building coastal resiliency involves understanding, planning and implementation. Using resources and data to help develop a holistic understanding of what is most at risk from tidal, stormwater or riparian flooding. The department aims to aid local governments in developing higher regulatory standards and/or risk-reducing strategies. By using existing data, the department can evaluate and make recommendations on strategies to move forward with updating and adopting updated planning processes. By implementing these resiliency projects, it can help local governments as well as non-profit organizations design, permit and construct resiliency projects that directly address coastal and stormwater hazards Community Resilience Program (maryland.gov).

The Community Resilience Program provides:

- Financial Assistance through Outcome 2 of Chesapeake & Coastal Grants Gateway
- Technical Assistance to local communities
- Training Opportunities for local practitioners

- Links to supportive information, federal and state resources, tools, visualizations and networks.

1.9.2 Climate Change

Climate change is a worldwide concern because of its potential to significantly impact people, natural resources, property, and economic conditions. While the magnitude of these changes is difficult to predict, there is broad agreement in the scientific community that they will continue to occur and will dramatically affect many aspects of people's daily lives.

Climate includes patterns of temperature, precipitation, humidity, wind, and seasons. Climate plays a fundamental role in shaping natural ecosystems, and the human economies and cultures that depend on them. “Climate change” refers to changes over a long period of time. It is generally perceived that climate change will have a measurable impact on the occurrence and severity of natural hazards around the world. Impacts include the following:

- Warming and rising ocean level
- Risk of drought and increase in frequency, intensity, and duration of heat waves
- Severe storms with extreme precipitation increasing the risk of flooding
- Increase in average temperatures

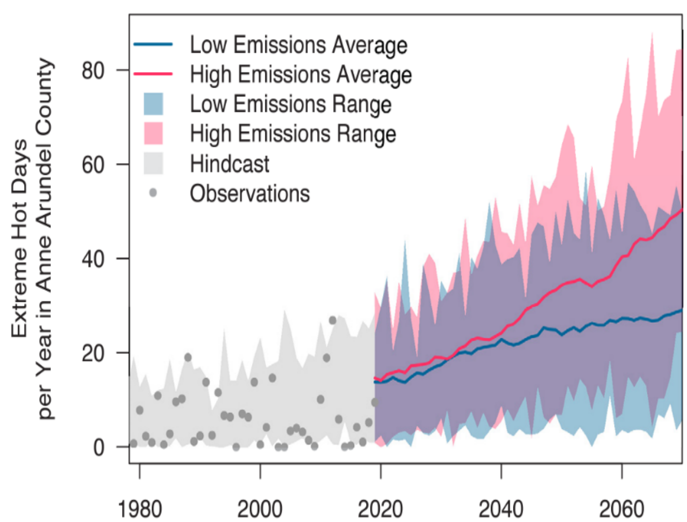
Climate change, in and of itself, is not an individual hazard, and it is not required to be addressed by federal mitigation planning criteria. However, analyzing the conditions brought on by climate change can provide a better understanding of its risk and how the population, the environment, property, and the economy may be affected by it. In addition, changing climatic conditions may exacerbate the impacts of other hazards currently affecting Anne Arundel County.

The effects of climate change are already impacting the communities across the County, and they are projected to increase in coming years. At the same time, this presents the opportunity to identify, through research and its application, appropriate mitigative and adaptive strategies and activities that can lessen the effects of climate change on the environment and future populations.

While Anne Arundel County is not seeing the highest increase in average temperatures compared to other parts of the nation and world, it is experiencing some of the effects of this phenomenon in different ways. Most importantly, increases in extreme heat events bring an increased risk to public health and the environment. In addition, some areas might experience longer periods of drought or more frequent excessive rainfall events as a result of higher levels of moisture absorbed into the atmosphere.

Anne Arundel County is expected to experience warmer summers and more

Figure 1.1-6: Number Of Days In A Year With Temperatures Above 95 Degrees.
Source: Mid-Atlantic Regional Integrated Sciences and Assessments MARISA. 2022.



days above 95°F in the next 50 years. Between 1990 and 2019, the County averaged 6 days per year with temperatures above 95°F. By 2070, the County could see 29–50 days per year above 95°F (Mid-Atlantic Regional Integrated Sciences and Assessments MARISA, 2022).

In 2018, the U.S. Global Change Research Program released the Fourth National Climate Assessment (NCA4), the authoritative and comprehensive report on climate change and its impacts in the United States. Not only did the report confirm that climate change continues to affect Americans in every region of the U.S., but the report also identifies declining snow and ice, rising sea levels, and rising temperatures as key climate-related concerns for the Northwest region of the U.S., which includes Maryland. The following is a summary of climate change impacts from the Fourth National Climate Assessment.

The recent dominant trend in precipitation throughout the Northeast has been towards increases in rainfall intensity, with increases in intensity exceeding those in other regions of the contiguous United States. Further increases in rainfall intensity are expected, with increases in total precipitation expected during the winter and spring but with little change in the summer.

Ocean and coastal ecosystems are being affected by large changes in a variety of climate-related environmental conditions. These ecosystems support fishing and aquaculture, tourism and recreation, and coastal communities. Observed and projected increases in temperature, acidification, storm frequency and intensity, and sea levels are of particular concern for coastal and ocean ecosystems, as well as local communities and their interconnected social and economic systems. Increasing temperatures and changing seasonality on the Northeast Continental Shelf have affected marine organisms and the ecosystem in various ways.

Urban areas are at risk for large numbers of evacuated and displaced populations and damaged infrastructure due to both extreme precipitation events and recurrent flooding, potentially requiring significant emergency response efforts and consideration of a long-term commitment to rebuilding and adaptation. Sea level rise has amplified storm impacts, contributing to higher surges that extend farther inland. Services and resource supply infrastructure is at increasing risk of disruption, resulting in lower quality of life, economic declines, and increased social inequality. Loss of public services affects the capacity of communities to function as administrative and economic centers and triggers disruptions of interconnected supply chains.

Increases in annual average temperatures range from less than 1°F to about 3°F since 1901. Although the relative risk of death on very hot days is lower today than it was a few decades ago, heat-related illness and death remain significant public health problems. Projected increases in temperature are expected to lead to substantially more premature deaths, hospital admissions, and emergency department visits

Fourth National Climate Assessment https://nca2018.globalchange.gov/chapter/18/

Given its location and very large extent of coastline, Anne Arundel County is keenly aware of the implications of climate change. The County's focus has been and will continue to be sea level rise caused by climate change. Sea level rise is discussed in some detail in the subsection immediately below this one.

In September 2023, Anne Arundel County and the City of Annapolis announced that the Resilience Authority had secured nearly $20 million in funding to help the County prepare for climate change. The goal is to make the region more adaptable to climate change by identifying infrastructure projects and securing funding to complete them. The Resilience Authority was established to help make the process of planning and funding these projects faster and more efficient.

Plan2040 is the County's General Development Plan, adopted May 3, 2021, provides a shared, long-range framework for County elected officials, staff, and community members for addressing land use issues and sets the policy framework to protect the natural environment, shape development of the built environment, provide public services to promote healthy communities, and support a diverse, resilient economy.

The General Development Plan was developed through dozens of public forums and is informed by thousands of comments from the community, as well as coordination from more than 20 County departments, State and Federal agencies, non-profit organizations, and members from the private sector. Plan2040 includes goals, policies, and strategies to address issues and concerns throughout the County and manage future development and redevelopment.

To coordinate climate resilience throughout the County, Plan2040 includes a goal specifically focused on climate change (BE16) and integrates climate related policies and strategies across multiple other areas.

Goal BE 16: Increase the County's resilience to future changes in climate and reduce emissions of greenhouse gases.

Policy BE 16.1. Establish systems in the County government to integrate climate change considerations across County functions.

a. Develop and implement a Climate Action Plan for Anne Arundel County that will provide detailed recommended actions to address adaptation and mitigation actions.
b. Establish a cross-department project team to manage implementation of recommended strategies and actions related to climate change.
c. Incorporate considerations of climate change, including sea-level rise, into the County's adopted plans as necessary to ensure implementation. These plans could include the Water and Sewer Master Plan; Hazard Mitigation Plan; Land Preservation, Parks and Recreation Plan; and other plans as appropriate.

The Association of Climate Change Officers (ACCO) recently partnered with the State of Maryland to form the Maryland Climate Leadership Academy. The Academy's purpose is to advance the capacity of state and local government agencies, businesses, and other organizations to develop and implement sound climate change initiatives in order to ensure current and future public health, security and economic prosperity.

As of 2025, there are eight staff in the Office of Planning and Zoning across all three Divisions who completed the Academy coursework. The County's goal is for all staff to be well educated and informed of the science and the public policy implications of climate change.

During its 2015 session, the Maryland General Assembly codified the Maryland Commission on Climate Change, officially charging the Commission with advising the Governor and General Assembly "on ways to mitigate the causes of, prepare for, and adapt to the consequences of climate change." The MCCC is chaired by the Maryland Department of the Environment Secretary and consists of members representing state agencies and the legislature, local government, business, environmental non-profit organizations, organized labor, philanthropic interests, and the State University system.

Under the Climate Solutions Now Act (CSNA) that was passed into law in 2022, an even more ambitious emissions reduction target has been established at 60%. The Commission is now charged with developing proposals that allow the state to reach that target by 2031, and “net zero" by 2045. The CSNA is arguably the most ambitious climate change law adopted by any state in the country. Since any proposals are likely to provide a cumulative, rather than immediate, impact on emissions, the changes will need to be implemented well before the target deadlines.

Under the new Act, the Commission must create several new reports and add four new working groups:

Greenhouse Gas Mitigation: Develops greenhouse gas reduction recommendations.

Adaptation and Response (Resilience): Develops recommendations for dealing with the impacts of climate change.

Scientific and Technical: Follows the latest science to support the Commission's recommendations,

Education, Communication and Outreach: Is the public affairs arm of the Commission.

According to the Maryland Commission on Climate Change 2023 Annual Report, Maryland is facing consequences of climate change including, but not limited to:

1. Changes expected to negatively impact coastal, bay, and inland water quality parameters and potentially change the viable uses of surface water, such as irrigation, recreation, or human consumption.
2. More frequent disruptions to urban and coastal infrastructure in Maryland caused by extreme weather events and sea level rise that may indirectly impact the economy of the region by restricting the flow of goods and affecting days worked.
3. Common stressors experienced among ecosystems, agriculture, fisheries, and forestry, such as those caused by general changes in temperature and precipitation regimes; increased extreme weather events; and increased pressures from weeds, diseases, and pests.
4. Changes in the severity, frequency, or distribution of human health issues which are affected either directly or indirectly by climate, including impacts on food and water supply, air quality, and extreme weather events; and
5. A higher probability of negative outcomes for individuals and communities inherently more sensitive or with a reduced adaptive capacity for responding to the impacts of climate change.

1.9.3 Sea Level Rise

Sea level rise is expected to continue and possibly accelerate as the Earth warms. The global mean sea level has risen approximately eight to nine inches since 1880, with most of that rise occurring in the past 25 years. The global mean sea level in 2019 was 3.4 inches higher than the 1993 average, the highest annual average in the satellite record during that time. In one year, 2018–2019, the global sea level rose 0.24 inches. In the United States, the mid-Atlantic region is experiencing the second fastest rate of sea level rise after the Gulf of Mexico (Dahlman, L. & Lindsey, R. 2021).

Historical records indicate a relative sea level rise occurring along Maryland's coastal areas at a rate of one foot per 100 years, and it is predicted that this rate will continue into the foreseeable future or possibly accelerate due to a variety of factors. The County is therefore susceptible to the effects of climate change and sea level rise and has a need to better understand the scientific findings to date and their implications for the County.

Sea Level Rise Strategic Plan

The County's Sea Level Rise (SLR) Strategic Plan includes recommendations to develop a strategic plan for a phased implementation response to avoid or reduce sea level rise impacts to property, infrastructure, and other resources, and to establish policies to guide the relocation, extension, or expansion of public infrastructure in at-risk areas.

The County recognizes that strategic planning for SLR will be an ongoing and evolving process as more research, analysis, and guidance becomes available. While the intent of the strategic plan is to identify steps that can be initiated by the County in both the near term and long term, it is anticipated that this plan will be built upon and revised in future years.

As part of the ongoing effort to maintain the Plan, the County's approach to updating the plan used a multi-phase planning process:

Phase 1: Vulnerability & Risk Assessment: *Analysis and identify vulnerable and at-risk areas and assets due to SLR*

Phase 2: Feasibility Study of Potential Action*: Review feasibility of implementing proposed mitigation actions to protect vulnerable and at-risk assets from SLR*

Phase 3: Implementation of Priority Actions: *Implementation of mitigation actions following feasibility analysis*

In 2023, the SLR Strategic Plan was updated utilizing new regional sea level rise scenario data from NOAA for 2050, 2065, and 2100. The 2023 planning effort included the development of a computer model that generated inundation maps for the new sea level rise scenarios. These maps allow users to identify areas at risk to flooding by simulating the effects of SLR based on highly detailed topographical elevations.

This static inundation model and vulnerability assessment was completed for all of Anne Arundel County. However, a more detailed investigation was completed for Region 9 (Mayo, Galesville, West River, Shady Side, Churchton, Deale, Tracy's Landing, and North Beach), due to the increased vulnerability for this region as identified in the 2011 Strategic Plan. In addition to quantifying impacted lands and infrastructure, the Region 9 study investigated FEMA HAZUS loss estimations for the 2050 sea level rise scenario plus the 1% storm event, social vulnerability as well as shoreline erosion. A project StoryMap summarizes Countywide findings and the results of the Region 9 study can be viewed within Part 3 of the SLR Strategic Plan Update, Region 9 Risk Assessment.

2023 SLR Strategic Plan Findings

The 2023 analysis results indicated that over 3,100 acres of land were vulnerable to the 2050 sea level rise scenario. A total of 4,462 acres of land could potentially be impacted by the 2065 sea level rise scenario, however this amount nearly doubles when the inundation area is expanded under the 2100 sea level rise scenario.

The total value of properties at risk under the 2050 sea level scenarios was over $10.6 billion and over 11.4 billion under the 2065 sea level scenario. The total assessment values for the 2100 sea level rise scenario were over $14.0 billion.

Climate Resilience Action Strategy

The goal of the strategy is to accelerate resilience planning and financing in three Chesapeake Bay Communities: Anne Arundel, Charles, and Queen Anne's counties. The approach identifies and leverages the linkages between water quality restoration and protection and climate change resilience.

The key issues and lessons learned section of the plan expanded on 6 key elements: the risk is real; there is a solid infrastructure foundation in place; resilience is about addressing uncertainty through redundancy; addressing the needs of the most vulnerable populations; focus on collaboration; making connections between natural resource protection and resilience.

The Strategy identified 4 hazards of most concern over the next decade: coastal flooding; extreme precipitation events; sea level rise, and extreme temperatures. Sea Level Rise was defined as having the highest profile and potential impact on the County's way of life and economic prosperity. The Climate Resilience Action Strategy provides a road map for moving forward with strategic infrastructure and policy development efforts.

1.9.4 Climate Change Vulnerability

People

Hazards linked to climate change can instigate both direct and indirect vulnerabilities that affect the health and well-being of the population, including the following:

- Contaminated water
- Decreased water quantity
- Failure of sanitation systems
- Outbreaks of infectious disease
- Loss of health and medical services, including mental health care
- Separation from social and/or community cultural systems
- Job loss
- Economic decline

Additional indirect impacts could result in long-term consequences that prohibit or delay the onset of conditions leading to public health issues. Extreme weather events encourage outbreaks of disease and infestation, flooding leads to an increase in fungal growth, while drought leads to increases in locust and white fly populations. Changes in ecosystems, agriculture, and water supplies can have extreme impacts on human health.

In addition to more intense heat, the related deterioration of air quality could increase the occurrence of many health problems, especially cardiovascular and respiratory problems. Other populations that may be considered vulnerable in relation to health and medical systems and services include:

- Those with physical and/or mental disabilities
- Those with visual impairments
- Those who are dependent on electricity, such as those on oxygen, ventilators, and other medical equipment required for life-support
- Older adults

- Those experiencing socioeconomic disadvantages
- Those without housing
- Those without sufficient access to healthcare

Projections for warmer winters and hotter summers also increase the frequency of outbreaks of vector borne diseases, such as West Nile virus and Lyme disease from mosquitos and ticks, respectively. Seasonal pollen production also will accelerate, extending the allergy season and increasing risks for asthma. Emergency responders may also be affected by climate change, such as increased service demands and stress-related and other personal vulnerabilities.

Structures and Systems

Projected changes in climate-related hazards will impact the built environment in a variety of ways. Severe weather events that produce high winds, such as hurricanes and tropical storms, will be more likely to damage or destroy residences, businesses, and Community Lifeline infrastructure.

Coastal areas and properties will be especially vulnerable to sea level rise. Much of the critical infrastructure in coastal areas, such as electricity, water, sanitary, communications, and transportation systems, could be negatively impacted by multiple hazard effects. For example, although power failures occur periodically from a variety of causes, the probability of failure of the energy system increases as the intensity of extreme events increases. This type of cascading incident, depending on severity, could pose significant health and safety risks, and it would normally require the involvement of local emergency management organizations to coordinate provisions for food, shelter, water, heating and cooling, and other support services.

Hazard-specific consequences for critical infrastructure are related to specific hazard impacts.

Temperature-related impacts may include:

- Increased strain on building and industrial materials
- Increased peak electricity loads in summer and reduced or increased heating requirements in winter

Precipitation-related impacts may include:

- Increased street, basement, and sewer flooding
- Reduction of water quality

Sea level rise-related impacts may include:

- Inundation of low-lying areas and wetlands
- Increased structural damage and impaired operations of Community Lifelines such as power, water, sewer, drainage, transportation, communication, health, and medical.

The impacts of climate change have the potential to affect military installations in low-lying areas susceptible to sea level rise and storm surge, also creating a threat to national security. Coordination between federal agencies, the military, and local jurisdictions in the planning area is critical to addressing these risks.

Depending on the approach and conditions of the sites being addressed for sea level rise, there could be unintended consequences of shoreline protection, such as armoring, which ignores the surge-reducing benefits of areas such as wetlands. Protecting one area could increase flood impacts in another. Other options include a mix of approaches that might have additional benefits.

In 2008, Maryland passed the Living Shoreline Protection Act, which requires shoreline property owners to use natural solutions to prevent erosion unless they can prove that such methods would not work on their property. The act's preferred method is living shorelines, which use natural materials such as plants, sand, rock, stone groins, and marsh grasses. Please refer to the Maryland Department of the Environment, “Shore Erosion Control Guidelines” (2008) for details: https://dnr.maryland.gov/ccs/Publication/Shoreerostext.pdf

Natural Environment

Environmental impacts from various climate change conditions increase the vulnerability of ecosystems, crops, livestock, and, ultimately, food supplies. Especially vulnerable to environmental impacts are the communities adjacent to the Chesapeake Bay and its tributaries. Water supplies and quality will also be impacted by extreme heat and drought. Rising sea levels and intense flooding will affect sensitive natural protective barriers along shorelines and inland waterways. Ultimately, changes in the natural environment will lead to a higher incidence of public health issues.

Economy

The economic costs of climate change can be extraordinary. Impacts from conditions linked to climate change can affect the region’s economy in relation to jobs, the prices of goods and services, and costs of development and construction.

Anne Arundel’s close vicinity to the nation’s capital has a significant portion of their economies focused on government facilities and workers and major commercial and industrial employers. Threats to Community Lifelines in the region could bring catastrophic losses to the economy.

Highly commercialized areas of the County, which has tidal influence from the Chesapeake Bay are the sites of federal agency headquarters, large employers, and multifamily residences. Increasing tidal action combined with flooding from more frequent excessive rainfall events and sea level rise can cause direct and indirect economic losses through building damage, business closures, and loss of infrastructure in the coming decades.

Actions to Reduce Risks Associated with Climate Change

Reduction of future risks from climate change depends primarily on decisions made now. Since we are already committed to some level of climate change, responding to climate change involves a two-pronged approach: 1) emissions reduction - seeks to reduce greenhouse gas (GHG) emissions to slow down climate change itself, and 2) climate resilience/adaptation - which is also necessary to ensure communities are prepared for and adapting to hazards such as severe storms, flooding, and extreme temperatures.

Table 1.1-11: Suggested Actions to Reduce Risk and Build Resilience Against Climate Change

Hazard	Suggested Actions
Extreme Heat	• Increase urban tree cover. • Install cool roofs to reduce the negative health impacts of heat. • Implement urban designs that facilitate air movement and alleviate heat. • Increase standards for insulation of buildings and homes. • Increase preparedness education about heat-related health issues for healthcare providers and the public.

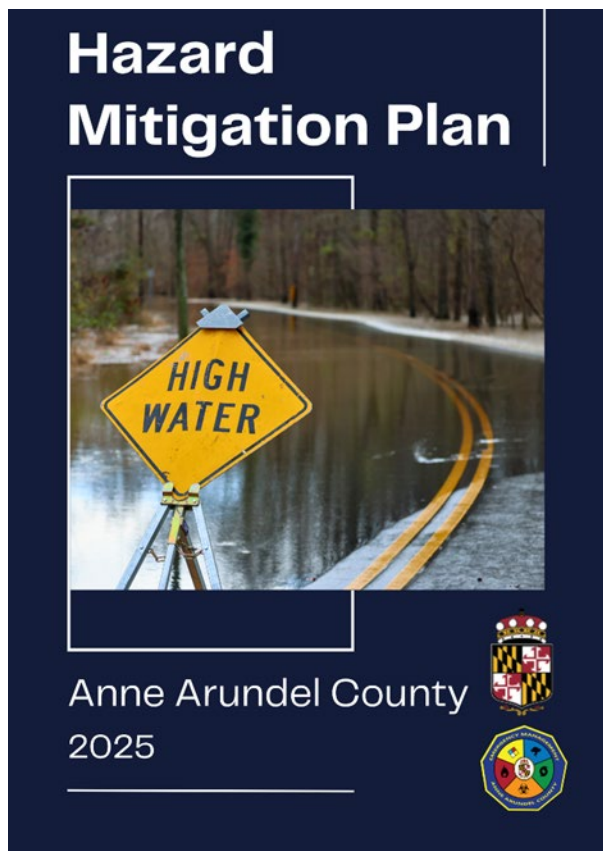
Table 1.1-11: Suggested Actions to Reduce Risk and Build Resilience Against Climate Change

Hazard	Suggested Actions
Increased Precipitation and Flood	• Increase capacities of stormwater systems. • Identify infrastructure that should be elevated or relocated to avoid future inundation. • Continue acquisition, elevation, and relocation projects for property owners. • Flood-proof mechanical systems and/or components of industrial and commercial structures. • Update flood hazard mapping.
Drought	• Develop water usage and/or restriction plans for governments, homes, and businesses. • Identify alternate water sources. • Develop new drought- and heat-resistant varieties of crops. • Develop new or improve existing irrigation systems to reduce water leakage. • Conserve soil moisture through mulching. • Implement drought-resistant landscaping. • Educate the public on water-saving measures.
Sea Level Rise	• Preserve estuaries and wetlands to accommodate rising levels of saltwater. • Develop long-term plans to address sea level rise for at-risk public and private property. • Conduct feasibility studies to determine potential shoreline protection measures against erosion and flood. • Change land use in high-risk areas.
Increased Severe Storms	• Enhance emergency preparedness messaging. • Expand or enhance early warning systems. • Update or increase resilience of infrastructure, including roads, power grids, and stormwater systems. • Identify options for effective post-event emergency relief.

Source: Liao, K. J. (2011, January 26).

Planning Process

Contents of this Section



2.0 Planning Process

The planning process documents how the plan was developed, who was involved and what data and information were used to build or update the plan. A successful planning effort includes active participation and buy-in from community leaders, stakeholders, and the public. The National Mitigation Framework emphasizes the valuable role of collaboration among various sectors to ensure that mitigation capabilities continue to grow, and that comprehensive mitigation includes strategies for all community sectors.

Requirements

A1. Does the plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? **(44 CFR § 201.6(c)(1))**

A2. Does the plan document 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 non-profit interests to be involved in the planning process? **(44 CFR § 201.6(b)(2))**

A3. Does the plan document how the public was involved in the planning process during the drafting stage and prior to plan approval? **(44 CFR § 201.6(b)(1))**

A4. Does the plan describe the review and incorporation of existing plans, studies, reports and technical information? **(CFR § 201.6(b)(3))**

2.1 Planning Context

Presidential Disaster and Emergency Declarations

Maryland: 37
Anne Arundel County: 16
A full list of these declarations is provided in Section 3, Risk Assessment.

Across the United States, natural and human-caused disasters have led to increasing levels of death, injury, property damage, and interruption of business and government services. The time, money, and effort needed to recover from these disaster events exhausts resources and diverts attention from important public programs and private agendas. Since 1962, there have been 37 Presidential Disaster Declarations and Emergency Declarations in Maryland, 16 of which have affected Anne Arundel County (FEMA, 2023). County officials recognize the impacts disasters can have on their communities and support proactive efforts needed to reduce the potential effects of natural and human-caused hazards. Emergency Management is the discipline of identifying, managing, and avoiding risks. It seeks to promote safer, more resilient communities and involves:

- Planning and preparing for a disaster before it occurs
- Supporting those affected by the disaster
- Rebuilding after the natural or human-made disaster event
- Taking actions to reduce or minimize long-term risk

> **Hazard Mitigation**: Any sustained action to reduce or eliminate long-term risk to life and property resulting from natural and human-made hazards and their impacts.

Mitigation plans are investment strategies that identify hazards, assess risks and vulnerabilities, and develop mitigation strategies that can be funded using a wide range of resources. As stated in 44 CFR § 201.1(b), "the purpose of mitigation planning is to identify the natural hazards that impact them, to identify actions and activities to reduce any losses from those hazards, and to establish a coordinated process to implement the plan, taking advantage of a wide range of resources." This coordinated process allows mitigation investments to be based on a community based, risk-informed decision-making process. The planning process helps the whole community understand the importance of mitigation and develop mitigation actions based on current and future risks and capabilities.

This process results in a HMP that identifies specific mitigation actions, each designed to achieve short-term planning objectives and realize a long-term community vision. To ensure the functionality of each mitigation action, responsibility is assigned to a specific individual, department, or agency along with a schedule for its implementation. Plan maintenance procedures are established to implement, as well as evaluate and enhance the 2025 HMP update as necessary. Developing clear plan maintenance procedures and implementation schedule ensures that the Plan remains current, dynamic, and effective over time.

Why undertake mitigation planning? Mitigation planning offers many benefits, including:

- Saving lives and preserving property
- Reducing insurance costs
- Promoting quick and effective recovery following disasters
- Reducing future vulnerability through wise development and post-disaster recovery and reconstruction
- Enhancing coordination within and across participating jurisdictions
- Expediting the receipt of pre-disaster and post-disaster grant funding
- Demonstrating a firm commitment to improving community health and safety

A core assumption of hazard mitigation is that pre-disaster investments will significantly reduce the demand for post-disaster assistance by lessening the need for emergency response, repair, recovery and reconstruction. Furthermore, mitigation measures enable local residents, businesses, and industries to reestablish themselves in the wake of a disaster, which helps get the community economy back on track sooner and with fewer interruptions. With careful selection, successful mitigation actions are cost-effective means of reducing risk of loss over the long-term.

The benefits of mitigation planning go beyond reducing hazard vulnerability. Measures such as the acquisition or regulation of land in known hazard areas can help achieve multiple community goals, such as preserving open space, improving water quality, maintaining environmental health, and enhancing recreational opportunities. Thus, it is vitally important that any local mitigation planning process be integrated with other concurrent local planning efforts, and any proposed mitigation strategies must consider other existing community goals or initiatives that will help complement or hinder their future implementation. Anne Arundel County has embraced this approach of identifying multiple opportunities to link the hazard mitigation planning with preexisting programs, policies, plans and initiatives. More information on this topic can be found in Section 4: Capability Assessment.

2.2 Planning Authority

This Plan Update has been prepared to meet requirements set forth by the Federal Emergency Management Agency (FEMA) and the Maryland Department of Emergency Management (MDEM) in order for Anne Arundel County to maintain eligibility for funding and technical assistance from state and federal hazard mitigation programs. The Plan will continue to be updated and maintained to continually address natural and human-made hazards as defined by the updated results of the Risk Assessment.

The 2025 HMP update is updated and FEMA approved within a five-year cycle. Updates may also take place following significant disasters, and the 2025 HMP update will be subject to reviews and potential updates on an annual basis. The 2025 HMP update was adopted by Anne Arundel County in accordance with the authority granted to Counties by the State of Maryland. The 2025 HMP update was updated in accordance with current state and federal rules and regulations governing local HMPs. Authority for this plan originates from the following federal sources:

- Robert T. Stafford Disaster Relief and Emergency Assistance Act, 42 U.S.C., Section 322, as amended.
- Code of Federal Regulations (CFR), Title 44, Parts 201 Mitigation Planning and 206 Hazard Mitigation Grant Program;
- Disaster Mitigation Act of 2000, Public Law 106-390, as amended.
- National Flood Insurance Act of 1968, as amended, 42 U.S.C. 4001 et seq.
- National Dam Safety Program Act (Pub. L. 92-367), as amended.
- Local Mitigation Planning Policy Guide FP 206-21-0002

> Robert T. Stafford Disaster Relief and Emergency Assistance Act is the statutory authority for most Federal disaster response activities.

The Disaster Mitigation Act of 2000 requires State and local governments to develop and adopt Hazard Mitigation Plans in order to be eligible to apply for Federal assistance under FEMA's Hazard Mitigation Assistance (HMA) program. HMA programs present a critical opportunity to reduce the risk to individuals and property from natural hazards while simultaneously reducing the reliance on Federal disaster funds.

The National Mitigation Investment Strategy is a single national strategy for advancing mitigation investment to reduce risks posed by natural hazards and increasing the nation's resilience to natural hazards. The National Mitigation Investment Strategy's objective is to identify and measure the effectiveness of mitigation investments, and to inform decisions on when and where to make investments. The Investment Strategy encourages the whole community, including individuals, to invest in pre- and post-disaster mitigation by adopting three shared goals:

Goal 1: Show How Mitigation Investments Reduce Risk

Goal 2: Coordinate Mitigation Investments to Reduce Risk

Goal 3: Make Mitigation Investment Standard Practice

Each HMA program was authorized by separate legislative action, and as such, each program differs slightly in scope and intent. While the statutory origins of the programs differ, all share the common goal of reducing the risk of loss of life and property due to natural hazards.

- **Flood Mitigation Assistance Program (FMA).** Since the National Flood Insurance Reform Act of 1994 was signed into law, funds are used for projects that reduce or eliminate the risk of repetitive flood damage to buildings insured by the National Flood Insurance Program.
- **Hazard Mitigation Grant Program (HMGP).** This program provides funds to rebuild after a disaster in a way that reduces, or mitigates, future disaster losses in their communities. This grant funding is available after a presidentially declared disaster.
- **Building Resilient Infrastructure & Communities (BRIC).** This program's guiding principles are supporting communities through capability and capacity building; encouraging and enabling innovation; promoting partnerships; enabling large infrastructure projects; maintaining flexibility; and providing consistency.
- **NFIP Community Rating System (CRS).** The CRS offers recognition to communities that exceed minimum requirements of the National Flood Insurance Program. Recognition comes in the form of discounts on flood insurance policies purchased by citizens. The CRS offers credit for HMPs that are prepared according to a multi-step process.
- **FEMA/NFIP Severe Repetitive Loss Program (SRL).** This program was authorized by the Flood Insurance Reform Act of 2004 to provide funding to reduce or eliminate the long-term risk of flood damage to residential structures under the NFIP that have suffered repetitive losses.

MDEM develops and coordinates emergency preparedness policy through the Maryland Emergency Preparedness Program. At all levels of government statewide, the Program outlines emergency preparedness, response and recovery responsibilities for natural, technological, terrorist and attack-related emergencies and disasters. The Program consists of four components: preparedness; response; mitigation; and recovery.

Under Executive Order 01.01.2013.06 MDEM reviews and updates the Maryland Emergency Preparedness Program and ensures that State agencies understand their responsibilities during times of emergency. The Department also coordinates emergency preparedness activities and operations among State and local agencies, the federal government, other states, and private and nonprofit agencies. The 2021 MDEM State Hazard Mitigation Plan was used in preparing this document:

2.3 Methodology & Update Summary

The 2025 HMP update brings together hazard risk and disaster resilience efforts through its planning process and related activities with the aim of reducing long term vulnerability across the County. The hazard mitigation planning process is built on the following:

- Hazard identification and risk assessment establish the foundation for all hazards and all phases of disaster and emergency management programs–mitigation, preparedness, prevention/ protection, response, and recovery.
- The inclusive planning process builds partnerships by involving agencies, organizations, individuals, and businesses.

- The planning process increases education and awareness of threats and hazards, as well as their impacts, consequences, and risks.
- The Plan communicates needs and priorities to federal officials, and it positions local jurisdictions for financial and technical assistance.
- The Plan provides for the most efficient and effective use of resources to reduce risk.
- The process provides opportunities to align hazard risk reduction with other state and local objectives.

The 2025 HMP update contains a narrative description of the process that was followed to prepare the plan. All participants were notified in April 2024 of the mitigation planning requirement and the 2025 HMP update timeline. Additionally, County departments were invited to participate on the Hazard Mitigation Planning Committee. The 2025 HMP update process was conducted over the course of nine months, from April 2024 to January 2025. Throughout the planning update process, the HMPC reviewed and analyzed each section of the plan. The planning process followed these steps:

- Conduct an Internal Pre-Kickoff Meeting with Anne Arundel County Emergency Management staff and Michael Baker International (MBI) staff
- Conduct a Kick-Off Meeting with the HMPC
- Develop and implement Public Outreach Strategy
- Conduct a Risk Assessment Meeting with the HMPC
- Review and update the Risk Assessment
- Conduct a Mitigation Solutions Meeting with the HMPC
- Update the Capability Assessment to assess existing capabilities and mechanisms for the County to carry out the Mitigation Strategy
- Update the Mitigation Strategy
- Update the Plan Maintenance procedures
- Complete a draft plan for review by Anne Arundel County
- Provide final draft to MDEM for review
- Provide final draft to FEMA for review
- Present the 2025 HMP update to Anne Arundel County for adoption
- Present the 2025 HMP update to Highland Beach for adoption

In accordance with the Disaster Mitigation Act of 2000, the Anne Arundel County 2018 HMP Update details the following topics:

- County Profile
- Planning Process
- Risk Assessment
- Capabilities Assessment
- Mitigation Strategy
- Plan Maintenance
- Approval & Adoption

Each of the planning steps described above resulted in key products and outcomes that collectively make up the 2025 HMP update. These work elements are further discussed below for introductory purposes.

County Profile: Section 1 describes the general makeup of Anne Arundel County, including prevalent geographic, demographic, economic, and development characteristics. This baseline information provides a snapshot of the County's planning area and thereby assists participating officials in recognizing those social, environmental, and economic factors that ultimately play a role in determining community vulnerability to natural and human-made hazards.

Planning Process: The planning process section documents how the plan was developed, who was involved and what data and information were used to build or update the plan. A successful planning effort includes active participation and buy-in from community leaders, stakeholders and the public. Involving members from these key sectors in the planning process will result in a shared understanding of risks. It will also help build widespread support for directing financial, technical and human resources toward natural hazard risk reduction. Documenting the planning process is a crucial step for future plan updates. By building on the work that has already been done, the County can incorporate best practices and insights learned from previous processes while avoiding past challenges.

Risk Assessment: Section 3 contains hazard profiles and a vulnerability assessment. Together, these elements serve to identify, analyze, and assess Anne Arundel County's overall risk. This chapter builds on available historical data from previous occurrences and provides a ranking based on conclusions about the frequency of occurrence, potential impact, spatial extent, and duration of each hazard. FEMA's Hazus loss estimation methodology was also used in evaluating known flood risks according to their relative long-term cost, measured in expected damages. Hazus results were integrated from other plans, such as the Sea Level Rise Plan; a new Hazus Level 2 analysis was not conducted for this plan update. Risk Assessment is designed to assist the County in seeking the most appropriate mitigation actions to pursue and implement by focusing efforts on those hazards of greatest concern in areas facing the greatest risks.

The original list of hazards was modified to include the following natural as well as new non-natural technological hazards:

Natural Hazards

- Flood
- Dam failure and release
- Tropical Systems (Hurricane, Tropical Storms, & Nor'easters
- Drought
- Earthquake
- Extreme Temperatures
- Thunderstorm (Lightning, Hail, Straight line Winds)
- Severe Winter Weather
- Tornado
- Wildfire
- Erosion
- Soil Movement (Land Subsidence & Sinkholes)

Non-Natural / Technological Hazards

- Emerging Infectious Disease
- Public Disorder & Active Assailant

- Transportation Accidents
- Cyber Attack.

Each of these hazards is addressed in detail in Section 3, which includes discussions of hazard history and occurrences, severity and extent of the hazards, and expected probabilities. The Risk Assessment was updated to include more detailed risk calculations, which supported the County's process for identifying and prioritizing mitigation actions and strategies. The risk assessment process included the following steps:

- Identify the natural hazards that are most likely to affect the County
- Describe how often hazards are expected to impact the County
- Explain the expected severity and extent of the impacts
- Describe what areas of the County are likely to be affected
- Estimate expected future losses if the risk is not mitigated

Capability Assessment: Section 4 includes an evaluation and update of the County's planning, regulatory, administration, technical, financial, educational, and outreach capabilities. This includes an assessment of governmental structure, political framework, legal jurisdiction, fiscal status, policies and programs, regulations and ordinances, and resource availability. These factors are evaluated with respect to their strengths and weaknesses in preparing for, responding to, and mitigating the effects of the profiled hazards. This exercise plays a key role in the hazard mitigation planning process by helping to determine the feasibility and relative appropriateness of various hazard mitigation action items that may be identified as part of the hazard mitigation strategy. This chapter also contains a section focused on plan integration, which assesses ways that Anne Arundel County currently integrates hazard mitigation with other community planning initiatives and examines additional opportunities for further integration. Combined with the risk assessment, the capability assessment informs the update of a meaningful and feasible Mitigation Strategy.

Mitigation Strategy: Section 5 consists of broad goal statements as well as specific mitigation actions for the County. This updated strategy provides the foundation for the detailed Mitigation Action Plan that links specific mitigation actions to assigned implementation mechanisms and target completion dates. Together, these sections are designed to make the 2025 HMP update more strategic and functional through the identification of both long-term goals and near-term actions that will guide day-to-day decision-making and project implementation. Mitigation goals and objectives were formulated with the intent to reduce or eliminate the long-term risk to human life and property from each hazard. An action plan was developed that identifies future mitigation actions, estimates costs, defines benefits, identifies the responsible organization(s), provides an implementation schedule, relates to the mitigation objectives, establishes priorities, and identifies potential funding sources for each action. In addition to the identification and prioritization of possible mitigation projects, emphasis is placed on the use of program and policy alternatives to help make Anne Arundel County less vulnerable to the damaging forces of hazards while improving the economic, social, and environmental health of the County.

Plan Maintenance: The County HMP must be updated every five years in order for the County to maintain its eligibility for various FEMA grant programs and funds. This chapter includes the measures that the County will take to ensure the HMP's continuous long-term implementation. The procedures also include the way the 2025 HMP update will be regularly monitored, reported upon, evaluated, and updated to retain a current and meaningful planning document. The plan is a blueprint for reducing risk and protecting County investments. Having a process for maintaining the plan reflects the recognition that things change. Not only is there a need to track progress on implementing the mitigation strategy, but new information may become available, and disasters may happen urging the need to update the plan.

The Anne Arundel County Council governs the County and has made the final decision on what projects are implemented and how they will be funded. The Council will coordinate with the Office of Emergency Management (OEM) and project managers the 5-year planning period to implement mitigation actions. The project managers will follow any current County procedures in completing the Action Items. Any progress reports and status reports (meeting minutes) will be submitted to the County Council. The OEM is responsible for overall HMP monitoring and maintenance, and the office will review the 2025 HMP update every year to consider changes in land development, population growth, or recent programs and activities that may affect mitigation initiatives. See Section 6 for the complete method and schedule for updating the HMP

Approval & Adoption: Adoption by the County and the Town of Highland Beach demonstrates commitment to the hazard mitigation goals and actions outlined in the plan. Adoption legitimizes the plan and authorizes responsible agencies to perform their responsibilities. Updated plans are adopted to demonstrate the community's recognition of the current planning process, acknowledge changes from the previous five years, and validate the priorities for hazard mitigation actions. Without adoption, the County will not be eligible for certain FEMA assistance.

2.4 The Hazard Mitigation Planning Committee

A well-rounded community-based planning team contributed heavily to the development of the 2025 HMP update. The Anne Arundel County Office of Emergency Management spearheaded the update process, with the support of the HMPC. County officials from various departments were designated to be part of the HMPC. The Office of Emergency Management identified and engaged key stakeholders in the planning and update process of the 2025 HMP update. The stakeholders were selected based on their respective role and authority to: regulate land use and development of property within the floodplain; adopt local ordinances, policies, and procedures that support the goals and strategies of the 2025 HMP update; provide administrative and managerial support to engage public participation in the 2025 HMP update process; procure capital and grant funds necessary to support mitigation projects and programs within the County; incorporate the goals and strategies of hazard mitigation planning into local plans and other planning tools during routine updates; and expand on and improve existing policies, programs, and resources that support Hazard Mitigation. The HMPC met three times during the HMP update process. These meetings took place at the Anne Arundel County Office of Emergency Management. See Appendix A for all meeting material, minutes and list of attendees.

- Meeting 1 - Virtual (Kickoff) April 25, 2024
- Meeting 2 – Risk Assessment (Mid-Point) December 5, 2024
- Meeting 3 – Mitigation Solutions Workshop February 26, 2025

A summary of the Departments and Offices with respect to their role and authority with local and regional hazard mitigation planning is described below.

The Anne Arundel **Department of Health** is responsible for improving the health of Anne Arundel County. The primary mission of the Anne Arundel Department of Health is to preserve, promote and protect the health and well-being of all people by advancing health equity in Anne Arundel County. With almost 700 Department of Health employees, the main goal is commitment to their work and providing services to the residents of Anne Arundel County. The Department of Health provides mandated, delegated and locally initiated public health services. The Department of Health focuses on inclusion, integrity, excellence, collaboration, innovation and respect.

The **Department of Aging & Disabilities** is responsible for improving the quality of life for aging adults as well as individuals with disabilities, veterans and caregivers. The Department Aging & Disabilities offers three core services which includes long term care services, aging and disabilities resource center services and disability and community services. Currently, the department offers 21 programs in 25 locations throughout the County.

The **Department of Social Services** is responsible for meeting the specific and dynamic needs of families, children and vulnerable adults in Anne Arundel County. The Department administers various outreach programs and services. Programs that the Department of Social Services offer include a holiday sharing program, back-to-school donor program, generous juror program, homeless services, mentoring program, representative payee program and volunteers/students. The Department routinely recruits volunteers and students to assist the agency.

The **Department of Transportation** is responsible for promoting and establishing multi-modal transportation throughout Anne Arundel County. The key focus is ensuring that transportation options are accessible to all people. The department supports various missions that include recommending priorities for all Anne Arundel County citizens, regardless of age or ability with accessibility and mobility. The department also works to maintain a comprehensive transportation development program, which guides long-term transportation needs. The department works directly with the State Highway Administration, Department of Public Works, and the Office of Planning and Zoning Development Division.

The **Fire Department** is responsible for ensuring the safety of the community. The Fire Department's main mission involves standing ready as an all-hazards organization to assure the safety of our communities, respond to calls for service for fires, medical and other emergencies as well as promote fire prevention strategies and life safety programs. The Anne Arundel Fire Department emsure that all firefighting and emergency response equipment and facilities are maintained and up to date.

The **Police Department** is responsible for preventing and/or crime solving while partnering and building relationships within the community. The three core services that the Anne Arundel Police Department provides include saving lives, improving the community and building community partnerships. The Anne Arundel is accredited by the Commission on Accreditation for Law Enforcement Agencies (CALEA -since 1994).

The **Office of Information Technology (OIT)** is responsible for providing professional resources, business and geographic data, computing and network applications, telecommunications, video services, and cable television administration and a high-quality secure technology infrastructure. The OIT has various divisions including cable communications, cybersecurity, enterprise services, and network. OIT also has a GIS group (OIT GIS) responsible for standardizing, coordinating and disseminating geographic information. OIT GIS provides County Maps and Data, Office of Planning and Zoning Research and GIS

Division, Department of Public Works Information Counter/File Room, Department of Public Works Engineering Records and GIS Data for Download.

Parks and Recreation is responsible for enriching the residents of Anne Arundel County. Their primary focus is to provide comprehensive recreational programs for all residents and management and maintenance of over 160 parks and natural areas. The department is also in charge of overseeing thousands of acres of land, which encompasses greenways, community parks, historical preserves, large regional parks, and archaeological sites. A key mission is to create opportunities for individuals to explore nature, improve health and well-being and enjoy life. Recreation and Parks | Anne Arundel County Government (aaCounty.org)

Economic Development Corporation is primarily responsible for growing business opportunities in the County. Increasing job opportunities, improving quality of life and expanding the tax base are all core missions. The Economic Development Corporation aids in recruiting new businesses, addresses workforce development needs, provides financing assistance to County businesses, and promotes technology development and innovation.

The **Resilience Authority** is responsible for developing, financing and supporting infrastructure projects that occur in the City of Annapolis and Anne Arundel County. Anne Arundel County established the Resilience Authority to create a structured approach to addressing the increasing threats posed by climate change and other environmental challenges. The authority aims to coordinate resources, implement cross agency strategies, and enhance community preparedness and response through targeted projects. By centralizing efforts, the Resilience Authority seeks to improve funding access, foster partnerships, and ensure a comprehensive strategy for building a resilient community that can adapt to and recover from climate-related impacts.

Partnership for Children, Youth, & Families is responsible for assessing community human services needs while also identifying any gaps, convening a group of diverse stakeholders that aid in developing solutions and building partnerships, and funding services for children and families.

The **Office of the County Executive** is responsible for creating economic opportunity throughout the County, restoring trust in the government, promoting health and wellness, and implementing smart growth policies. The Office of the County Executive focuses on community engagement and constituent services.

The **Town of Highland Beach** is bordered on the north by Black Walnut Creek and the community of Bay Ridge, on the east by Chesapeake Bay, and on the south by Oyster Creek and the community of Venice Beach. There are approximately 80 homes located in Highland Beach and the residents fiercely protect the heritage of the town. Highland Beach is strictly residential and cannot accommodate visits from the general public and tourism opportunities.

The **Deputy Chief Administrative Officer** supports the County Executive in managing daily operations, overseeing specific portfolios like strategic planning, and representing the County on various initiatives.

Annapolis City **Office of Emergency Management (OEM)** is responsible for managing all-hazards emergency preparedness, response, recovery and mitigation efforts and develop an overall culture of resiliency and safety. OEM works through the five phases of disasters which includes protection/prevention, preparedness, response, recovery, and mitigation. OEM is also responsible for activating the local Emergency Operations Center (EOC), which helps with coordinating and leading disaster response and recovery efforts.

The **Office of Planning and** Zoning is responsible for planning the physical growth, development, and land use in the County. OPZ has authority to update the County's general development plan (GDP); adopt local ordinances, policies, and procedures in land use governing subdivision of property, zoning or use of a property, Critical Area requirements, and protection of County resources including historic and archaeological sites. OPZ was identified as a key stakeholder in the update of the HMP based on their respective role and authority to regulate land use and development of property; adopt local ordinances, policies and procedures that the support the goals and strategies of the 2025 HMP update; and incorporate goals and strategies of the 2025 HMP update into local plans and planning tools during routine updates.

The **Department of Inspections and Permits** has authority to regulate land use activities through the adoption of local building, grading and site development codes; implementation of the local Floodplain Ordinance or floodplain management program; review of building, grading, and site development plans; and inspections, enforcement and issuance of permits and licenses. The Department of Inspections and Permits was identified as a key stakeholder in the update of the HMP based on their respective role and authority to review plans and issue building, grading, and site development permits; inspect, regulate, and enforce building, grading, and site development requirements within the floodplain; implement the local floodplain management program; and adopt local ordinances, policies and procedures that support the goals and strategies of the 2025 HMP update.

The **Department of Public Works** assists the Office of Planning and Zoning in updating and implementing the County's Master Plan for Water Supply and Sewerage Systems (WSMP). DPW tracks infrastructure capacity and expansion in accordance with the WSMP. The WSMP reflects the land use policies of Plan 2040, Small Area Plans, Town Center Plans and related planning policies. The WSMP identifies the mechanisms needed to meet future demand and guide development within the County by establishing criteria for which public and private water and sewer services can be provided. DPW was identified as a key stakeholder in the update of the HMP based on their respective role and authority to incorporate the goals and strategies of the 2025 HMP update into the WSMP and other planning tools during routine updates; and ensure the design and construction of public hazard mitigation planning projects within the County's Capital Improvement Program.

The **Office of Central Services** is responsible for providing administrative and managerial support by assisting HMPC representatives, County Departments and Offices with procurement activities related to the 2018 HMP update. The Office of Central Services is also responsible for administering and managing the County's fleet of vehicles, County buildings and facilities, and providing risk management services that meets the County's insurance needs by handling all claims, setting workplace safety standards, and working with commercial markets for all other coverage.

The **Office of Law** provides legal services to all County offices, departments, boards, commissions, agencies, and the County Council. The Office drafts and facilitates local legislation to regulate land use and development of property within the floodplain as well as other areas of the County; issues advice and opinions on legal questions affecting the interests of the County and reviews all deeds, bonds, contracts, and other legal papers involving the County's interests.

The **Office of Emergency Management** is responsible for implementing a comprehensive emergency management program that is aimed to prevent, protect, mitigate, respond, and recover from natural and man-made hazards that threaten the lives or property of citizens of the County. The Emergency Operations Center (EOC) allows proper coordination of resources and assets among local, State, and Federal partners to mitigate the effects of hazards on the community. OEM is also responsible for educating the public about emergency preparedness, mitigation strategies, and disaster recovery systems. Additional details on the programs and plans from these Departments and Offices are included in Section 4 Capabilities Assessment.

The participants listed in Table 2.1-1 represent the members of the HMPC who were responsible for participating in the updating of this HMP and those that participated in key meetings.

Table 2.1-1 2025 Hazard Mitigation Planning Committee Members

Name	Organization	Meeting 1 HMPC Kick-off	Meeting 2 Risk Assessment	Meeting 3 Mitigation Solutions
Preeti Emrick	Office of Emergency Management			X
Joe Corona				
Kerry Topovski		X	X	X
Alex Sperling		X	X	X
Joseph Seborowski			X	
Kasey Thomas				
Michael Jette				X
Kimberly Fisher				X
Alison Flores	Office of the County Executive			
Asha Smith				
Hannah Dier	Deputy Chief Administrative Officer			
Janssen Evelyn			X	X
Jason Fetterman	Office of Law	X		X
Greg Swain				X
Nicole Clinton	Office of Central Services, Risk Management		X	X
Shannon Hojnowski		X	X	
Matt Lawyer		X	X	X
Erik Michelson	Department of Public Works			X
Alex Baquie		X		X
Erin Dey			X	
Blake Lightcap				X
Sally Albright				
Debbie Saylor	Department of Health	X		X
Joelle Ridgeway	Department of Aging & Disabilities			
Kelly Mackall			X	X
Karen Taylor	Department of Social Services			
Rodney Tasker	Department of Transportation	X		
Christina Pompa	Office of Planning and Zoning			X
Mark Burt			X	
Desirae Williams		X	X	
Jenny Dempsey		X		

Table 2.1-1 2025 Hazard Mitigation Planning Committee Members

Name	Organization	Meeting 1 HMPC Kick-off	Meeting 2 Risk Assessment	Meeting 3 Mitigation Solutions
Kelly Krinetz			X	X
Cindy Carrier				
Andrew McCarra	Inspections and Permits	X	X	X
Jay Leshinski				
Greg Novak	Fire Department	X		X
Major Herb Hasenpusch	Police Department			X
Captain Dan Rodriguez				
Captain Tim Davis				
	Office of Information Technology			
Bradley Hunt	Recreation and Parks		X	
Bill Offutt		X		
Nolley Fisher				X
Johnathan Boniface	Economic Development Corporation			X
Lisa Grunder				
Matthew Fleming	Resilience Authority		X	
Kristina Alexander				X
Pamela Brown	Partnership for Children, Youth, & Families	X		
Randi Barclay				X
Crystal Chissell	Mayor of Highland Beach			X
Dave Mandell	Annapolis City Office of Emergency Management			
Marcia Barben	MDEM			X
Jesse Delph				X
David Ziff				X
Danna Reiss	DNR			X

2.4.1 The Stakeholder Group

The composition of the stakeholders group included representatives from local, regional, State agencies, public and private, and from neighboring communities with a vested interest in mitigation planning, or who have programs or constituent groups that would be affected by mitigation activities or projects.

The Stakeholders Group was provided with regular updates on the planning process and were requested to review the document at key points during its development. Table 2.1-2 provides the names, titles, and representation of the various members of the Stakeholder group. A representative from the Town of Highland Beach was included in the group with the same responsibilities as other group members. This provided the opportunity for the Town to review and provide feedback necessary to include in the 2025 HMP update and mitigation efforts.

Table 2.1-2 2025 Stakeholder Group

Organization	
Fort George G. Meade Emergency Management Office	Arundel House of Hope

Table 2.1-2 2025 Stakeholder Group

Organization	
Emergency Management Agency, Region 3	Medical Reserve Corps (MRC)
Environmental Protection Agency, Region 3	Mental Health Agency, Anne Arundel County
U.S. Department of Homeland Security	Kingdom Kare Inc.
National Security Agency (NSA)	BWI Business Partnership Inc.
U.S. Navy Regional Community Planning Liaison Office	Southern Anne Arundel County Chamber of Commerce
32nd Civil Support Team (WMD) MDARNG FT Meade (Ops Officer)	Central Maryland Chamber of Commerce (Odenton)
Defense Counterintelligence & Security Agency (DCSA)	Greater Crofton Chamber of Commerce
Defense Information Systems Agency (DISA)	Greater Severna Park/Arnold Chamber of Commerce
Federal Bureau of Investigation Baltimore Field Office	Maryland Responds - Medical Reserve Corps (MRC)
NASA Goddard Emergency Management Office	Mental Health Agency, Anne Arundel County
National Weather Service (NWS) Baltimore-Washington	Northern Anne Arundel County Chamber of Commerce (Glen Burnie)
U.S. Coast Guard Station, Curtis Bay	Pasadena Business Association
U.S. Fish & Wildlife Service, Patuxent Wildlife Refuge	Salvation Army (Baltimore)
U.S. Navy Support Activity - Annapolis Emergency Mgt Ofc	South County Chamber of Commerce (Deale)
MD Department of Emergency Management	Baltimore Gas & Electric (BGE), a subsidiary of the Exelon Corporation
MD Department of Environment	Colonial Pipeline
MD Department of Natural Resources	AMTRAK
MD Department of Agriculture	Norfolk Southern Railroad
MD Department of Health	Anne Arundel County
MD Department of Transportation, State Highway Administration	Maryland, University of
BWI Thurgood Marshall Airport	Federal
MD Department of Human Services	Anne Arundel County Board of Education
City of Laurel	Smithsonian Environmental Research Center
City of Annapolis	St. John's College
Baltimore County	Northrup Grumman
Baltimore City	Anne Arundel Health System
Harford County	Live! Casino and Hotel
Howard County	University of Maryland Baltimore Washington Medical Center
Prince George’s County	Amazon
Calvert County	Booz Allen Hamilton
Queen Anne’s County	Allegis Group
Highland Beach	Jacobs
Crofton, Town of	Raytheon Technologies
Crofton, Town of	Sams Club Severn Superstore
Crofton	Giant Food (Headquarters Landover)
Baltimore Metropolitan Council	Target
Anne Arundel County and City of Annapolis Community Emergency Response Team (AAACERT)	Lockheed Martin

Table 2.1-2 2025 Stakeholder Group

Organization	
American Red Cross of Southern Maryland	Verizon
American Red Cross Chesapeake and National Capital Region	L3 Communications
Amateur Radio Emergency Service (ARES)	Food Lion
Annapolis Light House	Rockwell-Collins
Anne Arundel County Food Bank	Verizon
Arundel House of Hope	KEYW
Medical Reserve Corps (MRC)	Johns Hopkins Healthcare
Mental Health Agency, Anne Arundel County	Laurel Park/Maryland Jockey Club
Kingdom Kare Inc.	Ciena
BWI Business Partnership Inc.	Home Depot
Southern Anne Arundel County Chamber of Commerce	Lowes
Northern Anne Arundel County Chamber of Commerce	
Anne Arundel County Chamber of Commerce (Annapolis)	

As drafts of the Plan update were prepared, the OEM notified members of the Stakeholder group about the status of the update and provided a general summary of changes via email. Stakeholders were offered the opportunity to review and provide comment on independent chapters as they were completed and the final draft. The group was requested to provide feedback through email to the OEM POC or a member of the consultant team. The consultant was responsible for compiling the comments and including them in edited versions of the 2025 HMP update.

2.5 Planning Meetings & Documentation

Below is a summary of the key meetings and workshops conducted by the Anne Arundel County HMPC during the plan update process.

2.5.1 Internal Kick-Off Meeting

The Internal Kick-Off Meeting held on March 12, 2024, served as a project coordination meeting with representatives from Anne Arundel County and MBI. The intent of this meeting was to discuss the planning process, project schedule, dates for upcoming meetings, and data needs and requirements.

Anne Arundel County staff compiled a list of HMPC members that will be used to send out upcoming meeting invitation and distribute plan material.

The planning team agreed to meet on a bi-weekly basis to provide updates, discuss data challenges, public outreach efforts, and set action items. Notes from these meetings can be found in Appendix B.

- First Meeting, Project Kickoff (virtual) – 1 hour
- Midpoint Meeting – 2 hours
- Third Meeting, Mitigation Workshop – 6 hours

Anne Arundel County

2025 HMP Update Timeline

March 12, 2024: Internal Kick-Off Meeting
April 25, 2024: HMPC Kick-Off Meeting
December 5, 2024: HMPC Midpoint Meeting
February 26, 2025: Mitigation Workshop
Date: Submission to April 4
Date: 2025 HMP update Adoption

Table 2.1-3 2025 Hazard Mitigation Committee Meeting Agenda Items

Date	Attendance	Agenda
April 25, 2024	18	• Welcome and Introductions • Project Overview • HMPC Member, Municipal and Public Participation • Hazard Updates • Data Collection and Next Steps

Plan milestones and deliverables were scheduled in line with the HMPC meetings. The consultant developed a task tracker that kept the plan on schedule and was used to provide County staff updates. The planning team also discussed suggested changes to the plan and developed a list of next steps.

It was also agreed that the Anne Arundel County website was used to post plan updates, and public surveys with linked notifications sent to HMPC members to disseminate to their networks. A web platform similar to the City of Annapolis was recommended to the contractor. Plan format including colors, design and GIS map templates were also agreed on during this meeting.

2.5.2 HMPC Kick-Off Meeting

The HMPC Kick-Off Meeting was held virtually on April 25, 2024, from 10AM to 11AM. The intent of this meeting was to provide an overview of the plan, discuss the planning process, FEMA's new local planning requirements, and review the 2018 HMP. Invitations were sent to the HMPC members listed in Table 2.1-1. The agenda for the meeting is presented below in Table 2.1-3.

The Anne Arundel County Office of Emergency Management, Project Development Administrator, welcomed everyone to the meeting, briefly introduced the project and turned the meeting over to the Consultant. A brief review of the definition of mitigation and the importance of mitigation planning was covered. The group went over the different parts that integrate the 2025 HMP update. During this initial introduction, expectations and the importance of committee member participation throughout plan update process was stressed. A tentative schedule for the plan update with meeting dates, agenda items, and expected progress was presented to the HMPC.

The HMPC reviewed hazards profiled in the 2018 HMP and completed a hazard risk evaluation exercise that determined if the County saw an increase or decrease in hazard impacts over the past five years. This data provided officials with a more thorough understanding of the risks of hazards in their communities, along with the varied levels of local capabilities available to address them.

2.5.3 Small Group Meeting – Equity & Social Vulnerability

On June 24th the Anne Arundel County Office of Emergency Management coordinated a small group meeting to discuss County policies addressing equity and social vulnerability. The group was composed of agency staff that have a role in coordinating public outreach efforts and addressing equity. The following people participated in the meeting:

Name	Position	Department/Organization
Kerry Topovski	Project Development Administrator	Office of Emergency Management
Bill Offutt	Chief of Park Operations	Recreation & Parks
Alexander Sperling	UASI Planner	Office of Emergency Management
Dave Mandell	Deputy Director	Annapolis OEM
Kasey Thomas	PIO	Office of Emergency Management
Asha Smith	Director	County Office of Equity and Human Rights
Daniel Rodriguez	Captain, SOD	County Police Department
Preeti Emrick	Director	Office of Emergency Management
Erin Karpewicz	CEO	Arundel Community Development Services (ACDS)
Janssen Evelyn	Deputy Chief Administrative Officer	Office of the County Executive
Hannah Dier	Deputy Chief Administrative Officer	Office of the County Executive
Mark James	Consultant	Michael Baker
Virginia Smith	Consultant	SP&D
Eric Messick	Consultant	SP&D

Participants were given an overview of the New State and Local Mitigation Planning Policy Guide (effective April 19, 2023). Among other things, the guidance requires that representatives of nonprofit organizations, including community-based organizations, which work directly with and/or provide support to underserved communities and socially vulnerable populations, must be given an opportunity to be involved in the plan update process. An opportunity to be involved in the planning process means that these stakeholders are invited to be engaged or are asked to provide information or input to inform the plan's content. Different communities may necessitate more targeted outreach and engagement, especially underserved communities.

Following the review of key terms and concepts, the presentation switched to discussion oriented questions.

- **Question 1:** Has your department, agency, or organization observed shifts in the needs of underserved communities or gaps in social equity?

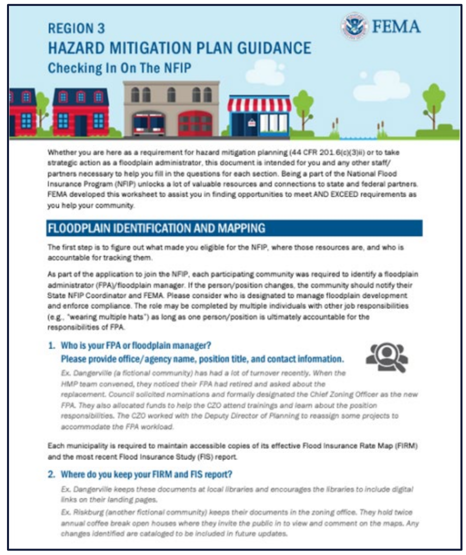
- **Question 2:** Do you know of locations/areas of particular social vulnerability concern?
- **Question 3:** Is there a specific organization that works directly with vulnerable populations? Particularly, those not represented today.
- **Question 4:** Has your department, agency, or organization included social equity and/or vulnerability in any of your planning or services provided since the previous HMP?
- **Question 5**: Do you currently target group(s) with public outreach materials? How – methods of dissemination. A social media post?

2.5.4 Small Group Meeting – Floodplain Management

On June 25 the Anne Arundel County Office of Emergency Management coordinated a small group meeting to discuss the County's floodplain management program. The group was composed of agency staff that work with floodplain regulations. The people participated in the meeting:

Name	Position	Department/Organization
Kerry Topovski	Project Development Administrator	Office of Emergency Management
Alexander Sperling	UASI Planner	Office of Emergency Management
Joe Corona	Deputy Director	Office of Emergency Management
Erik Michelsen	BWPR	Department of Public Works
Greg Novak	Deputy Chief	Fire Department
Christina Pompa	Deputy Planning & Zoning Officer	Office of Planning and Zoning
Mark Burt	Research and GIS	Office of Planning and Zoning
Andrew McCarra	Assistant Director, Building Review and Inspections	Inspections and Permits
Jenny Dempsey	Planning & Zoning Officer	Office of Planning and Zoning
Bill Offutt	Chief of Park Operations	Recreation & Parks
Nicole Clinton	Deputy Central Services Officer	Central Services
Janssen Evelyn	Deputy Chief Administrative Officer	Office of the County Executive
Shannon Hojnowski	Assistant Manager	Central Services, Risk Management
Mark James	Consultant	Michael Baker
Eric Messick	Consultant	SP&D

Participants had an opportunity to review and recommend changes to the FEMA Region 3's "Checking in on the NFIP" floodplain capability assessment that was prepopulated by the consultant. Areas where the questionnaires were incomplete were highlighted, and participants were given the opportunity to provide additional/complete information for each capability question. Information gathered during the meeting was integrated into the questionnaire and reviewed by the County's floodplain manager. Additional questions addressing topics not covered by the questionnaire were discussed and mitigation action ideas were also. Meeting slides and notes for both small group meetings can be found in Appendix C.


REGION 3
HAZARD MITIGATION PLAN GUIDANCE
Checking In On The NFIP

FEMA

Whether you are here as a requirement for hazard mitigation planning (44 CFR 201.6(c)(3)ii) or to take strategic action as a floodplain administrator, this document is intended for you and any other staff/partners necessary to help you fill in the questions for each section. Being a part of the National Flood Insurance Program (NFIP) unlocks a lot of valuable resources and connections to state and federal partners. FEMA developed this worksheet to assist you in finding opportunities to meet AND EXCEED requirements as you help your community.

FLOODPLAIN IDENTIFICATION AND MAPPING

The first step is to figure out what made you eligible for the NFIP, where those resources are, and who is accountable for tracking them.

As part of the application to join the NFIP, each participating community was required to identify a floodplain administrator (FPA)/floodplain manager. If the person/position changes, the community should notify their State NFIP Coordinator and FEMA. Please consider who is designated to manage floodplain development and enforce compliance. The role may be completed by multiple individuals with other job responsibilities (e.g., "wearing multiple hats") as long as one person/position is ultimately accountable for the responsibilities of FPA.

1. Who is your FPA or floodplain manager?
Please provide office/agency name, position title, and contact information.
Ex. Dangerville (a fictional community) has had a lot of turnover recently. When the HMP team convened, they noticed their FPA had retired and asked about the replacement. Council solicited nominations and formally designated the Chief Zoning Officer as the new FPA. They also allocated funds to help the CZO attend trainings and learn about the position responsibilities. The CZO worked with the Deputy Director of Planning to reassign some projects to accommodate the FPA workload.

Each municipality is required to maintain accessible copies of its effective Flood Insurance Rate Map (FIRM) and the most recent Flood Insurance Study (FIS) report.

2. Where do you keep your FIRM and FIS report?
Ex. Dangerville keeps these documents at local libraries and encourages the libraries to include digital links on their landing pages.
Ex. Riskburg (another fictional community) keeps their documents in the zoning office. They hold twice annual coffee break open houses where they invite the public in to view and comment on the maps. Any changes identified are cataloged to be included in future updates.

Table 2.1-4 2025 Hazard Mitigation Committee Meeting Agenda Items

Date	Attendance	Agenda
Dec 5, 2024	17	• Welcome and Introductions • Hazard Mitigation Project Overview • Project Update • Mitigation Strategies • Capability Assessment • Nuisance Flood Plan Kick-Off • Next Steps

2.5.5 LEPC Meeting – Hazard Mitigation Plan Update

On September 9 an update on the progress of the 2025 HMP update was presented to the Anne Arundel County Local Emergency Planning Committee (LEPC).

The LEPC coordinates planning for hazardous materials incident response and the dissemination of information regarding chemical hazards in the community. Committee Members represent the following groups or organizations: elected officials, firefighters and emergency medical services personnel, law enforcement, health, emergency management, media, hospitals, federal facilities, community groups, and owners and operators of facilities using or storing hazardous materials. Meeting slides for the LEPC meeting can be found in Appendix D.

2.5.6 Midpoint Meeting - Risk Assessment

The Midpoint meeting was held virtually on December 5, 2024. The purpose of this meeting was to provide updated hazard risk assessment results, preliminary results from the public survey, and to conduct a capability assessment work session with meeting participants. Invitations were sent to HMPC members on November 21,2024. The agenda for the meeting is presented below in Table 2.1-4.

Meeting participants were provided an update on plan activities that have occurred since the kickoff meeting that was held over 6 months. During this time OEM has undertaken a number of public outreach efforts. Project updates were presented for Public Outreach opportunities and Survey Results,

Public Outreach Efforts:

- Attendance at 11 public events occurring from June 29 through September 28
- Held 8 public meetings across the County from September 30 through December 11
- Circulated two public surveys that utilized Survey Monkey and ArcGIS123 to gather public perspectives on hazards and location of flooding across the County.

HMPC members were provided results and an opportunity to, comment on the status of both surveys. Additionally, HMPC members were asked to post and repost the public survey social media with survey link, as appropriate.

Results of the Hazard Identification and Risk Assessment (competed during the kick-off meeting) were presented and an update to declared disasters and local hazard events were reviewed.

Mitigation Action items included in the 2018 Plan were reviewed by lead departments and received a status update. These updates were also presented at the meeting:

- 64 Mitigation Action Items were reviewed
- 17 “Completed”
- 29 “In Progress”
- 8 “Not Yet Started”

Finally, the work session held during this meeting afforded HMPC members an opportunity to discuss current capabilities and answer discussion questions aimed at identifying gaps or opportunities for expansion. A follow-up questionnaire was sent to HMPC members in hopes to gain additional input on capabilities that were not received during the Midpoint meeting. Identified gaps and opportunities for expansion of current capabilities identified in this exercise were incorporated into new mitigation actions for this plan update.

2.5.7 Mitigation Solutions Workshop

The third Hazard Mitigation Committee Meeting was held in person on February 26, 2025. The focus of this meeting was to have HMPC members review and update plan goals, review and add mitigation actions, and develop project sheets. Save the dates and Invitations were sent to HMPC members. The agenda for the meeting is presented below in Table 2.1-5.

Table 2.1-5 2025 Mitigation Solutions Workshop Agenda

Date	Attendance	Agenda
February 26, 2025	32	• Welcome • Guest Speakers • Nuisance Flood Plan Update & Group Activity • Project Updates & the 2025 HMP update Goals& Objectives • Lunch • Mitigation Actions Development Session • Group Reports & Action Prioritization Session • Next Steps

Committee members had the opportunity to review current actions and determine it should be included in the plan update. In addition, tweaks were made to action items, as necessary based on participant feedback. All new mitigation actions included in this plan were either proposed by committee members or were identified from risk and vulnerability assessments conducted within the hazard profiles. Prior to the mitigation strategy workshop HMPC members were tasked with providing information on the current status of mitigation actions (e.g., Completed, Canceled, Delayed, or Ongoing).

During the meeting HMPC members reviewed the plan's current goals and objectives prior to review and development of mitigation strategies. Goals and objectives were first reviewed individually, then reviewed and discussed in groups. Groups were tasked with adding new goals and/or objectives and modifying or removing goals and objectives. Goals and objectives reviewed by the HMPC will be made available for review in the mitigation strategies section of the 2025 HMP update.

Mitigation action items were developed for the workshop and grouped by hazards. At least two mitigation action items were developed for each hazard. Committee members reviewed action items in the following groups:

- **Group 1:** Flood, Dam Inundation, and Coastal Hazards
- **Group 2:** Hurricane, Tropical Storm & Nor'easter, Winter Storm, Thunderstorm, and Tornado
- **Group 3:** Civil Disturbance & Active Assailant, Transportation Accidents, Cyber Attack, and Emerging Infectious Diseases
- **Group 4:** Drought, Extreme Temperatures, and Wildfire
- **Group 5:** Soil Movement Earthquake, and Erosion

Each group reported their top action items. Action items identified as resonating the most with workshop participants, meaning they had a high likelihood of completion, and they should be completed during this next planning cycle were identified during each of the four workshops. Results of the Mitigation Workshop are included in Section 5.0: Mitigation Strategy.

Each group designated a scribe responsible for submitting all written contributions at the workshop's conclusion. Groups were encouraged to focus on a single hazard at once, using hazard-specific file folders containing mitigation action sheets for each member and multiple reference material packets.

Following the group work session, each group's speaker reported out:

- What hazards did your group address?
- How many action items were reviewed?
- Which 3 action items resonated the most with the group?
    - These action items are identified for further prioritization.
    - Committee members were provided a reference list of all 63 action items, by hazard, to keep track of which hazards were identified for further prioritization.

In total, HMPC members working in these groups reviewed 63 mitigation action items. Of these, 46 action items were further developed for inclusion in the plan update. Each group was provided with reference material to aid in completing a mitigation action worksheet. When finished, each group reported their findings to the larger group, including their top action items and whether or not they added any new mitigation projects.

The HMPC also added 6 new mitigation action items – 3 flood, 1 tornado, and 2 erosion action items. Therefore, a total of **52 mitigation action items** are included as part of the 2025 mitigation strategy.

Each group identified at least 3 action items for further prioritization. These items were noted during the group report out. These action items will be further prioritized based upon a modified STAPLEE evaluation criterion. STAPLEE considers: Social, Technical, Administrative, Political, Legal, Economic, and Environmental Factors.

There were a total of 19 action items selected for further prioritization. Individually, participants completed the 6 STAPLEE questions for each of these action items. Results of the prioritization are included in the Mitigation Strategy section.

2.5.8 Public & Stakeholder Participation

A vital component of Anne Arundel County's community-based mitigation planning process involves public, stakeholder, and jurisdiction participation. Individual citizen involvement provides the HMPC with a greater understanding of local concerns and ensures a higher degree of mitigation success by developing community "buy-in" from those directly affected by the planning decisions of public officials.

Anne Arundel County understands the importance of a public information, outreach, and stakeholder campaign in seeking participation, input, and involvement of the public and stakeholders throughout the planning and update process. The public information, outreach, and stakeholder campaign provides the public, planning committee members, and stakeholders with the opportunity to participate and provide input in hazard mitigation planning activities. The public is able to comment on proposed local mitigation projects and assist the County with prioritizing local mitigation projects to meet the needs of the community. The public information, outreach, and stakeholder campaign also allows planning committee members and stakeholders the opportunity to participate, provide input, and incorporate goals and strategies of the 2025 HMP update into other local plans and planning tools to ensure the needs of the community can be met.

Opportunities to engage in the plan update process were offered. Public input was sought using the following methods:

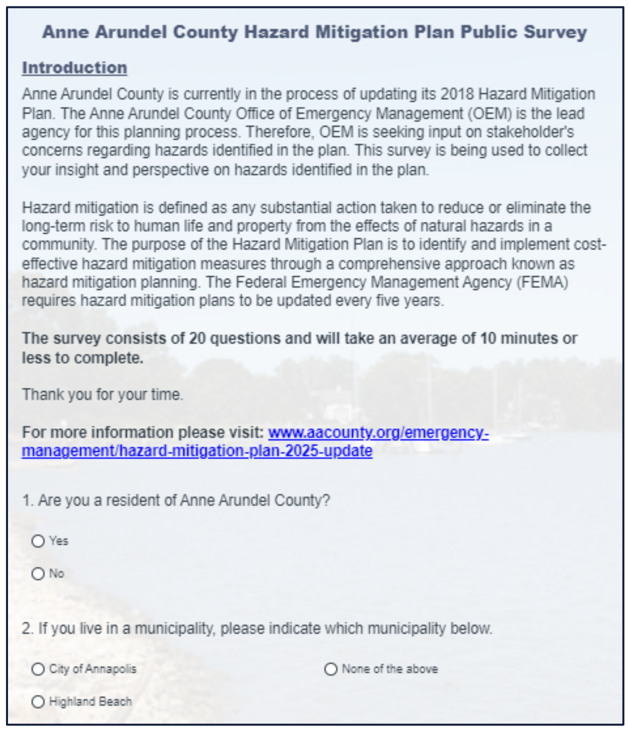
(1) Online public survey
(2) Press release and social media post about the plan update and ways to engage
(3) Advertised open public meetings
(4) Posting of all development materials and a draft of the 2025 HMP update on the Anne Arundel County Emergency Management website.

Each HMPC member was given multiple opportunities to participate in the HMP update process through invitations to meetings, review of risk assessment results and mitigation actions, and an opportunity to comment on the draft of the 2025 HMP update. The tools listed below were distributed at meetings or in meeting follow-up emails to solicit data, information, and comments from all municipalities in Anne Arundel County as well as other HMPC members and stakeholders. These resources were also posted to the project website.

- **Evaluation of Identified Hazards and Risk Worksheet:** Allows communities to provide information on the status of hazards in their community and nominate new hazards for inclusion in the 2025 HMP update.
- **Capability Assessment Survey:** Collects information on local planning, regulatory, administrative, technical, fiscal, political, and resiliency capabilities to inform the Countywide and local mitigation strategies.
- **National Flood Insurance Policy (NFIP) Survey**: Collects information on the County floodplain management program and ordinance enforcement of NFIP standards and requirements.
- **Social Equity Survey**: Collects information on shifts in the needs of underserved communities or gaps in social equity and if there has been any effort to include social equity and/or vulnerability into any planning or services.
- **Mitigation Action Review Worksheet:** Allows County departments and that submitted hazard mitigation projects for the 2018 HMP to re-evaluate them to determine if they are still viable or if they have been completed or discontinued.
- **Mitigation Action Worksheet:** Allows County departments to propose mitigation actions for the 2025 HMP update and include information about each action such as a lead agency/department, implementation schedule, priority, estimated cost, and potential funding source(s).

Public input was also solicited through an online hazard mitigation survey composed and disseminated on the Anne Arundel County Emergency Management website. The SurveyMonkey survey collected demographic data of respondents, had respondents assess hazard risks, asked for mitigation action ideas, and gauged respondents' participation in public hazard mitigation efforts. 194 residents participated. Participants' top 5 hazards of most concern are:

1. Coastal Flooding
2. Hurricane, Tropical Storm, and Nor'easter
3. Erosion
4. Severe Thunderstorm
5. Riverine Flooding



Anne Arundel County Hazard Mitigation Plan Public Survey

Introduction

Anne Arundel County is currently in the process of updating its 2018 Hazard Mitigation Plan. The Anne Arundel County Office of Emergency Management (OEM) is the lead agency for this planning process. Therefore, OEM is seeking input on stakeholder's concerns regarding hazards identified in the plan. This survey is being used to collect your insight and perspective on hazards identified in the plan.

Hazard mitigation is defined as any substantial action taken to reduce or eliminate the long-term risk to human life and property from the effects of natural hazards in a community. The purpose of the Hazard Mitigation Plan is to identify and implement cost-effective hazard mitigation measures through a comprehensive approach known as hazard mitigation planning. The Federal Emergency Management Agency (FEMA) requires hazard mitigation plans to be updated every five years.

The survey consists of 20 questions and will take an average of 10 minutes or less to complete.

Thank you for your time.

For more information please visit: www.aacounty.org/emergency-management/hazard-mitigation-plan-2025-update

1. Are you a resident of Anne Arundel County?

- Yes
- No

2. If you live in a municipality, please indicate which municipality below.

- City of Annapolis
- None of the above
- Highland Beach

Hazards that were rated as lowest concern included Earthquake, Dam Failure, and Wildfire. Overall, respondents show support for mitigation project types that:

1. Improve the damage resistance of utilities
2. Retrofit infrastructure
3. Inform property owners of ways they can mitigate hazard damages

Full Survey results can be found in Appendix E

Survey drop boxes were available during community outreach events and public meetings along with hard copies of the survey; there were collected throughout the planning process. Hardcopies of the surveys and drop boxes were also made available for public input at the following events:

Combined Outreach Events:

- 6/29/2024 11-4 RIVER DAYS: OUTREACH event Smithsonian Environmental Research Center 647 Contees Wharf Rd Edgewater, MD 21037

  Meeting Notes: Attended by Outreach Staff on behalf of OEM

- 6/30/2024 11-4 Kinder Farm Park Community Fair 1001 Kinder Farm Park Rd, Millersville, MD

  Meeting Notes: Attended by Outreach Staff on behalf of OEM

- 7/17/2024 6-8 Public Meeting: Deale Community Library, Shadyside Deale Adaptation Study

  Meeting Notes: We saw about 20 to 25 residents. The residents who attended were very receptive to the plan and were excited to participate in the survey. One completed hardcopy survey was received, and flyers were handed out to residents to take the survey online.

- 7/20/2024 11-4 RIVER DAYS: OUTREACH event, Annapolis Maritime Museum Park in partnership with CRAB & Annapolis Sailing School, 7300 Edgewood Road Annapolis, MD 21403

  Meeting Notes: There were about 125 visitors to the OEM table and gave out around 50 flyers. Residents seemed eager to participate but did not bring up any direct questions or concerns

- 8/6/2024 5-8 National Night Out,

  Meeting Notes: OEM office event were staff went to four different locations across the County.

- 8/11/2024 11-4 RIVER DAYS: OUTREACH event, West River Center,5100 Chalk Point Road West River, MD 20778

  Meeting Notes: Distributed about 10 flyers to residents. People were interested in being invested in helping update the plan. The overarching theme from talking with people was that climate change was affecting the weather and that it was only going to get worse.

- 8/13/2024 6-8 Public Meeting: Captain Avery Museum, Shadyside Deale Adaptation Study

  Meeting Notes: This event was well attended and an entire community showed up after organizing it on Facebook to make sure their community was properly represented in the study. We provided general outreach material for Flooding and Hurricanes as well as the mitigation handout. People were receptive to the update and were interested in completing the survey. The main topic that was brought up was flooding. Talked to 35-45 residents that took survey handout.

- 8/25/2024 11-4 "RIVER DAYS: OUTREACH event, Quiet Waters Park,600 Quiet Waters Park Rd, Annapolis, MD 21403

  Meeting Notes: The County estimated about 1200 residents at River Days IV at Quiet Waters Park. Our OEM Booth had about 225 visitors. Distributed around 50 Survey flyers. Everyone I had time to briefly discuss the concept with seemed happy about having the opportunity to have their concerns heard. The County executive stopped by and saw the surveys as well.

- 9/28/2024 9-3 Hispanic Heritage Festival

  Meeting Notes: Attended by Outreach Staff on behalf of OEM

Designated 2025 HMP update Public Meetings:

- 9/30/2024 6-7:30 PUBLIC MEETING 1: Linthicum Library, 400 Shipley Road, Linthicum Heights, MD 21090
- 10/14/2024 5-7:30 PUBLIC MEETING 2: Crofton Library, 1681 Riedel Road, Crofton, MD 21114
- 10/21/2024 5-7 PUBLIC MEETING 3: HIGHLAND BEACH & SURROUNDING COMMUNITIES
  Hillsmere Elementary School cafeteria, 3052 Arundel on the Bay Road, Annapolis, MD 21403
- 10/30/2024 5-7 PUBLIC Meeting 4: Edgewater Library 25 Stepneys Lane Edgewater, MD 21037
- 11/12/2024 5:30-7 PUBLIC MEETING 5: Deale Library
- 11/14/2024 5:30-7 PUBLIC MEETINGH 6: MD City @ Russett Library
- 12/3/2024 5:30-7 PUBLIC MEETING 7: Broadneck Library1275 Green Holly Drive, Annapolis, MD 21409
- 12/11/2024 5:30-7 PUBLIC MEETING 8: OEM Auditorium (registration required) - hybrid meeting 7480 Baltimore Annapolis Blvd, Glen Burnie, MD 21061

Meeting slides handouts that were used at public outreach meetings can be found in Appendix F. The following list of public outreach material and guidance can also be found in Appendix F:

- Public Meeting Presentation Slides and Handout
- County OEM Public Meeting Tracker
- Draft Media Release

- Example Social Media Post
- Project Briefing Sheet
- Website Updates

Legislative process will provide additional opportunity for public participation and input once the legislation for the 2025 HMP update has been introduced to the Anne Arundel County Council. The Anne Arundel County Charter requires the Council Chair to schedule a public hearing within 7 days for any new legislation, and the Anne Arundel County Council may not adopt any legislation until a public hearing is held. Since a public hearing is required before the legislation on the 2025 HMP update can be adopted, the public will have additional opportunity to comment. OEM will request to receive documentation of any public comments received during the public hearing and will incorporate any key revisions to ensure the final 2025 HMP update meets the needs of the community. Any revisions will be submitted to MDEM and FEMA for final review and approval before the legislation is adopted.

2.6 Town of Highland Beach Planning & Participation

Though County departments have resources such as technical expertise and data which local jurisdictions may lack; involvement from local municipalities is critical to the collection of local knowledge related to hazard events. Local municipalities also have the legal authority to enforce compliance with land use planning and development issues. The 2025 Anne Arundel County HMP update includes the participation of County officials and the Town of Highland Beach Mayor.

To satisfy multi-jurisdictional participation requirements, Highland Beach was asked to perform the following tasks:

1. Designate a representative to serve on the Anne Arundel County HMPC
2. Actively participate in the HMP update process
3. Provide best available data as required to update to the local hazard, risk, and vulnerability assessment
4. Determine capability and provide copies of any planning, mitigation, or hazard-related documents for review and incorporation into the 2025 HMP update
5. Support the updating of the current Countywide mitigation strategy, including the update, evaluation of plan goals and the review and development of new hazard mitigation actions.
6. Review and provide timely comments on all draft components of the 2025 HMP update
7. Adopt the 2025 Anne Arundel County HMP update, including the local mitigation actions specific to Highland Beach

Through the completion of these tasks, Highland Beach has met the requirements needed for participation in the Anne Arundel County Plan update. Further, through the preparation of their own local mitigation action plans, Highland Beach was responsible for addressing their most significant hazard concerns. This component of the 2025 HMP update provides the opportunity for Highland Beach to monitor and update their own specific HMP implementation responsibilities without necessarily having to meet with the HMPC. It also enables Highland Beach to be solely responsible and accountable for those actions that apply to their jurisdictions.

Table 2.1-4 The Town of Highland Beach Participation

Jurisdiction	HMPC Meetings			Worksheets and Exercises			
	KICK-OFF	MIDPOINT	MITIGATION SOLUTIONS	Evaluation of Identified Hazards	Capability Assessment Survey	Mitigation Action Review Worksheet	New Mitigation Action Worksheet
Town of Highland Beach			X	X		X	X

2.7 Incorporation of Plans, Studies, & Reports

The Town of Highland Beach has their own Comprehensive Plan, Emergency Operations Plan, and maintains their own zoning ordinance. The town adopted the 2018 Hazard Mitigation Plan and Nuisance Flood Plan updates and integrated them both into their local planning process. After FEMA APA the town will pass a resolution to adopt the 2025 plan updates.

The City of Annapolis has its own HMP and is not integrated into the County's Plan. The OEM will remain the lead agency for coordination of future HMP updates and planning activities. As part of future reviews and updates, OEM will explore opportunities with our partners and key stakeholders on how to integrate the mitigation goals, strategies, actions and projects into respective local plans, programs and initiatives. The County intends to use the 2025 HMP update, namely the actions and projects described in Section 5 Mitigation Strategy, to prioritize and recommend mitigation actions and risk reduction projects for consideration in the County's Capital Improvement Program. Assessment of these mitigation action items will be completed by the OEM Deputy Director on an annual basis.

Planning documents are used as a resource for integrating hazard mitigation strategies and actions. The 2025 HMP update included a review of other local comprehensive plans, studies, and reports for the purpose of determining where and how to incorporate the hazard mitigation strategies and actions identified from the 2025 HMP update. A discussion on new plans, studies, and reports was also conducted to identify the results of those plans, studies, and reports that need to be incorporated into the 2025 HMP update.

Before the next HMP update, the Office of Emergency Management (OEM) will establish a process by which partners and stakeholders will work collaboratively to identify hazards, assess vulnerabilities, identify significant risks, and develop hazard mitigation actions to meet the needs of the community. The process will involve an annual review and assessment of existing comprehensive plans in an effort to identify how the hazard mitigation strategies and actions of the 2025 HMP update can be integrated into local comprehensive plans, policies, and programs such as the Anne Arundel County Master Plan – Plan 2040, and Capital Improvement Program. The process will involve meeting with the HMPC members and stakeholders on an annual basis to:

- Evaluate the progress of existing mitigation projects and actions included in Section 5
- Identify any new projects that need to be added to the 2025 HMP update

The result of this coordination effort will enable the County to maintain an up to date the 2025 HMP update as well as increase the level of awareness about hazard mitigation planning, projects, and actions occurring within the County. This process will also ensure HMPC members and stakeholders have the opportunity to provide input and have the capability to integrate hazard mitigation strategies, actions, and best practices into local comprehensive plans, programs, policies, and standard practices.

Table 2.1-5 Incorporating Plans, Studies and Reports

Plan Name	Update Process	Incorporating Mechanism/s
Planning and Zoning		
General Development Plan (GDP) – Plan2040	Last Updated on May 3, 2021.	HMPC considered implementing resiliency actions such as limiting or restricting future development in areas subject to coastal flooding and sea level rise that are consistent with those presented in Plan2040.
Article 16- Floodplain Management, Sediment & Stormwater Management	Last Updated in 2021.	Actions that were addressed in this update and will continue to be assessed include: evaluate local building standards, as necessary, in high flood risk areas including areas subject to high velocity wind, wave action, erosion and tidal flooding, areas with failing stormwater systems;
Article 17- Subdivision & Development Regulations	Individual amendments occur as needed.	Plan2040 evaluated subdivision & development regulations with regard to future development and land use potential in areas subject to flooding, sea level rise, & climate change. As part of this plan update the HMPC provided recommendations to improve local development regulations and implement best practices for development in high flood risk areas of the County.
Article 18- Zoning Ordinance	Individual amendments occur as needed.	Plan2040 evaluated the Zoning Ordinance with regard to future development and land use potential in areas subject to flooding, sea level rise, and climate change. As part of this plan update the HMPC provided recommendations to improve County zoning practice in high flood risk areas.
Nuisance Flood Plan	Last Updated in 2025	The inventory of known flood hazard areas identified in the nuisance flood plan was integrated into the flood section of the 2025 HMP update. One hundred and fifty-four (154) flood prone roads have been modeled, and fifteen (15) flood prone roads have been observed through a collaborative effort by the OEM, DPW, GIS, County Fire and County Police. Future projections of sea level change and nuisance flooding will be integrated into land use planning, floodplain management, comprehensive planning, and capital investment planning.
Climate Resilience Action Strategy	Last Updated in 2020	The goal of the Climate Resilient Action Strategy is to accelerate resilience planning. An approach that identifies and leverages the linkages between water quality restoration and protection and climate change resilience were developed in the strategy and considered by the HMPC when developing hazard mitigation measures.
Sea Level Rise Strategic Plan	Last Updated in 2023	The Strategic Plan incorporates 7 goals and recommendations related to sea level rise that were implemented as part of the planning process and considered by the HMPC when developing hazard mitigation measures. The 2025 HMP update integrated the list of recommendations and schedule

Table 2.1-5 Incorporating Plans, Studies and Reports

Plan Name	Update Process	Incorporating Mechanism/s
		that were developed as part of the Sea Level Rise Strategic Plan. These recommendations detailed a series of actions and policy updates that are aimed at increasing the level of technical knowledge about sea level rise, its effects, and mitigating impacts on existing and future development.
Land Preservation, Park, and Recreation Plan	Last Updated in 2022	The LPPRP's goals, objectives, and implementation policies are developed in the context of and support the 12 visions for planning in Maryland adopted by the Maryland General Assembly in 2009. These were established as part of Maryland's Smart, Green and Growing initiative and provide a context for growth and development, land preservation, resource conservation, and parks and recreation planning. These goals, objectives and implementation policies have also been integrated into the 2025 HMP update and used for consideration of mitigation measures by the HMPC.
Green Infrastructure Plan	Last Updated in 2022	Recommendations of the Green Infrastructure Plan were coordinated and integrated into the 2025 HMP update. Similar to the LPPRP the priority will be planning for coastal properties and acquisition. The goal to conserve an additional 5,000 acres of land in the Network by 2030, representing 30% of the County land area was used in considering coastal mitigation measures by the HMPC.
Office of Emergency Management		
Recovery Plan	Last Updated in December 2017.	OEM incorporated hazard mitigation strategies and actions identified in the Recovery Plan that reduces the potential for future damage and losses to critical infrastructure and enhances recovery operations.
Emergency Operations Plan (EOP)	Last Updated in July 2018.	The EOP describes how the County will respond to emergencies within the County. OEM incorporated mitigation strategies essential in easing the burden and recovering from the effects of a disaster into the 2025 HMP.
Continuity of Operations Plan (COOP)	Last Updated was in July 2018.	The COOP indicates how OEM and other agencies and departments will continue to provide essential services within the County and to the public. COOP planning is a fundamental aspect of establishing resiliency within the community by identifying the systems, facilities, and resources that are needed by County government to recover from disaster events.
Department of Inspections and Permits		
Article 15– Construction and Property Maintenance Codes	Last Updated in 2024. Updated every 3-6 years.	During the annual HMP review process, the HMPC discussed whether changes to international building codes have been or should be adopted to reduce the potential impact of natural hazards on human life, property, and critical infrastructure.
Department of Public Works		
Water Supply and Sewage Systems	Last Update in 2022. Updated every 3 years, or as needed.	DPW will continue to identify best management practices and risk reduction measures that protects water supply and wastewater systems, and other critical infrastructure from potential damage and future losses.

Table 2.1-5 Incorporating Plans, Studies and Reports

Plan Name	Update Process	Incorporating Mechanism/s
10-Yr Solid Waste Management Plan	The currently adopted plan is for 2024-2033,	OEM will continue to support regulations imposing constraints upon the establishment of solid waste acceptance facilities to minimize the impacts on citizens and environment. This Plan outlines the elements of the solid waste system in use by Anne Arundel County during the planning period and includes existing and planned facilities -- both public and private.

Since the 2018 update, Anne Arundel County has updated plans and adopted codes and development standards that integrated hazard mitigation planning into other local planning mechanisms. The following are a few examples of how hazard mitigation planning efforts identified in the 2018 HMP were integrated into other County planning efforts:

- In 2023, the Sea Level Rise Strategic Plan was updated to incorporate more recent projections available for the State of Maryland. The County obtained a NOAA grant to update the spatial model and reassess the County's vulnerability to sea level rise. In the 2011 SLR report, Region 9 was identified as having communities with the high vulnerability to sea level rise including Shady Side, Churchton, and Mayo. The 2022 study provided a higher resolution vulnerability assessment model for Region 9. The 2023 report included mitigation actions the County should undertake to build coastal resiliency within the highly vulnerable communities and in other areas across the County. Mitigation actions including education and awareness, structure and infrastructure projects, and adoption of newer building codes and development standards to ensure structures are better able to withstand a disaster were included in the 2023 Sea Level Rise Strategic Plan update.
    - The Office of Planning and Zoning and the Office of Emergency Management partnered to undertake education and outreach efforts to address the risks associated with hurricanes, tropical storms, and other coastal storm events and discuss the potential future impacts of sea level rise on life and property. Education and outreach improve community resilience in knowing what actions to take when disasters affect their community.
- In 2024, Anne Arundel County adopted the 2021 International Building Code, the 2021 International Residential Code, the 2021 International Energy Conservation Code, the 2021 International Existing Building Code, the 2021 International Swimming Pool and Spa Code, the 2021 Fuel Gas Code, the 2021 International Mechanical Code, and the 2021 International Plumbing Code. Adoption of new building and development codes improves the County's ability to withstand the future effects of disasters on the built environment.
- Plan2040 identifies several goals and objectives that support incorporating sea level rise considerations across all County functions including transportation and capital improvement projects.

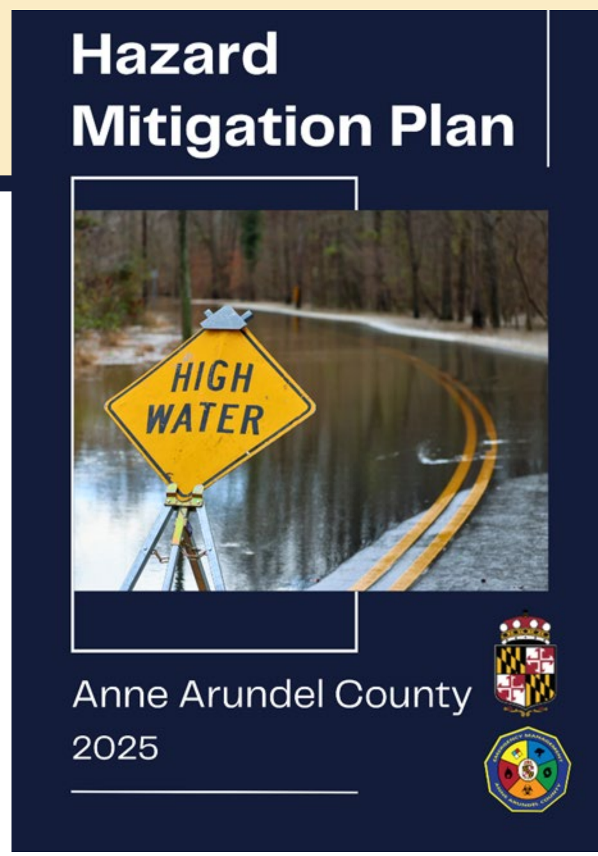
- Anne Arundel County received a grant (BRIC 2021-11 Shady Side peninsula climate adaptation study) that would allow the County to undertake efforts to assess and identify mitigation actions for high-risk communities to flooding, storm surge, and other coastal storm events within the Deale-Shady Side peninsula.
- Anne Arundel County received a grant (BRIC 2020-2) to undertake a Roadway vulnerability assessment of County roads, highways, and bridges. The study will incorporate an evaluation of the current and future stressors of flooding, climate change and sea level rise. This effort will enhance the County's ability to identify and prioritize the at-risk infrastructure and will assist in demonstrating the need for grant funding.
- In 2023, Anne Arundel County adopted a bill that updated the County's Solid Waste Management Plan (2024-2033). The Plan was subsequently approved by the Maryland Department of the Environment (MDE) in February 2024. This plan ensures the County is equipped to manage the amount and type of debris that is generated from a major storm event or disaster.
- The Office of Emergency Management adopted the Disaster Housing Recovery Plan in 2023, the Nuisance Flood Plan in 2025, the Extreme Temperature Plan in 2024, and conducted a Dam Safety workshop in 2025. These updates ensure the County is prepared to address disaster housing and recovery needs as well as address flooding and extreme temperature events as they impact the County.

2.9 Limitations & Data Sources

Throughout the HMP Update Process, existing plans, studies, reports, and technical information were reviewed and incorporated when applicable. Key data incorporated into the 2025 Plan Update included updated GIS data from Maryland's Mapping and GIS Data Portal (MD iMap), current parcel and critical facilities GIS data from Anne Arundel County, updated population and demographic information from the U.S. Census Bureau, the effective Flood Insurance Rate Map (FIRM) database and Flood Risk Database from FEMA, historic hazard event data from the National Oceanic and Atmospheric Administration's Storm Events Database, historic property GIS data from Maryland Historical Trust and the National Park Service, and more. Additionally, the State of Maryland 2021 Hazard Mitigation Plan as well as Anne Arundel County's Comprehensive Plan, Emergency Operations Plan, and Flood Insurance Study were reviewed and referenced throughout the planning process. Plans, studies and data specific to Highland Beach were also reviewed and incorporated when applicable. A full list of reference material used during the planning process can be found in the Bibliography Appendix.

Risk Assessment

Contents of this Section



3.0 Risk Assessment

The Risk Assessment identifies the hazards that can affect jurisdictions participating in the mitigation plan. It analyzes each of these hazards with respect to: where each hazard might affect the planning area (location); its potential magnitude (extent); how often events have happened in the past (previous occurrences); how likely they are to occur in the future (future probability); what parts of the community are most likely to be affected (vulnerability); and the potential consequences (impacts).

Risk is the potential for damage or loss created by the interaction of natural hazards with assets, such as buildings, infrastructure, or natural and cultural resources.

Requirements

B1. Does the plan include a description of the type, location and extent of all natural hazards that can affect the jurisdiction? Does the plan also include information on previous occurrences of hazard events and on the probability of future hazard events? (**44 CFR § 201.6(c)(2)(i))**

B2. Does the plan include a summary of the jurisdiction's vulnerability and the impacts on the community from the identified hazards? Does this summary also address NFIP insured structures that have been repetitively damaged by floods? **(44 CFR § 201.6(c)(2)(ii))**

3.1 Risk Assessment Changes Since 2018

The 2025 HMP consolidates and updates content from the 2018 loss estimation and vulnerability analysis, which built upon previous analyses conducted in 2013 and 2008. The 2018 plan update integrated climate considerations into the vulnerability analyses, but this 2025 process further emphasizes how climate change will affect the frequency and intensity of some hazards due to their interactions with climate-related factors, like precipitation and temperatures.

The 2025 plan considers all hazards previously assessed in the 2018 plan, with the addition of emerging infectious disease, plus and three non-natural hazards. The foundation for the 2018 assessments remain valid, but each hazard was re-analyzed when updated data was available. All hazard sections received the following updates and changes:

- Updated hazard descriptions
- Updated hazard histories
- Broken out sections and expanded content for location, extent, and impacts
- New tables and maps
- Updated data for determining the probability of future occurrences
- Updated climate interaction information
- Updated critical facilities assessment

According to the National Oceanic Atmospheric Administration's (NOAA) National Center for Environmental Information (NCEI) database, Anne Arundel County experienced 305 natural hazard events that affected the County from 1929 to 2024. These events resulted in 4 deaths and 44 injuries, which are summarized in Table 3.1-1. The probability for determining future natural hazard events was made based on the historical data. The future probability is defined as follows:

- "Highly likely" is the probability that an event is likely to occur every 1-10 years.
- "Likely" is the probability that an event is likely to occur every 10-50 years.
- "Unlikely" is the probability that an event is likely to occur at intervals greater than 50 years.

Table 3.1.1 provides brief descriptions of particularly significant natural hazard events occurring in Anne Arundel County's recent history. This list is not meant to capture every event that has affected the area, rather lists examples of the types of events that have occurred in the County in the past.

Table 3.1-1 History of Natural Hazard Events Affecting the County

Natural Hazard/Date Range	Previous Occurrence	Deaths	Injuries	Future Probability (2018 Plan)
Flooding 2003 – 2024	71	1	0	Highly Likely
Coastal Hazards 1998 – 2024	75	0	0	Highly Likely
Dam Failure 1929 – 2024	1	0	00	Unlikely
Hurricane 1998 – 2024	4	0	10	Likely
Drought 1950 – 2024	13	0	0	Likely
Earthquake (Maryland) 2000 – 2024	17	0	0	Likely
Extreme Temperatures 2000 – 2024	41	0	0	Likely
Thunderstorms 1950 - 2025	278	2	33	Highly Likely
Winter Storm 1996 – 2024	4	1	1	Highly Likely
Tornado 1950 – 2024	24	0	0	Highly Likely
Wildfire 2000 – 2023	48	0	0	Unlikely
Erosion 1990 - 2023	5	0	0	Highly Likely
Soil Movement (Maryland) 1950 - 2024	4	0	0	Unlikely

Source: NOAA National Center for Environmental Information database.

Various federal agencies maintain records of property losses and damages associated with natural hazards. Unfortunately, no sole source offers a definitive accounting of such losses, many of which are covered by private insurers. The Federal Emergency Management Agency (FEMA) maintains records on federal expenditures associated with declared major disasters. The U.S. Army Corps of Engineers and the Natural Resources Conservation Service collect data on losses during the course of some of their ongoing projects and studies. Additionally, NOAA collect and maintain data on occurrences of natural hazards.

3.2 Update Process Summary & Methodology

This risk assessment provides a factual basis for activities proposed by Anne Arundel County in its mitigation strategy. Hazards that may affect Anne Arundel County are identified and defined in terms of location and geographic extent, magnitude of impact, previous events, and likelihood of future occurrence. Wherever data could be validated, information from the previous plan has been incorporated and/or updated in the 2025 HMP. In addition, new data sources and analysis have been incorporated throughout the Risk Assessment.

At the HMPC Kickoff Meeting, members discussed and evaluated each hazard and discussed whether they should be *continued*, *removed*, or *changed*. It was agreed that the addition of 4 new hazards would be included to account for non-natural or technological hazards. The four new hazards are: Emerging Infectious Disease, Public Disorder and Active Assailant, Transportation Accidents, and Cyber Attack. HMPC members were also asked to comment on the severity of each hazard during the virtual kickoff meeting. Each hazard was presented in the chat section and committee members provided one of the following answers to rate the frequency of occurrence, magnitude, and geographic extent: (I) Increase, (D) Decrease, or (NC) No Change Table 3.1-2 documents the results of this analysis by the HMPC. Members of the public were also asked this question via the SurveyMonkey public survey. The public perspective is included on this table for comparative purposes.

Table 3.1-2 Review of Hazards

2025 Hazard	HMPC Perspective	Public Perspective
Flood	Increase	Increase
Coastal Hazards	-	Increase
Dam Failure	No Change	No change
Hurricane, Tropical Storms, Nor'easter	Increase	Increase
Drought	No Change	Increase
Earthquakes	No Change	Decrease
Extreme Temperatures	Increase	Increase
Thunderstorms	Increase	Increase
Severe Winter Weather	Decrease	Decrease
Tornado	No Change	No Change
Wildfire	No Change	No Change
Erosion	Increase	Increase
Soil Movement	No Change	-
Emerging Infectious Disease (New Hazard)	Increase	-
Public Disorder and Active Assailant (New Hazard)	No Change	-
Transportation Accidents (New Hazard)	Increase	-
Cyber Attack (New Hazard)	Increase	-

Source: Hazard Mitigation Planning Committee & SurveyMonkey Public Survey results.

After identifying and profiling hazards, a vulnerability assessment was performed to identify the impact of hazard events on people, buildings, infrastructure, and the community. Each hazard is discussed in terms of its potential impact on individual communities in the County, including the types of structures and infrastructure that may be at risk. The assessment allows the County to focus mitigation efforts on areas most likely to be damaged or most likely to require prompt response to a hazard event. Depending upon data availability, assessment results may consist of an inventory of vulnerable structures and populations.

The data collection effort utilized meetings with Anne Arundel County officials, HMPC members, existing reports and studies, state and national data sets and other sources such as newspaper archives. Hazard data collected at the state or national level, such as the NCEI Storm Event Database, is aggregated at a County level and does not provide site-specific information. To the greatest extent possible, information specific to the Institute was included.

The NCEI Storm Events Database is published by the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce. The storm events database contains information on storms and weather phenomena that have caused loss of life, injuries, significant property damage, and/or disruption to commerce. Records for the majority of weather events were reported starting in 1996.

As part of the plan update, new hazard risk information was included in this chapter. FEMA's National Risk Inventory (NRI) information specific to Anne Arundel County was extrapolated and assessed for inclusion. The information included provides a national perspective on hazard risk and vulnerability. In addition, social vulnerability using the 16 variables included within the Centers for Disease Control and Prevention (CDC) Social Vulnerability Index (SVI) was added.

3.2.1 Disaster Declarations

In 1965, the federal government began to maintain records of events deemed significant enough to warrant declaration of a major disaster by the U.S. President. Presidential Disaster Declarations are made at the County level when an event has been determined to be beyond the capabilities of state and local governments to respond. An emergency declaration is more limited in scope and does not provide the same long-term federal recovery programs as a presidential disaster declaration.

Two important sources for identifying hazards that can affect a locality are the record of federal disaster declarations and historic storm data. According to FEMA, Anne Arundel County has received sixteen Presidential Disaster Declarations since 1970. Some of the more significant Presidential Disaster declarations include Tropical Storm Agnes (DR-341) in 1972, Hurricane Floyd (DR-1303) in 1999, Hurricane Isabel (DR-1492) in 2003, and Hurricane Sandy in 2012. Table 3.1-3 represents actual natural hazard events affecting the County which resulted in a declaration of a local or State of emergency. Information on the extent of the event in terms of strength or magnitude is provided in the description section of the table. Table 3.1-3 also includes the number of deaths and injuries associated with each historical natural hazard event.

Table 3.1-3 History of Natural Hazards and Declared Major Disasters Impacting Anne Arundel County, Maryland

Disaster (DR)	Hazard	Description	Deaths	Injuries
August 17, 1971 (DR-309)	Severe storms & flooding	No detailed open-source information is available.	0	0
June 26, 1972 (DR-341)	Tropical Storm Agnes	The entire State of Maryland was declared a disaster area. In Anne Arundel County, structures were flooded along Old Annapolis Road, in North Pumphery, and in a trailer court on Belle Grove Road. It was estimated that Agnes exceeded a 100-year flood.	0	0

Table 3.1-3 History of Natural Hazards and Declared Major Disasters Impacting Anne Arundel County, Maryland

Disaster (DR)	Hazard	Description	Deaths	Injuries
October 4, 1975 (DR-489)	Heavy rains & flooding	No detailed open-source information presently available.	0	0
September 14, 1979 (DR-601)	Severe storms, tornadoes & flooding	No detailed open-source information presently available.	0	0
March 16, 1994 (DR-1016)	Severe winter storm	No detailed open-source information presently available.	0	0
January 11, 1996 (DR-1081)	Blizzard of 1996	The Blizzard of 1996 is ranked by some winter weather experts as the second- worst snowstorm ever to strike the Northeast in modern times. The Nor'easter buried portions of Maryland under three to four feet of snow. Baltimore recorded 26.6 inches over three days at BWI Marshall Airport. Snowfall totals in Anne Arundel County ranged from 15 to 18 inches.	0	0
September 24, 1999 (DR-1303)	Hurricane Floyd	Hurricane Floyd made landfall just east of Cape Fear, North Carolina in the early morning hours of the 16th and moved north-northeast across extreme southeast Virginia to near Ocean City, Maryland by evening on the 16th. The event resulted in over 1,000 homes reported flood damage and over 100 roads closed. In Anne Arundel County, between eight and 12 inches of rain were reported. Strong southerly winds ahead of the hurricane pushed tides two to three feet above normal, flooding several low lying areas in St. Mary's, Calvert, Harford, and Anne Arundel Counties. High water destroyed five homes, caused major damage to 23 others, and caused minor damage to an estimated 1,000 homes in the eastern portion of Anne Arundel County.	0	0
April 10, 2000 (DR-1324)	Severe winter storm	No detailed open-source information presently available.	0	0
March14, 2003 (DR-3179)	Severe winter storm	No detailed open-source information presently available.	0	0

Table 3.1-3 History of Natural Hazards and Declared Major Disasters Impacting Anne Arundel County, Maryland

Disaster (DR)	Hazard	Description	Deaths	Injuries
September 19, 2003 (DR-1492)	Tropical Storm Isabel	On September 18, 2003, Hurricane Isabel made landfall on the North Carolina coast. By the time Isabel moved into central Virginia, it had weakened and was downgraded to a tropical storm. Isabel's eye tracked well west of the Chesapeake Bay. However, the storm's 40 to 50 mph sustained winds pushed a bulge of water northward up the Bay and its tributaries, producing a record storm surge. The Maryland western shore Counties of the Bay and along the tidal tributaries of the Potomac, Patuxent, Patapsco and other smaller rivers experienced a storm surge that reached five to nine feet above normal tides. Over 2,000 people were evacuated from their homes. In Maryland alone, 472 homes and buildings were destroyed. Of these, 3,260 had major damage and over 3,600 more were affected. In Anne Arundel County, FEMA initially estimated the storm caused approximately $500 million in damages.	0	0
December 18-20, 2009, & February 5-11, 2010 (DR-1875 & DR-1910)	Winter Storms	One winter storm in late 2009, and two severe storms in early February 2010 resulted in widespread power outages, closed roads, and caused a significant need for emergency snow removal. The two disasters were declared to provide the State and Counties reimbursement funds primarily for snow removal.	0	0
September 6, 2011 (DR-4038)	Remnants of Tropical Storm Lee	The remnants of Tropical Storm Lee brought torrential rainfall and flooding to numerous counties in Maryland. A Pasadena (Anne Arundel County) man died by drowning.	1	0
October 26–November 4, 2012 (DR-4091)	Hurricane Sandy	Sandy created heavy rainfall and relatively high winds in Anne Arundel County, with some 57,000 Baltimore Gas and Electric customers losing power in the County. A falling tree killed a Pasadena man. Overall, damages in Anne Arundel County were relatively minor compared to other jurisdictions and States on the eastern seaboard.	1	0
January 22-23, 2016 (DR-4261)	Winter Storm	Heavy snow caused widespread disruptions and resulted in a long clean-up period after the event.	0	0
2025 Plan Update				
January 20, 2020 – May 11, 2023 (DR-4491-MD)	Maryland Covid-19 Pandemic	On March 24, 2020, Governor Lawrence J. Hogan requested a major disaster declaration due to the Coronavirus Disease 2019 (COVID-19) pandemic beginning on January 20, 2020, and continuing. On March 26, 2020, President Trump declared that a major disaster exists in the State of Maryland.	1,147*	107,255 cases reported*
January 20, 2020 – May 11, 2023 (EM-3430-MD)	Maryland Covid -19	On March 24, 2020, Governor Lawrence J. Hogan requested a major disaster declaration due to the Coronavirus Disease 2019 (COVID-19) pandemic beginning on January 20, 2020, and continuing. On		

Table 3.1-3 History of Natural Hazards and Declared Major Disasters Impacting Anne Arundel County, Maryland

Disaster (DR)	Hazard	Description	Deaths	Injuries
		March 26, 2020, President Trump declared that a major disaster exists in the State of Maryland.		
		TOTAL	**1,149**	**107,255**

*Source: FEMA, NOAA National Climatic Data Center database * [Anne Arundel County, Maryland coronavirus cases and deaths | USAFacts]*

3.2.2 FEMA Community Lifelines

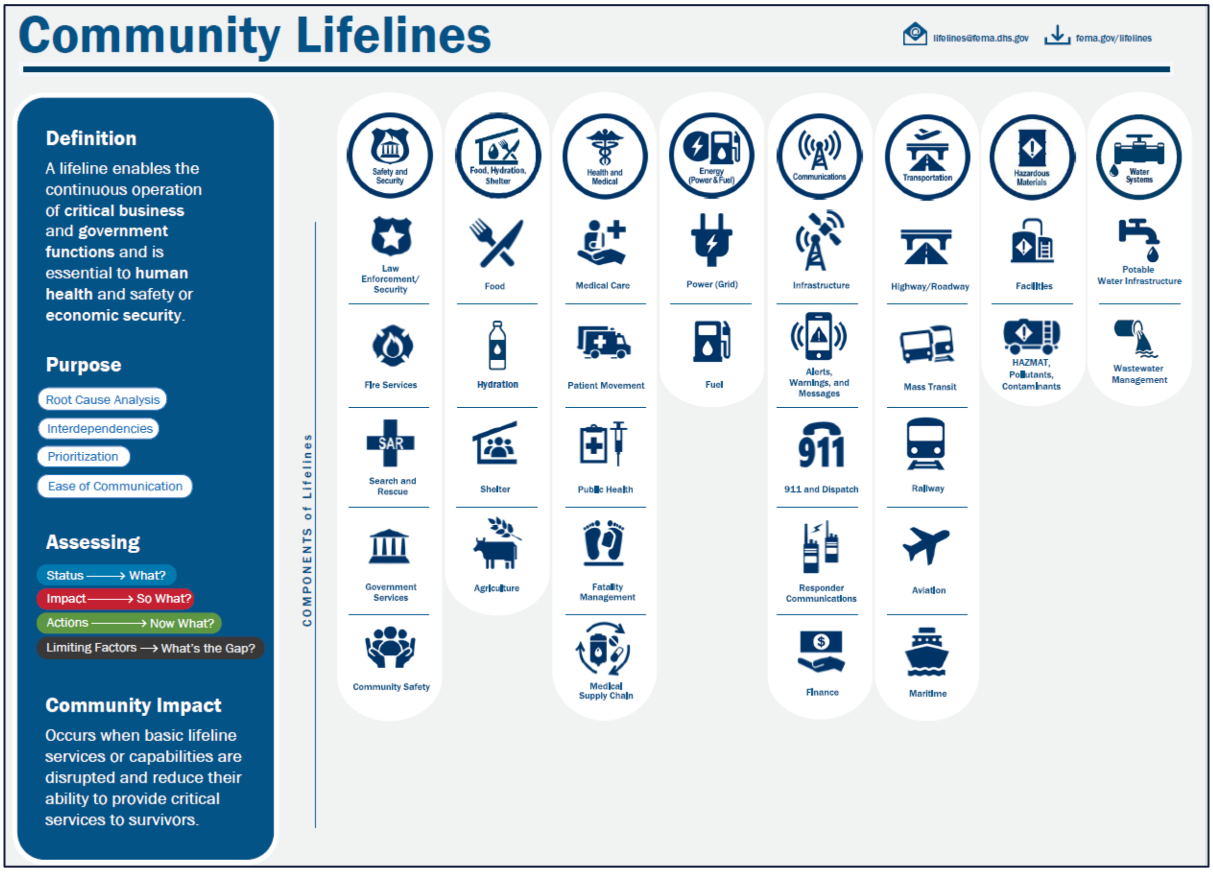
FEMA developed the community lifelines to increase effectiveness in disaster operations and better position the jurisdictions to respond to incidents. Lifelines are the most fundamental services in a community that, when stabilized, enable all other aspects of society. A lifeline enables the continuous operation of critical business and government functions and is essential to human health and safety or economic security. There are eight FEMA-identified lifeline categories, each of which has its own components: safety and security; food, water, and shelter; health and medical; energy (power and fuel); communications; transportation; and hazardous materials.

The goals and objectives of FEMA's Strategic Plan promote using mitigation to reduce the risk to community lifelines before a disaster and to quickly stabilize a community after a disaster by preventing cascading impacts. FEMA's Building Resilient Infrastructure and Communities (BRIC) grant program focuses on projects and initiatives that reduce the likelihood that community lifelines will fail as a result of an incident.

During the 2025 HMP update planning process, the vulnerability of these lifelines were analyzed in relation to each hazard to determine any gaps and opportunities for mitigation that may exist and be identified in the jurisdictional annexes.

- **Safety and Security:** Law Enforcement/Security, Fire Service, Search and Rescue, Government Service, Community Safety
- **Food, Water, Shelter:** Food, Water, Shelter, Agriculture
- **Health and Medical:** Medical Care, Public Health, Patient Movement, Medical Supply Chain, Fatality Management
- **Energy:** Power Grid, Fuel
- **Communications:** Infrastructure, Responder Communications, Alerts Warnings and Messages, Finance, 911 and Dispatch
- **Transportation:** Highway/Roadway/Motor Vehicle, Mass Transit, Railway, Aviation, Maritime
- **Hazardous Materials:** Facilities, HAZMAT, Pollutants, Contaminants
- **Water Systems:** Potable Water Infrastructure, Wastewater Management

Figure 3.1-1: FEMA Community Lifelines



Source: FEMA Community Lifelines Poster chrome- https://www.fema.gov/sites/default/files/documents/fema_community-lifelines-poster_072623.pdf

3.3 Overview of Risk Assessment

The hazards identified earlier in this Chapter will now be profiled. This analysis will include details on hazard location, extent, range of Magnitude, past occurrences, and future occurrences. A vulnerability analysis will be conducted that will provide details on the impact on People, Structures, Systems, Natural, Historic, Cultural, and Resources, and Community Activities. This section will also address impacts to land use and development trends for each hazard. The sources used to collect information for these profiles include the following:

- Disaster declaration history from FEMA
- State of Maryland Hazard Mitigation Plan
- Anne Arundel County Comprehensive Plan
- Internet resources on past hazard events, such as the National Oceanic and Atmospheric
- Administration's NCEI databases, and the National Response Center.
- Geographic information systems (GIS) data from the Office of Information Technology, Geographic Information Services (OIT GIS)
- Statewide GIS datasets compiled by state and federal agencies
- Personal interviews with HMPC members and other stakeholders
- Other County and State plans and reports

Detailed profiles for each of the identified hazards include information on the following characteristics of the hazard:

Location, Extent, and Range of Magnitude: This section describes the geographic coverage, or location, of the hazard in the planning area and assesses the extent of impact. This section also summarizes the range of magnitude or extent of a hazard event in terms of deaths, injuries, property damage, and interruption of essential facilities and services. Magnitude is classified in the following manner:

- **Catastrophic:** Multiple deaths; property destroyed and severely damaged; and/or interruption of essential facilities and service for more than 72 hours
- **Critical:** Isolated deaths and/or multiple injuries and illnesses; major or long-term property damage that threatens structural stability; and/or interruption of essential facilities and services for 24-72 hours
- **Limited:** Minor injuries and illnesses; minimal property damage that does not threaten structural stability; and/or interruption of essential facilities and services for less than 24 hours
- **Negligible:** No or few injuries or illnesses; minor quality of life loss; little or no property damage; and/or brief interruption of essential facilities and services

Past Occurrences: This section includes information on historic incidents. A historic incident worksheet was used to capture information on past occurrences. Information from the HMPC was combined with other data sources, including those previously mentioned.

Future Occurrence: The frequency of past events is used to gauge the likelihood of future occurrences. Based on historical data, the Probability of Future Occurrence is categorized as follows:

- **Highly Likely:** Near 100% chance of occurrence next year or happens every year
- **Likely:** 10-100% chance of occurrence in next year or has a recurrence interval of 10 years or less
- **Occasional:** 1-10% chance of occurrence in the next year or has a recurrence interval of 11 to 100 years
- **Unlikely:** Less than 1% chance of occurrence in next year or has a recurrence interval of greater than every 100 years

The probability, or chance of occurrence, was calculated where possible based on existing data. Probability was determined by dividing the number of events observed by the number of years and multiplying by 100. This gives the percent chance of the event happening in any given year.

Vulnerability Assessment: The vulnerability assessment further defines and quantifies populations, buildings, critical facilities and infrastructure, natural/cultural resources, and other community assets at risk to the profiled hazards, as well as the potential impacts to the economy and future development trends of the planning area. The assessment of vulnerability includes these sub-sections per applicable hazard:

- People (including vulnerable populations)
- Structures
- Systems
- Natural, Historic, Cultural, and Resources
- Community Activities
- Land Use and Development Trends

Hazard Profiles

The Risk assessment is comprised of the following 17 natural and man-made/technological hazards.

- Flooding
- Coastal Hazards
- Dam Failure and Inundation
- Hurricane, Tropical Storm, and Nor'easter
- Drought
- Earthquakes
- Extreme Temperatures
- Severe Thunderstorm (Lighting, Hail)
- Severe Winter Storm
- Tornado
- Wildfire, Urban Interface Fire
- Erosion
- Soil Movement (Land Subsidence And Sinkholes)
- Emerging Infectious Disease
- Public Disorder and Active Assailant
- Transportation Accidents
- Cyber Attack

Each section includes the following topics:

1. Description of Hazard
2. Location, Extent, Magnitude
3. Past Occurrences
4. Probability of Future Events
5. Hazards in Highland Beach
6. Risk Assessment
7. Impacts to People, Structures, Systems, and Resources
8. Future Land Use and Development Trends
9. Future Conditions
10. Considerations for Next Planning Cycle

3.3.1 Riverine Flooding

The Flooding section includes the following sub-topics:

1. Description of Riverine Flooding
2. Location, Extent, Magnitude
3. Past Occurrences
4. Probability of Future Riverine Flood Events
5. National Flood Insurance Program Participation
6. Repetitive Loss Properties
7. Flood Hazards in Highland Beach
8. Impacts to People, Systems, and Resources
9. Future Land Use and Development Trends
10. Future Conditions
11. Considerations for the Next Planning Cycle

3.3.1.1 Description of Riverine Flooding

Flooding is defined as the accumulation of water within a water body and the overflow of excess water onto adjacent floodplain lands. A floodplain is the land adjoining the channel of a river, stream, ocean, lake, or other watercourse or water body that is susceptible to flooding.

Hundreds of floods occur each year in the United States, including overbank flooding of rivers and streams and shoreline inundation along lakes and coasts. Flooding typically results from large-scale weather systems generating prolonged rainfall. Flooding in Anne Arundel County can be the result of the following weather events: hurricanes, thunderstorms (convectional and frontal), storm surge and winter storms. Flooding from storm surge is covered in Section 3.3.2 and flooding from hurricanes is covered in Section 3.3.4.

Key Flood Terms & Definitions

Floodplain is any land area susceptible to being inundated by water from any source of flooding.

Flood zones are geographic areas that the FEMA has defined according to varying levels of flood risk. These zones are depicted on a community's Flood Insurance Rate Map (FIRM) or Flood Hazard Boundary Map. Each zone reflects the severity or type of flooding in the area.

A digital elevation model (DEM) is a digital model or 3D representation of a terrain's surface — commonly for a planet (including Earth), moon, or asteroid — created from terrain elevation data.

3.3.1.2 Location, Extent, Magnitude of Riverine Flooding

Anne Arundel County is located on the western shore of the Chesapeake Bay. The County's 533 miles of shoreline constitutes more coastline than any County in Maryland. According to the U.S. Census Bureau, the County has a total area of 588 square miles. Of that, 416 square miles is land, and 172 square miles is water. An updated Flood Insurance Study (FIS) and Flood Insurance Rate Maps (FIRMs) for Anne Arundel County were published by FEMA and adopted by Anne Arundel County in 2015. This study characterizes flooding in Anne Arundel County and the surrounding area, describes its causes, and identifies flood protection measures. The FIS indicates that the principal cause of flooding within the County is from severe thunderstorms, hurricanes and tropical storms that follow a northern route along the Atlantic coastline (Source: Anne Arundel County FIS, final 2015).

Topography in the County ranges from level to very steep. Nearly level and gently sloping soils are in large areas north of the Severn River and Magothy River, on the Deale-Shadyside flats, and in the southwestern portion of the County adjoining the Patuxent River. The steepest slopes are found in a north-south section that runs through the central part of the County, where many small streams have cut deep V-shaped valleys into the soft unconsolidated materials of the coastal plain. Broad alluvial terraces border many of the large streams and rivers that flow into the Chesapeake Bay to more than 300 feet in the northwestern part of the County (Source: Anne Arundel County 2015 Flood Insurance Study). The average annual precipitation varies from 40 to 44 inches and is evenly distributed throughout the year. Most precipitation in the colder half of the year is the result of low-pressure systems moving northeast along the coast. In the summer, precipitation occurs in the form of showers and thunderstorms. Thunderstorms occur on an average of 31 days per year, with almost 70 percent occurring from May through August.

The specific causes and effects of flooding within the County are discussed in more detail in the risk assessment part of this section. The FIS produced for the County also includes Flood Insurance Rate Maps (FIRMs). FIRMs identify the 1 percent and 0.2 percent annual chance floodplain boundaries and are shown on Map 3.3.1-1. This area is also known as the Special Flood Hazard Area (SFHA). FEMA Flood Zones are described in detail in Table 3.3.1-1.

Table 3.3.1-1 FEMA Flood Zones

Flood Zone	Description
SFHA-High Risk Areas	
A	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas; no depths or base flood elevations are shown within these zones.
AE	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Base flood elevations derived from detailed analyses are provided. AE Zones are now used on new format FIRMs instead of A1-A30 Zones.
Coastal AE	Portions of the SFHA landward of a V zone (i.e., areas where wave heights are computed as less than 3 feet) are mapped as ‘A zones’ on the FIRM. While the wave forces in coastal A zones are not as severe as those in V zones, there is still an added risk of damage or destruction of buildings.
LiMWA	The LiMWA identifies areas that will be affected by waves with a 1.5-foot wave height or greater within the coastal A zone. While FEMA does not require special floodplain management standards based on LiMWA delineations, it is likely that properties and structures within the LiMWA will receive substantial damage from wave action during a 1%-annual-chance flood event.
VE	Coastal areas with a 1% or greater chance of flooding and an additional hazard associated with storm waves. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
Moderate Risk Areas	
X (Shaded) 0.2% or 500 yr.	Moderate flood area(s), shaded area(s) shown on FIRM, are the areas between the limits of the base flood and the 0.2-percent-annual-chance (or 500-year) flood.
Minimum Risk Areas	
X (Un-shaded)	The areas of minimal flood hazard, which are areas outside the SFHA and higher than the elevation of the 0.2 percent-annual-chance flood, are labeled Zone X (un-shaded).

Source: Federal Emergency Management Agency.

Table 3.3.1-2 summarizes the increases, decreases, and net change of SFHA's, Floodways, and Coastal High Hazard Areas (CHHAs) for Anne Arundel County.

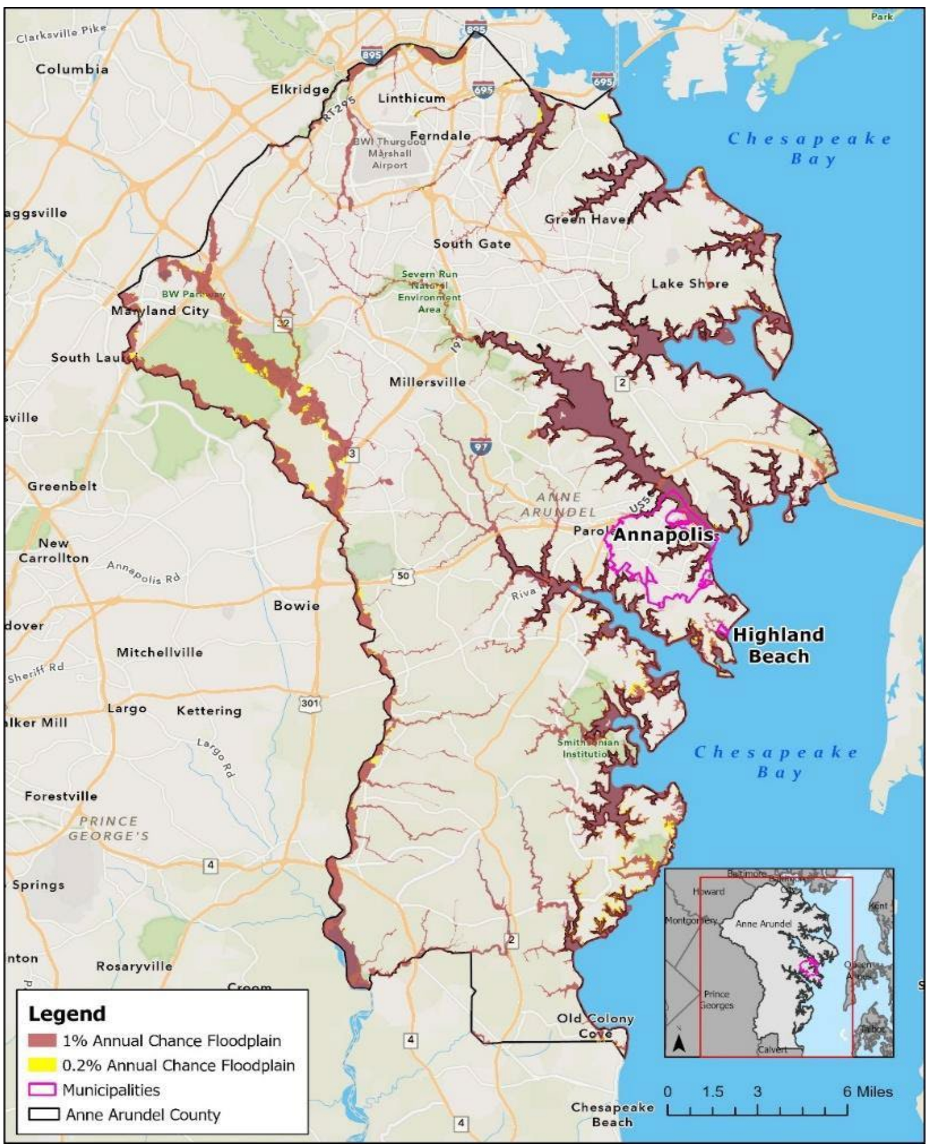
Table 3.3.1-2 Changes Since Last FIRM

Area of Study	Total Area (mi^2)	Increase (mi^2)	Decrease (mi^2)	Net Change (mi^2)
Within SFHA	32.7	0.2	3.7	-3.5
Within Floodway	0	0	0.1	-0.1
Within CHHA (Zone VE or V)	9.1	0	0.1	-0.1

Source: FEMA Flood Risk Report-Anne Arundel County, Maryland Coastal Study, September 9, 2015.

For purposes of riverine flooding, flood zones A and AE are part of the 1 percent annual chance floodplain. Review of the FIRM shows that approximately five percent of the County is within the 1 percent annual chance floodplain. Map 3.3-1 shows the 1 percent annual chance and 0.2 percent annual chance floodplains for Anne Arundel County.

Map 3.3.1-1 Anne Arundel County 1-Percent Annual Chance & 0.2-Percent Annual Chance Floodplains



Flood severity is measured in several ways, including depth, velocity, duration, and presence of contamination, among others. NOAA NCEI has compiled annual estimates of flood losses annually, including the total number of deaths caused by major floods, as part of its Billion-Dollar Weather and Climate Disasters project. According to NOAA NCEI, about 45 billion-dollar flood events have occurred throughout the U.S. from 1980 to 2024. Total losses associated with these floods is $203 billion, which equals about $4.5 billion per event annually. These events are responsible for a total of 742 deaths – which is 16 deaths annually.

Floods have been and continue to be the most common natural hazard affecting Anne Arundel County. This is supported by the risk assessment conducted for the 2021 State Hazard Mitigation Plan, which ranks flooding as “high risk” in Anne Arundel County. The State Plan indicates that Anne Arundel County has the second highest amount of repetitive loss properties in the State of Maryland – just behind Baltimore County.

3.3.1.3 Past Occurrences

Past versions of this HMP included more detailed summaries of past flood events, based on data provided in NOAA’s National Centers for Environmental Information (NCEI) Storm Events Database. Since the 2012 version of the HMP, the NCEI database has changed, and now provides only limited summaries of past events. This is not particularly significant, since the previous data set was largely incomplete as well. The 2018 County HMP indicated that the NCEI database listed 71 flood events between 2003 and 2018, with four resulting in property damage. The most recent query, shown in Table 3.3.1-3, summarizes flood events that have occurred in the County between 2003 and 2024. Since 2018, the County has experienced an additional 15 flood events. Based on these past occurrences, the County experiences about 4.1 flood events annually.

Note: Damage estimates included in the NCEI database should be considered a significant underestimate of damages, presumably because of the reporting processes used by NOAA. The NFIP claims data discussed elsewhere in this section offer a better overall picture of the magnitude and locations of flood losses.

Table 3.3.1-3 Inland Flood Events Resulting in Property Damage, Anne Arundel County, 2003 – 2024

Date	Location	Death	Injury	Property Damage
02/22/2003	Anne Arundel (Zone)	0	0	0.00K
12/11/2003	Anne Arundel (Zone)	0	0	0.00K
07/07/2005	Anne Arundel (Zone)	0	0	0.00K
10/08/2005	Anne Arundel (Zone)	0	0	0.00K
11/16/2006	Severn	0	0	0.00K
03/16/2007	Glen Burnie	0	0	0.00K
04/15/2007	Ft. Meade	0	0	0.00K
05/12/2008	Annapolis	0	0	100.00K
08/18/2010	Revell	0	0	0.00K
08/18/2010	Severna Park	0	0	0.00K
09/30/2010	Arnold	0	0	0.00K
04/17/2011	Rutland	0	0	0.00K
07/08/2011	Jacobsville	0	0	0.00K
07/08/2011	Green Haven	0	0	0.00K
08/28/2011	Lyons Creek	0	0	0.00K
09/06/2011	Rive	0	0	0.00K

Table 3.3.1-3 Inland Flood Events Resulting in Property Damage, Anne Arundel County, 2003 – 2024

Date	Location	Death	Injury	Property Damage
09/07/2011	Earleigh Heights	1	0	0.00K
09/08/2011	Glen Burnie	0	0	0.00K
09/08/2011	Lyons Creek	0	0	0.00K
09/08/2011	Annapolis	0	0	0.00K
10/02/2012	Tipton Airport	0	0	1.00K
10/29/2012	Ordnance	0	0	0.00K
04/30/2014	North Linthicum	0	0	0.00K
04/30/2014	Glen Burnie	0	0	0.00K
05/16/2015	Glen Burnie	0	0	0.00K
05/19/2015	Crofton	0	0	0.00K
05/19/2015	Ft Meade Jct	0	0	5.00K
06/21/2016	Rutland	0	0	0.00K
09/29/2016	Crofton	0	0	0.00K
05/05/2017	Laurel Suburban Arp	0	0	0.00K
07/29/2017	Raynor Heights	0	0	0.00K
07/29/2017	Crofton	0	0	0.00K
02/11/2018	Rutland	0	0	0.00K
05/15/2018	North Linthicum	0	0	0.00K
05/15/2018	Bestgate	0	0	0.00K
05/18/2018	Riva	0	0	0.00K
05/18/2018	Crofton	0	0	0.00K
05/27/2018	Glen Burnie	0	0	0.00K
06/03/2018	Maryland City	0	0	0.00K
06/03/2018	Raynor Heights	0	0	0.00K
06/04/2018	Tipton Airport	0	0	15.00K
07/17/2018	Garland	0	0	0.00K
07/17/2018	North Linthicum	0	0	0.00K
07/21/2018	Rutland	0	0	0.00K
07/21/2018	Arundel Gardens	0	0	0.00K
07/21/2018	Baltimore Highlands	0	0	0.00K
07/22/2018	Raynor Heights	0	0	0.00K
07/22/2018	Raynor Heights	0	0	0.00K
07/22/2018	Riva	0	0	0.00K
07/23/2018	Raynor Heights	0	0	0.00K
07/23/2018	Raynor Heights	0	0	0.00K
07/24/2018	North Linthicum	0	0	0.00K
07/25/2018	Crofton	0	0	0.00K
07/25/2018	Raynor Heights	0	0	0.00K
07/26/2018	Raynor Heights	0	0	0.00K
08/04/2018	Raynor Heights	0	0	0.00K
08/31/2018	Arnold	0	0	0.00K
08/31/2018	West Annapolis	0	0	0.00K
08/31/2018	West Annapolis	0	0	0.00K
09/09/2018	Crofton	0	0	0.00K
09/09/2018	Raynor Heights	0	0	0.00K
09/09/2018	Arundel Gardens	0	0	0.00K
09/09/2018	Churchton	0	0	0.00K
09/10/2018	Raynor Heights	0	0	0.00K
09/18/2018	Raynor Heights	0	0	0.00K
09/18/2018	Raynor Heights	0	0	0.00K
09/18/2018	Raynor Heights	0	0	0.00K

Table 3.3.1-3 Inland Flood Events Resulting in Property Damage, Anne Arundel County, 2003 – 2024

Date	Location	Death	Injury	Property Damage
09/28/2018	Raynor Heights	0	0	0.00K
10/12/2018	Crofton	0	0	0.00K
12/15/2018	Maryland City	0	0	0.00K
06/28/2019	Rutland	0	0	0.00K
2025 PLAN UPDATE				
06/05/2020	Crofton	0	0	0.00K
08/04/2020	Riva	0	0	0.00K
08/04/2020	Raynor Heights	0	0	0.00K
09/03/2020	Londontowne	0	0	0.00K
09/03/2020	Rutland	0	0	0.00K
09/03/2020	Riva	0	0	0.00K
11/12/2020	Riva	0	0	0.00K
03/24/2021	Raynor Heights	0	0	0.00K
06/14/2021	Crofton	0	0	0.00K
09/01/2021	Arundel Gardens	0	0	0.00K
07/07/2022	Margate	0	0	0.00K
07/09/2022	South River	0	0	0.00K
07/16/2022	Davidsonville	0	0	0.00K
07/16/2022	Londontowne	0	0	0.00K
08/10/2022	Conaways	0	0	0.00K
Totals	**-**	**1**	**0**	**121K**

Source: NOAA NCEI Storm Events Database
Note: No recorded crop damage during this time.

A review of past Presidential Disaster Declarations and historical records such as the Anne Arundel County FIS, showed that there have been several other flood events in Anne Arundel County that are not listed in the NCEI database. Highlights of the declared events and other significant past floods are provided in Table 3.3.1-4 below. The inclusion of a Disaster (DR) Number indicates a Presidentially declared event. Note that coastal flooding events, such as those associated with Hurricane Isabel in September 2003, can be found under Section 3.3.2 Coastal Flooding.

Table 3.3.1-4 Description of Significant Flood Events in Anne Arundel County from 1950 – 2024

Event & Date	Flood Description
June 26, 1972 (DR-341)	Tropical Storm Agnes. The entire State of Maryland was declared a disaster area. In Anne Arundel County, structures were flooded along Old Annapolis Road, in North Pumphery, and in a trailer court on Belle Grove Road. It was estimated that Agnes exceeded a 100-year flood.
June 19, 1996	Heavy rains from severe thunderstorms, combined with runoff from earlier events upstream, pushed the Patapsco River out of its banks along the Howard/Baltimore County line shortly after noon. For the second time in three days, portions of Baltimore City were flooded. In Anne Arundel County, Defense Highway (near Annapolis) was closed due to high standing water. Numerous basements were flooded, as were low-lying neighborhoods, especially in Arnold near the Magothy River. Five other County roads were closed as well. The event caused an estimated $25,000 in damages in Anne Arundel County.

Table 3.3.1-4 Description of Significant Flood Events in Anne Arundel County from 1950 – 2024

Event & Date	Flood Description
December 13, 1996	A north-south band of moderate to heavy rain dumped between two and three inches onto fairly saturated soil across northern and central Maryland, producing several areas of flooding and flash flooding. In Anne Arundel County, six thoroughfares were closed prior to and during the evening commute, including the intersection of State routes 32 and 198 near Laurel, Route 450 at St. Stephens Church Road near Annapolis, and route 648 at Dorsey Road. Several motorists were stranded in the high water.
February 4, 1998	A powerful Nor'easter, carrying copious moisture from the Gulf of Mexico and Caribbean region, dumped between two and four inches of rain across much of Maryland between the foothills and the Chesapeake Bay. The highest totals, ranging from three to five inches, fell in lower southern Maryland, causing widespread flooding of low-lying areas and small streams and creeks. The Nor'easter caused tides of three to four feet above normal from the Calvert/Anne Arundel County line south to Point Lookout in extreme southeastern St Mary's County. The flooding closed seven roads in Anne Arundel County. The event caused approximately $650,000 in damages in Anne Arundel County.
August 26, 1999	Significant flooding of low-lying areas and streams resulted in many roads submerged. A line of intense thunderstorms moved across much of Maryland during the afternoon, producing damaging winds and frequent lightning. Anne Arundel County reported significant flooding after two to seven inches of rain fell in less than four hours. In Anne Arundel County, Brock Bridge, Mill Creek, Race, River, Rideout, and Severn Side Roads were closed by high water.
September 16, 1999 (DR-1303)	Hurricane Floyd. Hurricane Floyd made landfall just east of Cape Fear, North Carolina in the early morning hours of September 16, 1999, and moved north-northeast across extreme southeast Virginia to near Ocean City, Maryland by evening. The event resulted in over 1,000 homes with flood damage, and over 100 roads closed. In Anne Arundel County, between eight and 12 inches of rain were reported. Strong southerly winds ahead of the hurricane pushed tides two to three feet above normal, flooding several low-lying areas in St. Mary's, Calvert, Harford, and Anne Arundel Counties. High water destroyed five homes and caused major damage to 23 homes, and minor damage to an estimated 1,000 homes in the eastern portion of Anne Arundel County. The NCEI database estimated damages totaled approximately $2 million.
October 8, 2005	Tropical Storm Tammy. The remnants of Tropical Storm Tammy caused widespread heavy rainfall between three and seven inches across the region. Many roads flooded due to the prolonged rains. Localized areas received close to 12 inches of storm total rainfall. Several roads were flooded and closed across Anne Arundel County due to high water.
June 27, 2006	The NCEI database indicates that a weak cold front settled over area from June 23 until June 27. Waves of low pressure rode northeast along the front. As a result, double-digit rainfall totals affected parts of the region through the five-day period. Scattered areas of flash flooding began on June 23 and continued into June 24. In Anne Arundel County, secondary roads near Annapolis were flooded. A foot of water flooded a basement in Annapolis. Route 450 east of Crofton was closed due to high water.
May 12, 2008	On May 12, 2008, widespread showers and thunderstorms produced heavy rain. Anne Arundel Emergency Management as well as newspapers reported widespread flooding that closed roads across Anne Arundel County.
October 5, 2011	Remnants of Tropical Storm Lee. Some flooding in Anne Arundel County.
October 29, 2012	Hurricane/Tropical Storm Sandy. This event is discussed in detail in the Hurricane hazard section of the County mitigation plan update and is noted here for clarity.

Table 3.3.1-4 Description of Significant Flood Events in Anne Arundel County from 1950 – 2024

Event & Date	Flood Description
May 27, 2018 (DR-4376-MD)	Severe storms brought flash flooding to Ellicott City and parts of northeastern Anne Arundel County. Flooding caused road closures. The NWS recorded 3 to 6 inches of rainfall in 24 hours, with some areas receiving 9 inches of rainfall.

Sources: Anne Arundel County Flood Insurance Study & FEMA Presidential Declarations

3.3.1.4 Probability of Future Flood Events

Based on past occurrences, certain parts of Anne Arundel County have a high probability of experiencing riverine flooding in the future. Over the last 21-year period, the County experiences about 4.1 riverine flooding events annually. Therefore, it is likely that the County will experience about 4.1 flood events annually in the future. Factors such as climate change and sea level rise will likely increase frequency and intensity of events that cause riverine flooding, such as severe storms.

3.3.1.5 National Flood Insurance Program Participation

The National Flood Insurance Program (NFIP) is managed by FEMA and is delivered to the public by a network of more than fifty insurance companies and NFIP Direct. The NFIP provides flood insurance to property owners, renters, and businesses – having this coverage helps them recover faster after a flood event. Flood insurance is available to anyone living in one of the almost 23,000 participating NFIP communities. Homes and businesses in high-risk flood areas with mortgages from government-backed lenders are required to have flood insurance.

Anne Arundel County has been a participant in the National Flood Insurance Program since May 1983. The County is Community Number 240008B. The initial Flood Hazard Boundary map was adopted in November 1974, and the initial Flood Insurance Rate Map was adopted in May 1983. The current effective FIRM is dated February 18, 2015, as shown in Table 3.3.1-5. The Town of Highland Beach also participates in the NFIP (Community Number 240161B). The Town joined the program in November 1981. The Town's current effective FIRM is dated February 18, 2015. The County has floodplain management authority over the Town of Highland Beach. Therefore, the County's capabilities are also the Town's capabilities.

Table 3.3.1-5: Anne Arundel County's NFIP Insurance Report

Community Name	NFIP Status	Special Flood Hazard Area	Coastal/ Tidal	Coastal Barrier Resource System	Updated Ordinance	Freeboard
Anne Arundel County (Unincorporated Area)	Participating	Yes	Yes	No	February 18, 2015	1 ft
Town of Highland Beach	Participating	Yes	Yes	No	February 18, 2015	1 ft
City of Annapolis	Participating	Yes	Yes	No	October 28, 2013	2 ft

Source: Anne Arundel County Flood Insurance Report. Data obtained August 26, 2024.

A total of 2,642 flood insurance policies are active within Anne Arundel County as of July 30, 2024. These active policies have a total annual premium value of $1,278,964. On average, property owners with a flood insurance policy pay $484.09 per year, or $40.34 a month. The County's participation in the program is voluntary, however compliance is mandatory. The County is currently participating in the Community Rating System (CRS), as a Class 10 community. Property owners could save more on their flood insurance premiums should the

County decide to participate in CRS activities to improve its score in the future. However, the County is not interested in engaging with CRS activities without first hiring dedicated staff members.

The NFIP report also shows that as of July 30, 2024, a total of 2,150 claims have been made since 1979. Of the total claims, 1,558 resulted in payments totaling $38,506,090.54. This represents an average of $24,713.15 per claim. The remaining 592 claims were closed without payment. In the last 10-year period (i.e., beginning of January 2014 to August 28, 2024), 289 claims have been made. These claims totaled $3,590,887.02 in payments.

Town of Highland Beach

A total of ten flood insurance policies are active within the Town of Highland Beach as of July 30, 2024. These active policies have a total annual premium value of $5,103. On average, property owners with a flood insurance policy in Highland Beach pay $510.30 per year.

The NFIP report shows that as of July 30, 2024, a total of four claims have been made since 1979. In fact, the first claim to have been made was not until 2003. These claims resulted in payments totaling $60,702.48, or an average of $15,175.62 per claim.

3.3.1.6 Repetitive Loss Properties

Considering the number of flood insurance policies and the amount of claims that have been reported, identifying areas of repetitive loss within a community is a good indicator in determining areas of high flood damage vulnerability. While flood damage is not necessarily limited to these areas, repetitive loss data provides location indicators for areas where structures are experiencing recurring and costly flooding damage.

The FEMA NFIP defines a **repetitive loss property** as:

- Properties are those for which two or more losses of at least $1,000 each have been paid under the National Flood Insurance Program (NFIP) within any 10-year period since 1978.

The FEMA NFIP defines **severe repetitive loss properties** as:

- A property that has at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or,
- A property for which 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.

The 2023 Hazard Mitigation Assistance Program and Policy Guide (page 304) defines repetitive loss and severe repetitive loss properties differently, and these definitions are as follows:

A **repetitive loss property** is a structure covered by a contract for flood insurance made available under the NFIP that:

- Has incurred flood-related damage on two occasions, in which the cost of the repair, on the average, equaled or exceeded 25 percent of the market value of the structure at the time of each such flood event and
- At the time of the second incidence of flood-related damage, the contract for flood insurance contains increased cost of compliance coverage.

A **severe repetitive loss property** is a structure that:

- Is covered under a contract for flood insurance made available under the NFIP.
- Has incurred flood related damage –
    - For which four or more separate claims payments (includes building and contents) have been made under flood insurance coverage with the amount of each such claim exceeding $5,000, and with the cumulative amount of such claims payments exceeding $20,000 or
    - For which at least two separate claims payments (includes only building) have been made under such coverage, with the cumulative amount of such claims exceeding the market value of the insured structure.

Based on the FEMA NFIP and FMA definitions for repetitive loss properties and severe repetitive loss properties, as of July 30, 2024, there are a total of 109 repetitive loss properties in Anne Arundel County. Nine properties of the total 109 meet the definition of a severe repetitive loss property. There are no repetitive loss properties located in the Town of Highland Beach.

The total of 109 repetitive loss properties is an increase of sixteen properties compared to 2018. Of these properties, 100 are single family residential, two are business nonresidential, and seven are other-nonresidential. Three structures are identified as “mitigated.”

Table 3.3.1-6 provides a more detailed breakdown of these repetitive loss properties.

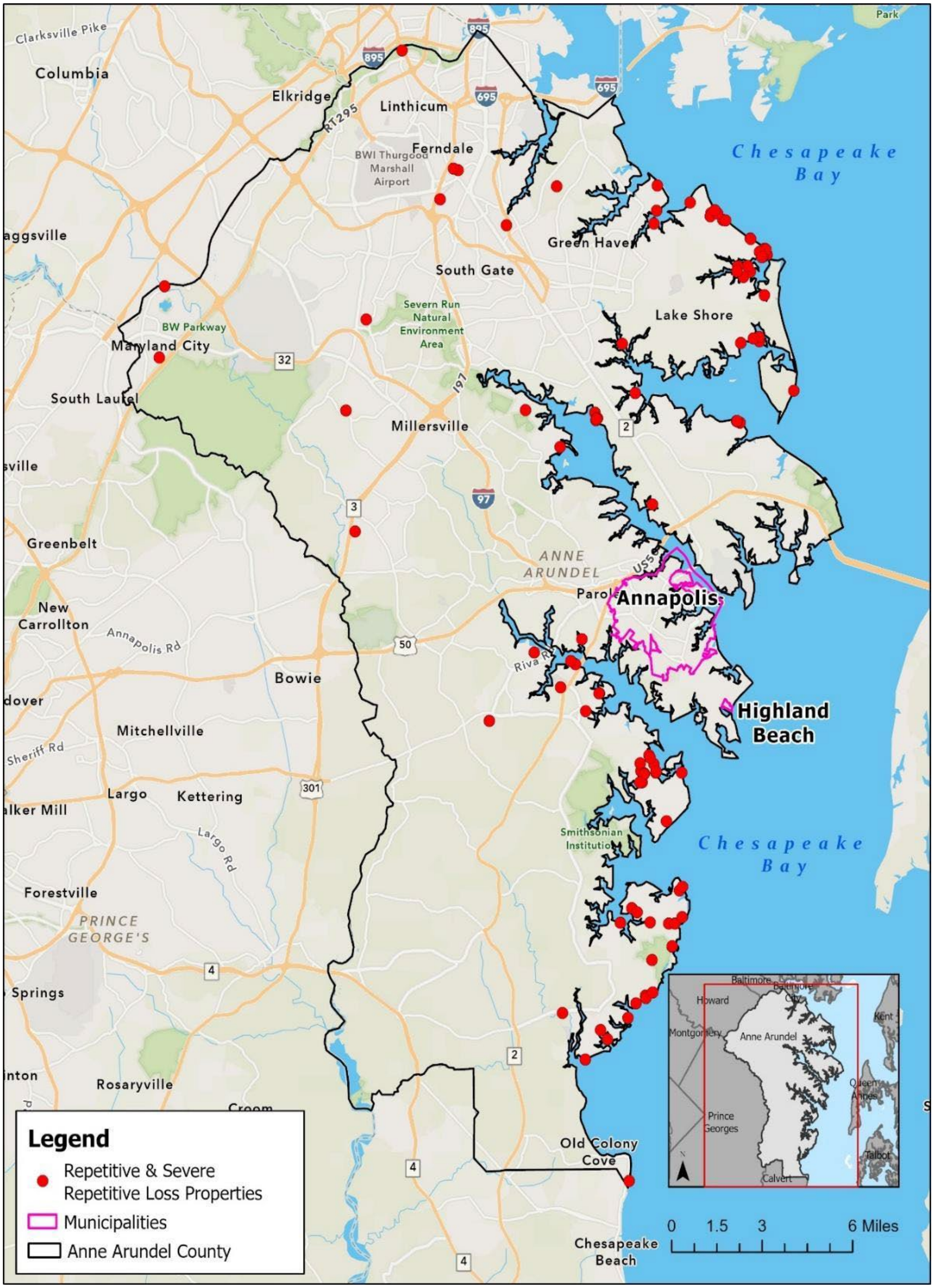
Table 3.3.1-6: Summary of Residential and Non-Residential NFIP Repetitive Loss Statistics

Repetitive Loss Category	Properties	Structure Value	Building Payments	Contents Payment	Total Payments	# Claims	Average
Residential	100	$25,645,412	$2,886,059	$399,746	$3,285,805	251	$13,091
Non-Residential	9	6,564,261	$719,372	$591,881	$1,311,253	31	$42,298
Total	**109**	**$32,209,673**	**$3,605,431**	**$991,627**	**$4,597,058**	**282**	**$55,389**

Source: FEMA/NFIP PIVOT Database Query, July 30, 2024.

Map 3.3.1-2 shows the locations of the 109 residential and non-residential repetitive loss properties in the County. The map shows most of the repetitive loss properties are concentrated along the eastern border of the County, along the shoreline and tributaries of the Chesapeake Bay

Map 3.3.1-2
NFIP Repetitive and Severe Repetitive Loss Properties, Anne Arundel County
(Source: FEMA/NFIP PIVOT Database, July 30, 2024)



Residential Repetitive Loss Properties

As mentioned above, as of July 30, 2024, Anne Arundel County has 100 residential repetitive loss properties in the NFIP database. Table 3.3.1-7 provides basic NFIP residential repetitive loss statistics, sorted by the total number of residential repetitive loss properties in each community.

Table 3.3.1-7 indicates that Pasadena has the highest number of repetitive loss properties in Anne Arundel County. As of July 2024, Pasadena had a total of 36 repetitive loss properties (up from 29 in the 2018 plan). The table shows that Pasadena is followed by Edgewater and Shady Side with 19 and 11 repetitive loss properties, respectively. Edgewater has fewer total repetitive loss properties than Pasadena but has higher building values and average claim values than Pasadena. Total repetitive loss properties for all three top communities have increased, in some cases doubled, in the last 5-year planning period.

Table 3.3.1-7 Summary of NFIP Residential Repetitive Loss Property Statistics, Anne Arundel County; Ordered by Number of Repetitive Loss Properties in each Census-designated area

City Name	# RL Props	Building Value ($)	Building Payment ($)	Contents Paid ($)	Total Paid ($)	# of Claims	Average $ Claim
Pasadena	33	**5,995,853**	**1,739,324**	**483,176**	**2,223,500**	**94**	**23,654**
Edgewater	19	**6,763,139**	**1,272,802**	**250,083**	**1,522,885**	**52**	**29,742**
Shady Side	11	**2,309,036**	**326,770**	**48,148**	**374,918**	**25**	**14,831**
Churchton	6	1,008,191	623,855	24,806	648,662	15	47,411
Severna Park	6	3,384,223	486,280	60,187	546,468	15	36,749
Arnold	5	876,334	236,967	28,106	265,073	12	22,221
Glen Burnie	5	1,343,216	171,100	22,373	193,474	15	13,567
Deale	4	1,769,544	174,931	18,731	193,663	10	17,892
Crownsville	2	223,363	46,164	9,749	55,913	5	12,061
Laurel	1	171,730	5,502	0	5,502	2	2,751
Crofton	1	184,920	6,211	0	6,211	2	3,105
Davidsonville	1	431,118	15,925	8,554	24,480	3	8,160
Gibson Island	1	109,950	10,509	0	10,509	2	5,254
North Beach	1	155,000	49,718	1,822	51,541	3	17,180
Odenton	1	190,694	40,454	0	40,454	2	20,227
Riva	1	307,273	6,491	9,030	15,522	2	7,761
Severn	1	182,082	12,001	0	12,001	2	6,000
West River	1	78,643	51,302	0	51,302	2	25,651
Total	**100**	**25,484,309**	**5,276,306**	**964,765**	**6,242,078**	**263**	**314,217**

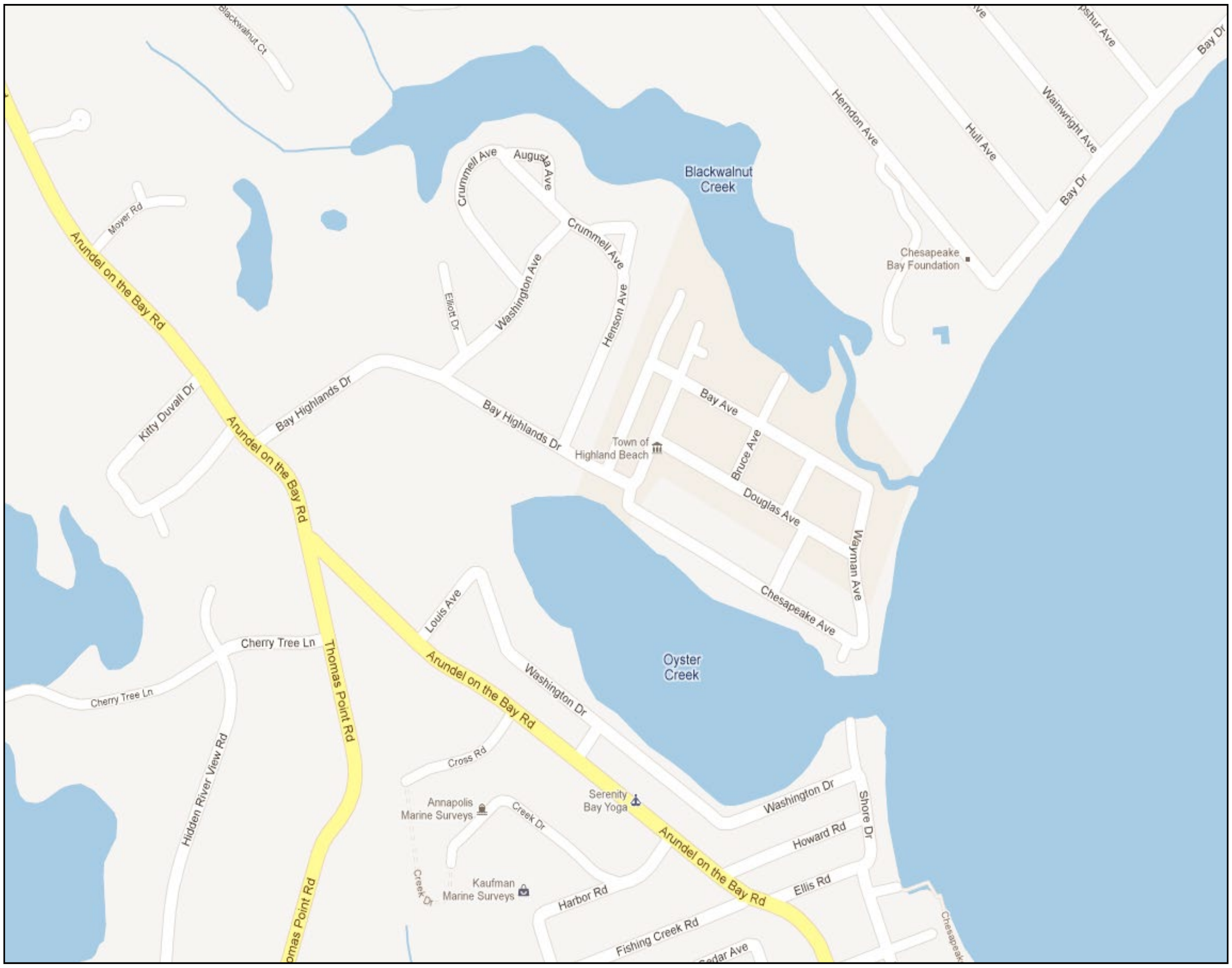
Source: FEMA/NFIP PIVOT Database Query, July 30, 2024.

3.3.1.7 Flood Hazards in Highland Beach

The Town of Highland Beach is an incorporated jurisdiction within Anne Arundel County. It was founded in 1893 and presently comprises about one-tenth of a square mile of land area and is home to a population of 117 per the 2020 U.S. Census. There are 79 housing units in the area, and according to the 2020 Census, 55 are presently occupied and used for residences. Figure

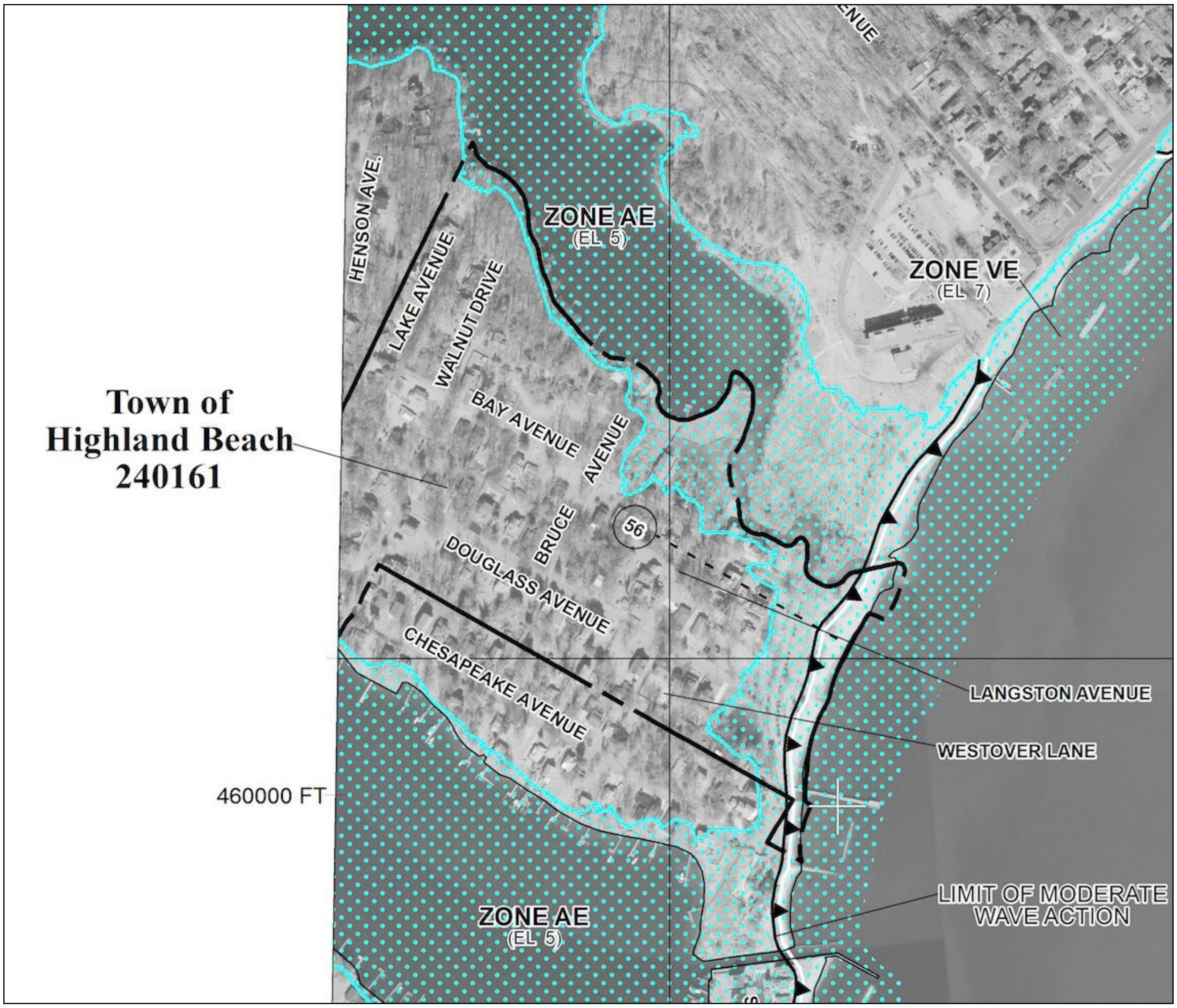
3.3.1-2 shows the location of the Town on the eastern side of the County, south of the City of Annapolis. The Town is surrounded on three sides by water – the Chesapeake Bay on the east, and Blackwalnut Creek and Oyster Creek on the north and south sides, respectively.

Figure 3.3.1-2
Town of Highland Beach Location Map
(Source: Google)



Because of its location on the western side of the Chesapeake Bay, the Town is potentially subject to the effects of flooding and storm surge. The current effective Flood Insurance Rate Map (FIRM) is dated February 18, 2015, and shows that part of the Town is in the floodplain, either in designated A zones, or in V zones, as shown in the figure below. It appears from the FIRM and a review of aerial imagery that there are a few structures in the 1 percent annual chance floodplain in the northeast quadrant of the Town, north of Bay Street and east of Walnut Street.

Figure 3.3.1-3
Town of Highland Beach Flood Insurance Rate Map (2015)
(Source : FEMA Map Service Center)



Over time, the small amount of development that has occurred in Highland Beach has moved inland from the Chesapeake Bay, with the result that there is only a small residual exposure to flooding for structures in the jurisdiction. A review of NFIP flood insurance records supports this conclusion – while the County overall has 109 designated Repetitive Loss properties, none are listed in Highland Beach. Part of the reason for this may be that residents have not chosen to buy flood insurance (or to make claims if they had policies and were flooded), but it is notable that in an area with such exposure (9 structures) to potential flooding, there is little evidence to suggest that there is significant risk, and potential impacts should be considered small except in extreme events.

3.3.1.8 Impacts to People, Systems, and Resources

Flood impacts people, structures, and critical resources in many ways, and has been described in this chapter primarily through the historical event narratives of flooding throughout the County. The following sections examine the vulnerability of, and impacts to, these systems based on previously observed impacts combined with forecasting for future conditions. These sections include impacts to people, structures, systems, natural historic and cultural resources, and community activities in Anne Arundel County.

Riverine Flooding
The Public's Perspective

A survey conducted during the 2025 plan update asked County residents their level of concern for hazards identified in the plan.

Over half, 54.24% of respondents, are either "concerned" (26.14%) or "very concerned" (28.10) with the riverine flood hazard. The riverine flooding hazard ranks as the sixth hazard of most concern.

51.35% of respondents indicated that they have seen an "increase" in the frequency or intensity of riverine flooding over the last 10 years. 47.97% have seen "no change" in frequency or intensity.

59.86% of property owners indicated that they do not carry flood insurance. Of those who said no, 63.64% indicated that the primary reason is because flood insurance is too expensive.

Finally, just 12.15% of respondents indicate that a riverine flood event has caused damage to their residential or commercial property.

People

People are impacted in numerous ways from riverine flooding, including but not limited to:

- Property damage: Flooding can damage homes, businesses, and other property.
- Life safety: Flooding can lead to drowning, physical trauma, and electrocution.
- Health risks: Flooding can expose people to pathogens and harmful chemicals from contaminated water, wastewater infrastructure, and downed power lines.
- Transportation issues: Flooding can close roads, making it difficult to get around.
- Disruption of services: Flooding can disrupt essential services, such as transportation and community lifeline services.
- Stress on infrastructure: Flooding can stress infrastructure, emergency response, and public health.
- Increased risk of future flooding: Sea level rise is increasing the risk of flooding in Anne Arundel County.

Those who are at increased vulnerability to flooding are those who live or work in a special flood hazard area, particularly the 1 percent annual chance flood zone, as well as those who are part of a socially or medically vulnerable population. Map 3.3.1-1 shows the geographic extent of the 1 percent annual chance and 0.2 percent annual chance floodplain (i.e., the 100 year and 500-year flood, respectively). The County's peninsula regions are by far the most impacted by the floodplain. Particularly, the peninsula area including Shady Side and Deale along the Chesapeake Bay are nearly entirely within the floodplain and are vulnerable to climate change and sea level rise. Due to current development policies and restrictions, new development is encouraged outside of the floodplain and well-regulated within the floodplain. Past occurrences of flood events as well as the locations of repetitive loss properties indicate geographic areas where flooding is likely to impact people in the future. The top five communities which have experienced the most flood events in the last two decades include:

1. Raynor Heights/North Linthicum (21 events)
2. Crofton (9 events)
3. Riva (6 events)
4. Rutland (6 events)
5. Glen Burnie (5 events)

Communities with the most repetitive loss properties and/or NFIP claims include:

1. Pasadena
2. Edgewater
3. Shady Side
4. Churchton
5. Severna Park

Additionally, Anne Arundel County has multiple socially vulnerable groups, including medically vulnerable populations. These groups include, but are not limited to:

- Elderly residents (aged 65 and older)
- Residents with disabilities
- Individuals experiencing homelessness
- Residents with limited English proficiency
- Low-income populations
- Outdoor workers
- Residents with difficulty recovering quickly from disasters
- Medically fragile or electric-dependent Medicare beneficiaries
- Essential workers are at higher risk due to their inability to avoid work during hazardous conditions.

An important aspect to reducing the flood vulnerability of socially vulnerable populations is identifying these groups and engaging with them effectively. According to the Centers for Disease Control and Prevention (CDC), social vulnerability refers to “the negative effects on communities caused by external stresses on human health. Such stresses include natural or human-caused disasters, or disease outbreak.” Reducing social vulnerability can decrease both human suffering and economic loss.

The CDC developed a Social Vulnerability Index (SVI) to help local jurisdictions determine their level of vulnerability based on fifteen (15) indicators that are routinely utilized to measure social vulnerability. These indicators comprise four overall themes as follows:

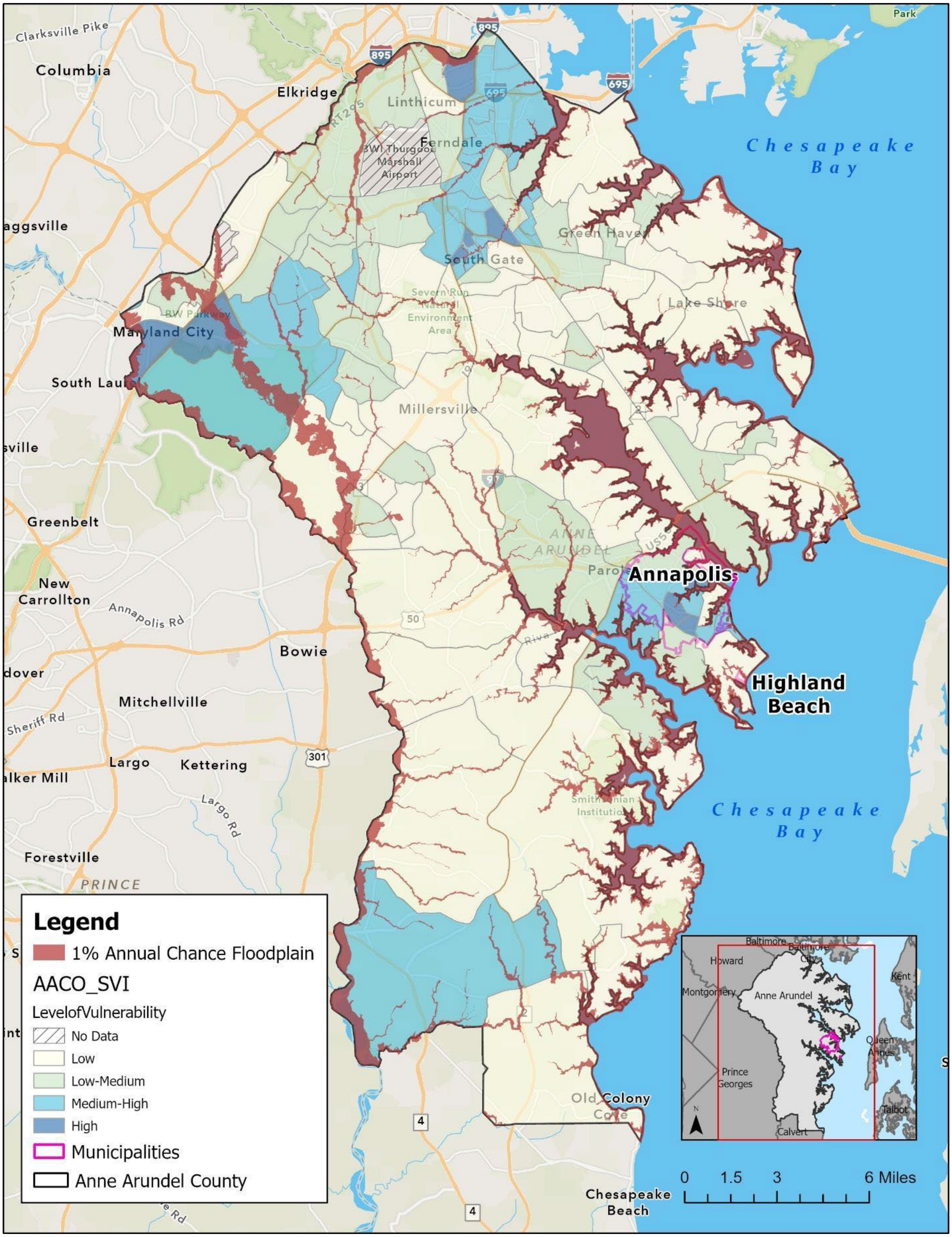
1. Socioeconomic Status – below 150% poverty, unemployed, housing cost burden, no high school diploma, no health insurance.
2. Household Characteristics – aged 65 and older, aged 17 and younger, civilian with disability, single-parent household, English language proficiency.
3. Racial & Ethnic Minority Status – race, ethnicity.
4. Housing Type & Transportation – multi-unit structures, mobile homes, crowding, no vehicle, group quarters.

The 2022 SVI has been conducted for Anne Arundel County at the census tract level and results are shown on Map 3.3.1-3. The dark blue census tracts indicate areas of higher social vulnerability while the light-yellow tracts indicate relatively low social vulnerability.
The SVI results have been mapped alongside the 1-percent-annual-chance flood hazard area to aid in determining areas of concern where flood mitigation activities might make the most sense

due to increased social vulnerability. Areas of concern are locations where high social vulnerability and extensive flood hazard areas overlap. Measuring social vulnerability at the census tract level is meant to help guide further planning. Investigation at the neighborhood level is required to fully identify vulnerable populations.

Relative to other jurisdictions in Maryland, Anne Arundel County has low to medium level of social vulnerability. Themes with higher social vulnerability in the County include Household Characteristics and Housing Type/Transportation. Areas of greatest overall social vulnerability include South Gate through Pumphrey and Brooklyn Park, Maryland City, and areas south of City of Annapolis. These areas are all impacted by the 1 percent annual chance floodplain to some extent, particularly the Maryland City and Russett communities due to the Little Patuxent River. Linthicum and the City of Annapolis both have a recent history of flooding events and Linthicum has one non-residential repetitive loss property.

Map 3.3.1-3 Social Vulnerability and the 1 Percent Annual Chance Flood Zone
(Source: Source: CDC Social Vulnerability Index & FEMA



Structures

Repetitive loss properties are the most impacted structures in Anne Arundel County. As addressed earlier in this section, Anne Arundel County has a total of 109 repetitive loss properties. The top three communities based on total repetitive loss properties are Pasadena, Edgewater, and Shadyside. Communities or locations with large concentrations of repetitive loss properties are known as "repetitive loss areas." Structures in these areas are more at-risk of flooding than in other locations due to the history of flooding in the area. It is likely that more than the repetitive loss properties are flooding in these areas, however a lack of flood insurance or NFIP claims means that these incidents are not captured. Outreach should be conducted to repetitive loss areas to increase awareness, educate about flood mitigation measures, and encourage the purchase of flood insurance.

Critical facilities and community lifelines within the riverine 1 percent annual chance floodplain have been determined for this plan update. These facilities and detailed information have been included in Table 3.3.1-8.

The County has an extensive critical facility and community lifeline database, of which little is within the special flood hazard area. The facilities that are within the floodplain include fixed hazardous materials storage sites and sewer pump stations (SPS). Facilities with the highest flood depths are highlighted in yellow on Table 3.3.1-8. These facilities should be prioritized for investigation of their current mitigation status to determine if additional action is necessary. These facilities and their depth of flooding are mapped on Map 3.3.1-4. Darker blue areas indicate higher depth of flooding.

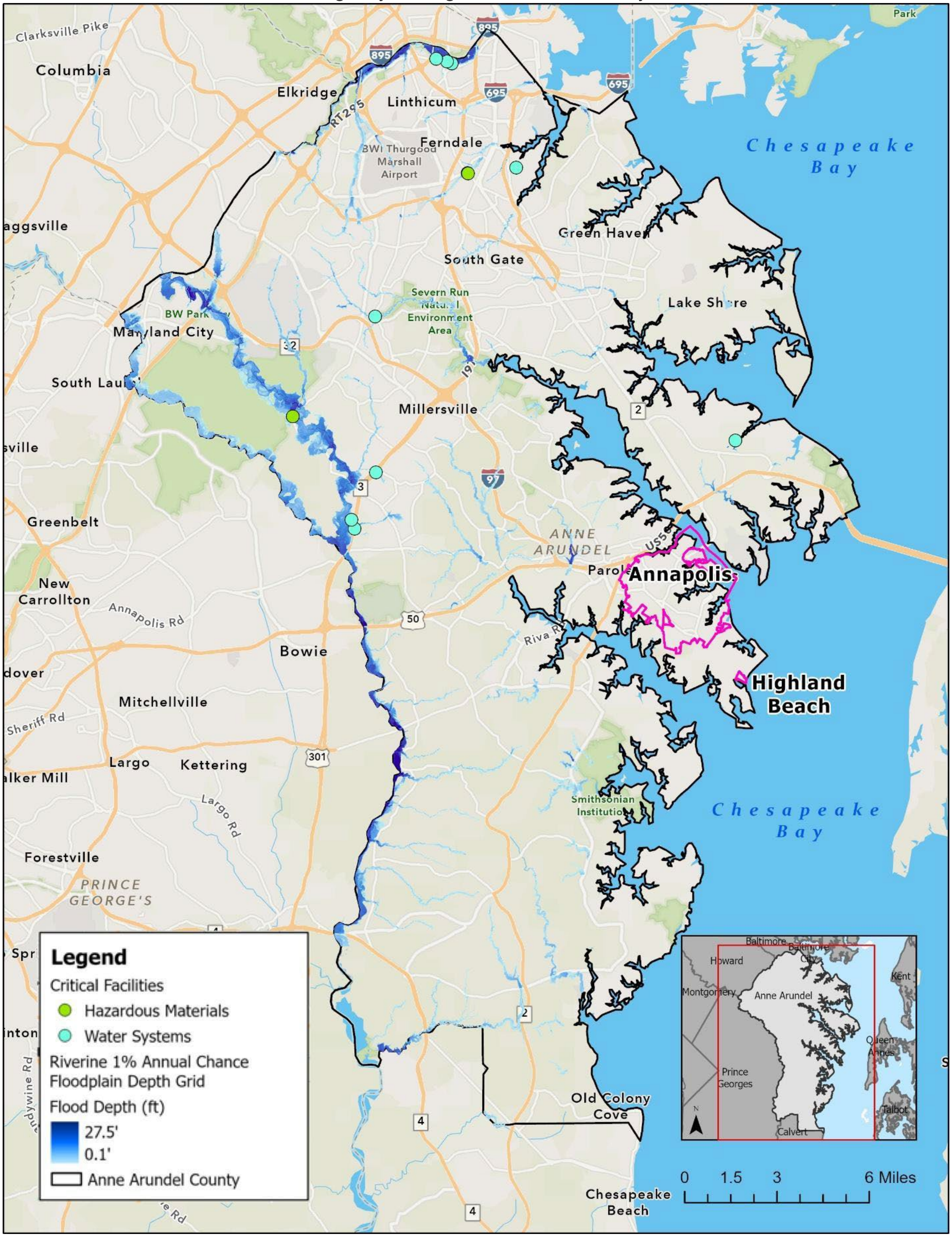
Table 3.3.1-8 Critical Facilities & 1% Annual Chance Floodplain – Riverine

Community Lifeline	Facility Type	Facility Name	Address	City	SFHA	Flood Depth
Hazardous Materials	Fixed HazMat Storage Sites	AT&T	2801 5th Ave	Odenton	Zone AE	10.4
		Hein Brothers, Inc.	7400 Baltimore Annapolis Boulevard	Glen Burnie	Zone AE	0.9
		Griffith Energy Services, Inc.	7400 Baltimore Annapolis Blvd	Glen Burnie	Zone AE	0.9
Water Systems	Sewer Pump Stations	Bay Hills SPS	571 Bay Green Dr	Arnold	Zone A	0.5
		Margate SPS	917 Sunnybrook Dr	Glen Burnie	Zone A	1.6
		Patapsco Park SPS	200 Shenandoah Ave	Baltimore	Zone AE	9.3
		Patapsco SPS	6816 Baltimore Annapolis Blvd	Linthicum Heights	Zone AE	7.9
		Ridgeway Manor SPS	Terrace Rd	Linthicum Heights	Zone AE	1.4
		Severn Run SPS	1501 Old Mill Rd	Severn	Zone AE	0.1

Table 3.3.1-8 Critical Facilities & 1% Annual Chance Floodplain – Riverine

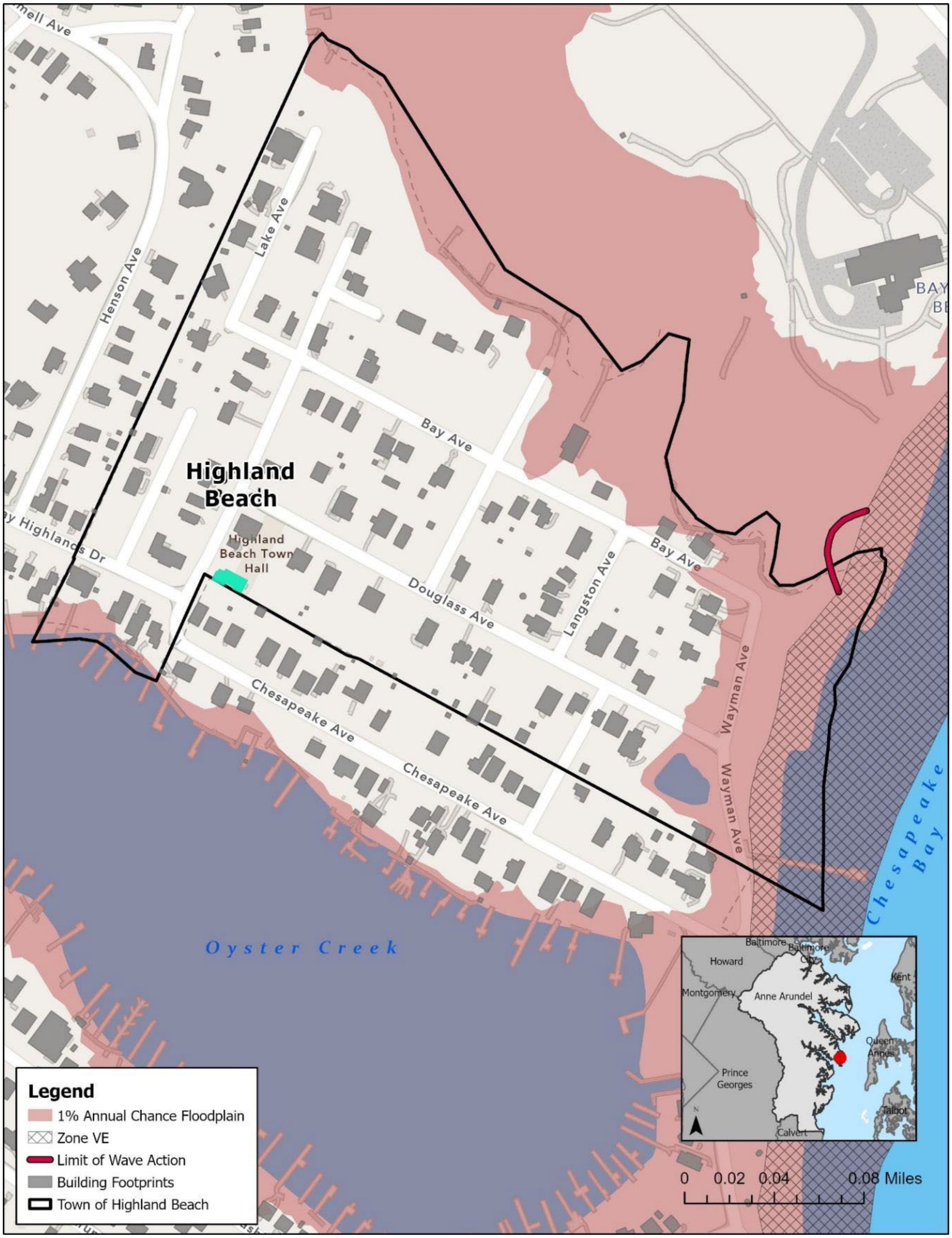
Community Lifeline	Facility Type	Facility Name	Address	City	SFHA	Flood Depth
		Crofton Walk-In SPS	1451 N Crain Hwy	Crofton	Zone A	1.6
		Storch Property SPS	1035 N Crain Hwy	Gambrills	Zone A	4.9
		Riverwalk at Crofton SPS	1304 Foggy Turn	Crofton	Zone AE	1.8

Map 3.3.1-4 Critical Facilities & 1% Annual Chance Floodplain – Riverine Depth Grid
Source: Office of Emergency Management Critical Facility Database & FEMA



The Town of Highland Beach only has one critical facility (i.e., Town Hall) and it is outside the floodplain – Map 3.3.1-5.

Map 3.3.1-5 Critical Facilities & 1% Annual Chance Floodplain – Highland Beach
Source: Office of Emergency Management Critical Facility Database & FEMA



Systems

Riverine flooding in Anne Arundel County can impact homes, businesses, infrastructure, agriculture, and public health. Flooding can also disrupt daily activities, such as closing roads. Infrastructure systems such as roads, stormwater systems, and drainage systems can all be impaired or rendered temporarily ineffective due to flooding. Additionally, both health and emergency response systems can be impacted by flooding. Emergency responders may have a challenging time reaching certain areas due to inundated roadways.

Roadways and bridges within the special flood hazard area are more vulnerable to flooding than elsewhere. Specifically, the communities of Linthicum, Maryland City, Glen Burnie, and Odenton have stretches of roadway that frequently flood during storms. These areas have a history of flooding events as well as the presence of repetitive loss properties. For roadways that experience repetitive nuisance flooding, refer to Section 3.3.2 Coastal Hazards.

Water systems, particularly sewer pump stations as identified in Table 3.3.1-8, are especially vulnerable to flooding due to their locations within the 1 percent annual chance floodplain. Most of the County's critical facilities and community lifelines are outside the 1 percent annual chance floodplain.

Natural, Historic and Cultural Resources

Flooding can significantly impact natural infrastructure by causing erosion of riverbanks, altering sediment deposition patterns, damaging vegetation, disrupting aquatic ecosystems, and impacting the overall health and function of wetlands, which are crucial natural flood control mechanisms; essentially, floodwaters can disrupt the natural balance of landscapes and their natural ability to mitigate flood risks.

Anne Arundel County is home to thousands of significant historic sites, archaeological sites, cemeteries, and Scenic & Historic Roads that warrant preservation. The County provides protection to these cultural resources through its Code (see Article 17-6-501 to 504). Historic structures as listed in the National Register or Historic Places were assessed for vulnerability to flooding. Historic structures within the 1 percent annual chance floodplain are more vulnerable to flooding. There are a total of 161 historic and cultural resources located within the 1% annual chance floodplain; this includes structures, sites, and districts. These historic structures are mapped on Map 3.3.1-6.

Historic and cultural resources within Highland Beach have also been determined. These resources are included in Table 3.3.1-9 and shown on Map 3.3.1-7. There are a total of nine resources within Highland Beach that are vulnerable to flooding due to their location within the 1 percent annual chance floodplain.

Map 3.3.1-6 Historic and Cultural Resources Within 1 Percent Annual Chance Floodplain
Source: National Register of Historic Places & FEMA

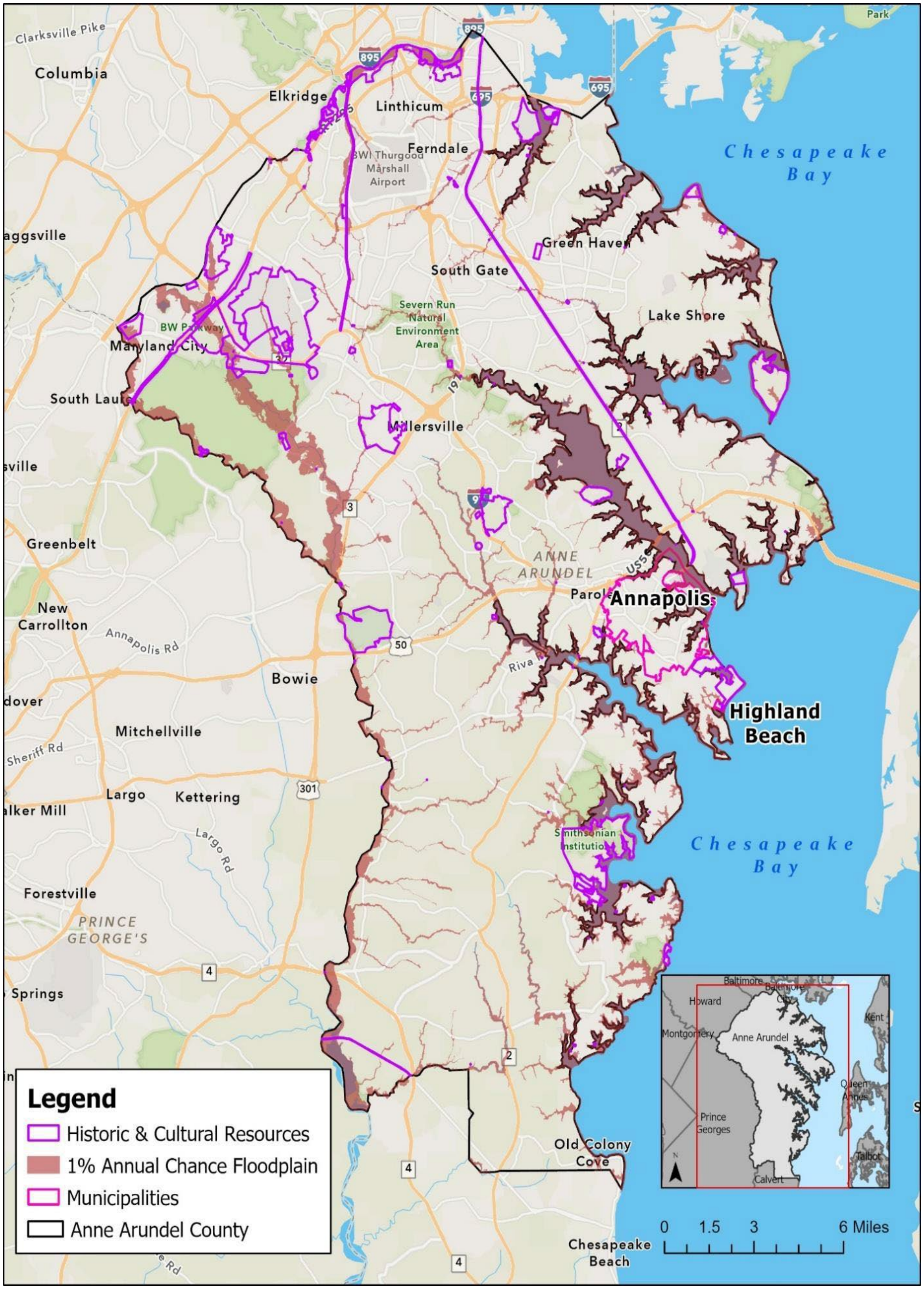
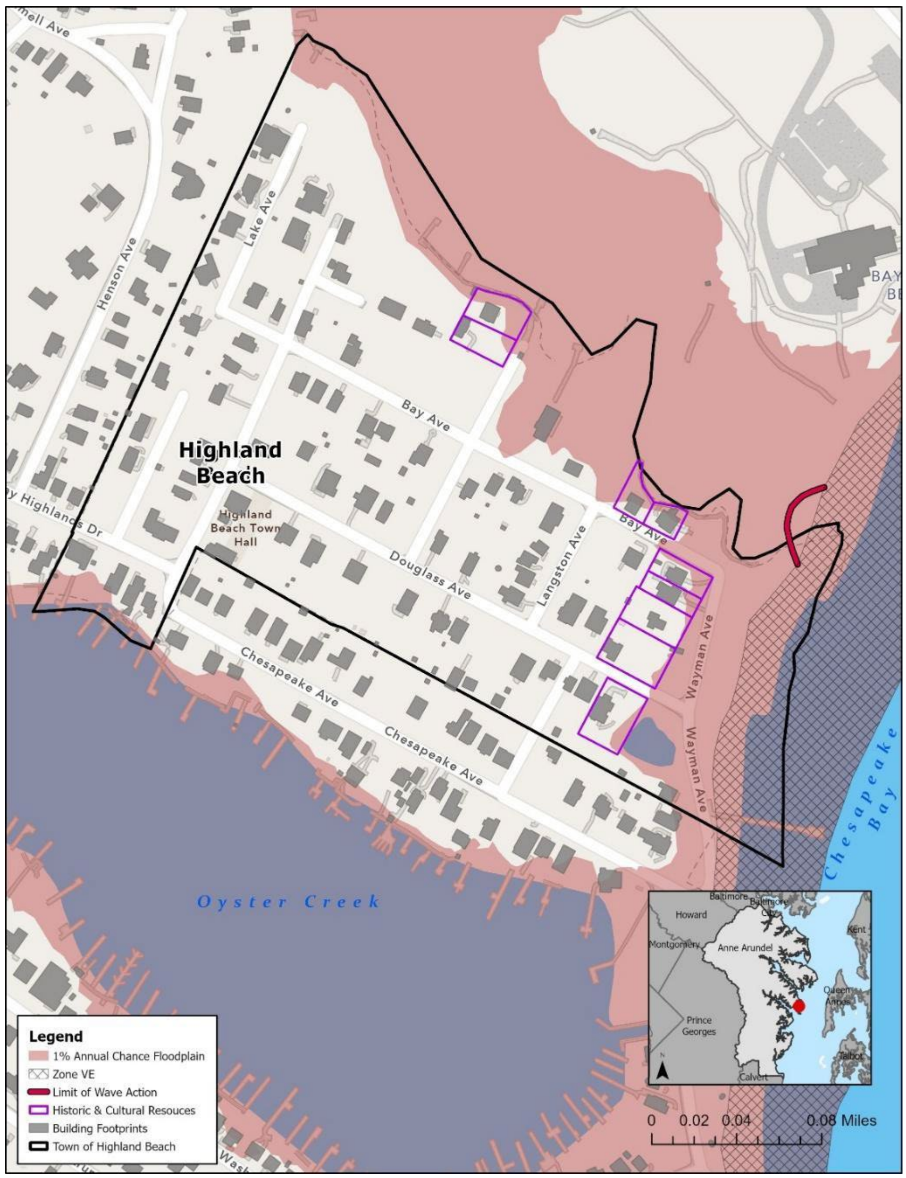


Table 3.3.1-9 Historic and Cultural Resources Within 1 Percent Annual Chance Floodplain – Highland Beach

Historic & Cultural Resource Name	Address
Anne Marie and Edwin M. Henderson House	3200 Bruce Avenue
Cary and Maxie Freeman House	3202 Bruce Avenue
William Wyatt House	1336 Bay Avenue
Dr. John R. Francis House	1340 Bay Avenue
Frederick Douglass Summer House	3200 Wayman Avenue
Judge and Mary Church Terrell House	3202 Wayman Avenue
Jean M. Green House	3206 Wayman Avenue
Murray House	1340 Douglass Avenue
Leslie S. and Ruth Perry House, site	1345 Douglass Avenue



Map 3.3.1-7 Historic and Cultural Resources Within 1 Percent Annual Chance Floodplain – Highland Beach
Source: National Register of Historic Places & FEMA

Community Activities

Community activities are integral to Anne Arundel County's economy and impacts to these activities due to flooding may cause disruptions to the County's ability to thrive. Flooding may impact systems and structures (e.g., roadways) that are necessary for community activities to proceed such as road blockages and/or power system disruptions. Typically, events occurring within or near the floodplain (such as within public parks along popular rivers) would be most vulnerable to disruptions or cancellation caused by flooding. However, road closures caused by flooding could impede travel to and from activities.

Online resources to watch for community activities include the County's Programs and Activities, Recreation and Parks calendar, as well as the County Events calendar. Additionally, social media accounts for the County and those created by citizens are a primary source of local event information. The top ten most popular recreational activities or amenities in Anne Arundel County include the Annual Park Pass, Dogs in the Park, Concerts in the Parks, Park Pavilion Rentals, Water Access, Swimming Access, Kayaking Trips, Cartop Boat Launch, Boat Ramps, and Fishing.

3.3.1.9 Future Land Use and Development Trends

New development can change, or worsen, flooding in the following ways:

- Removing natural landscape features, such as vegetative buffers
- Adding impermeable surfaces
- Changing geology
- Changing hydrology
- Building in floodplains

Flooding can be especially dangerous or impactful in urban areas due to higher population density, high property values, and high concentration of economic activity. Note: Land use and development trends centered around coastal flooding are discussed in Section 3.3.2 Coastal Hazards.

Future development is guided by the County's General Development Plan (GDP), Plan2040 and the Planned Land Use Map. Additionally, the Development Policy Areas Map shows areas where development and redevelopment are encouraged because they meet the vision, goals, and policies of Plan2040. Policy areas include Rural and Agricultural, Peninsula, Neighborhood Preservation, and Critical Corridors. Growth areas include Critical Economic, Town Centers, Village Center Overlay, and Transit-Oriented Overlay.

The Resource Sensitive Policy Area Overlay focuses on areas of natural, cultural, or physical features of special concern or significance within the County intended for conservation and preservation from the adverse effects of development. Development in these areas is guided by policies and regulations to limit or prohibit impacts of land use to sensitive areas. Planned land use and land use policies are mapped and are described in detail in Plan2040.
Additionally, future development will be guided through the creation of nine Region Plans. These plans offer community members an opportunity to get together to develop a shared vision for their future. After adoption of the 1997 GDP, a set of Small Area Plans were prepared for each of 16 designated subareas of Anne Arundel County. The latest update of the GDP, Plan2040, directs the County to prepare 9 Region Plans. The Region Plans build on the work of the previous Small Area Plans as well as Plan2040.

Region Plans 2, 4, and 7 as well as corresponding comprehensive zoning bills were adopted by the County Council in 2024. Region Plans 1, 3, and 9 and corresponding comprehensive zoning bills are being considered by Council through May 2025. Development of Region Plans 5, 6, and 8 are underway.

Future development is most likely to impact flooding in areas where significant floodplain and sea level rise vulnerability overlap with growth areas, adjacent high development density, and sensitive resources. The County's peninsula regions are by far the most impacted by the floodplain. Particularly, the peninsula area including Shady Side and Deale along the Chesapeake Bay is nearly entirely within the floodplain and is vulnerable to climate change and sea level rise.

In accordance with the Sustainable Growth and Agricultural Preservation Act of 2012, OPZ adopted Growth Tiers administratively on June 17, 2013. The Growth Tiers map was updated through the Plan2040 General Development Plan. The purpose of Growth Tiers is to protect agriculture, control development in rural areas, promote development in areas that have infrastructure in place for it, and reduce pollution from septic systems. Tier 1 and 1A Growth Areas are largely centralized to the northern and western portions of the County. There are Tier 1 Growth areas within the Peninsula Policy Areas, but development in these areas is primarily limited to infill and redevelopment, meaning new development is not occurring in the floodplain. Redevelopment in the peninsula areas must consider negative impacts from salt-water intrusion and sea level rise vulnerability.

In general, new development is encouraged away from the floodplain throughout the County, except in existing villages or town centers which are already largely within the floodplain. Nearly half of the Plan2040 areas overlay districts (in total land area) are along existing transportation corridors and outside of the floodplain.

Floodplains in the County are protected through the Floodplain Ordinance (Article 16), the Subdivision and Development Ordinance (Article 17) and the Zoning Ordinance (Article 18). The Floodplain Ordinance defines the floodplain districts, requires delineation of the floodplain on development plans submitted to the County, requires structures to be elevated above the 100-year flood level and that safe vehicle access to and egress from a development is provided. The Subdivision Ordinance requires subdivisions with floodplain areas that are not deeded to the County as open space to provide an easement for access to and maintenance of the floodplain. Some of the floodplain areas in the County is zoned Open Space, which limits development potential and supports protection of the floodplain in its natural state. Additionally, the stream buffer requirements and stormwater management requirements for new development also serve as a means of floodplain protection.

The County conducts an analysis of development trends in the Annual Development Measures and Indicators Report. These reports indicate that recent development patterns are consistent with the plans and policies referenced above. The majority of development is located within areas with existing water and sewer infrastructure in the northern and western portions of the County. The indicators also show the County's strong position in continuing to preserve farmland and natural resource areas including floodplains.

The Town of Highland Beach is surrounded by the 1-percent annual chance floodplain, but new development is not directed to this area, nor is increased or significant development expected in the timeframe of the 2025 HMP update or within Plan2040.

3.3.1.10 Future Conditions

The frequency of flooding and events that cause flooding such as storms and heavy rain events are likely to increase due to climate change and associated projected sea level rise. Some areas will become permanently inundated, making them uninhabitable in the long term. Areas that currently experience regular flooding are likely to see conditions change or worsen due to sea level rise. And some new land areas that historically flood little or not at all are likely to experience flooding.

According to a 2021 study published in Nature “when it comes to riverine flooding, climate change is likely exacerbating the frequency and intensity of extreme flood events but decreasing the number of moderate floods.” Flash flooding will continue to increase as there are more extreme precipitation events. Warmer temperatures increase evaporation, putting more moisture into the atmosphere that then gets released as rain or snowfall.

The 3rd National Risk Assessment: Infrastructure on the Brink (2021) quantifies risk as “the unique level of flooding for each infrastructure type relative to operational thresholds, as established by the federal government and other authoritative bodies.” Operational flood risk at the local level denotes when a facility is flooded to the point where it can no longer function as intended or becomes unsafe. At a high level, the assessment finds the following:

- Risk to residential properties is expected to increase by 10% over the next 30 years, with 12.4 million properties at risk today (14%) and 13.6 million at risk of flooding in 2051 (16%).
- Additionally, 2.0 million miles of road (25%) are at risk today and that is expected to increase to 2.2 million miles of road (26%) over the next 30 years (a 3% increase over the next 30 years).
- Commercial properties are expected to see a 7% increase in risk of flooding from 2021 to 2051, with 918,540 at risk today (20%) and 984,591 at risk of flooding in 30 years (21%).
- Currently, 35,776 critical infrastructure facilities are at risk today (25%), increasing to 37,786 facilities by 2051 (26% and a 6% increase in risk).
- Compounding that risk, 71,717 pieces of social infrastructure facilities are at risk today (17%), increasing to 77,843 by 2051 (19% and an increase of 9% over that time).

In Maryland, there are 112,187 residential properties, 11,990 miles of roads, 8,445 commercial properties, 379 infrastructure facilities, and 826 social facilities with operational flood risk today. According to Riskfactor.com, in Anne Arundel County, there are 34,630 properties that have risk of flooding over the next 30 years. This represents 17.1% of all properties in Anne Arundel County.

In addition to damage to properties, flooding can also cut off access to utilities, emergency services, transportation, and may impact the overall economic well-being of an area.
Overall, Anne Arundel County has a “moderate” risk of flooding over the next 30 years, which means flooding is likely to impact day-to-day life within the community. This is based on the level of risk the properties face rather than the proportion of properties with risk.

3.3.1.11 Considerations for the Next Planning Cycle

Future monitoring, evaluation, and updating of this Plan should consider the following factors related to flood hazards.

- Have any flood hazard events occurred since this Plan was adopted?
- Has any new scientific research or methodology changed the ability to predict flood hazards or assess risk and vulnerability?
- Has a new local analysis of flooding been conducted for planning regions in the County?
- Has there been any notable change in the population, built environment, natural environment, or economy that could affect the risk or vulnerability to flood hazard events?
- Is there any new evidence related to the impacts of climate change that could affect the level of risk or vulnerability to these events?

3.3.2 Coastal Hazards

The Coastal Hazards section includes the following sub-topics:

1. Description of Coastal Hazards
2. Location, Extent, Magnitude
3. Past Occurrences
4. Probability of Future Coastal Hazard Events
5. Coastal Hazards Risk Assessment
6. Coastal Hazards in Highland Beach
7. Impacts to People, Structures, Systems, and Resources
8. Future Land Use and Development Trends
9. Future Conditions
10. Considerations for the Next Planning Cycle

3.3.2.1 Description of Coastal Hazards

This section profiles coastal hazards related to coastal flooding, storm surge, and sea level rise. The Flood section of this plan includes more information specific to riverine flooding, and the Hurricane, Tropical Storm and Nor'easter section profiles tropical systems.

Coastal flooding is defined as flooding of coastal areas due to the vertical rise above normal water level caused by strong, persistent onshore wind, high astronomical tide, and/or low atmospheric pressure, resulting in damage, erosion, flooding, fatalities, or injuries. These events are not associated with tropical cyclones such as hurricanes or tropical storms (Source: NOAA NCEI).

Storm surges occur when the water level of a tidally influenced body of water increases above the normal high tide. Storm surges occur with coastal storms caused by massive low-pressure systems with cyclonic flows that are typical of hurricanes. Storm surges are particularly damaging when they occur at the time of a high tide, combining the effects of the surge and the tide. This increases the difficulty of predicting the magnitude of a storm surge because it requires weather forecasts to be accurate to within a few hours. Coastal flooding occurs in seasonal patterns. Tropical storms tend to come together from June until October.

According to the University of Maryland Extension, relative, or local, **sea level rise** (SLR) is an increase in mean sea level relative to a point on land. Maryland is experiencing higher rates of relative sea level rise than the global average due to several factors, including Maryland's geographic position in relation to melting polar ice sheets and land subsidence.

Anne Arundel County, surrounded by more than 530 miles of shoreline, is vulnerable to increased flooding because of relative sea level rise. Historic maps and aerials over the past century showing increasingly visible changes to the County shoreline demonstrate that relative sea level rise is happening in our past and present and will happen in our future. It is evident that the Chesapeake Bay is moving further inland, since the relative rise of sea level to any existing land surface at a particular location is exacerbated by a combination of changing climate and natural land subsidence. Today, rising temperatures from human-induced greenhouse gas emissions are affecting the volume of the sea by both warming the oceans and increasing the melting of glaciers and ice sheets. These factors taken with the occurrence of heavier, more severe precipitation events in tandem with a sinking coastal land mass will accelerate future rates of relative sea level rise (Source: Anne Arundel County Sea Level Rise Strategic Plan Update, 2023).

3.3.2.2 Location, Extent, Magnitude of Coastal Hazards

Coastal Flooding

Coastal flooding occurs along Anne Arundel County's low-lying coastal and tidal regions of the Chesapeake Bay.

Storm Surge

The storm surge hazard associated with hurricanes and other severe storms are responsible for coastal flooding and erosion along the Maryland Gulf Coast. In Anne Arundel County, the coastal flooding hazard is greatest along areas adjacent to the Chesapeake Bay. The effects of coastal flooding can be felt in the County from hurricanes that make landfall as far away as New Jersey, Virginia, and the Carolinas.

Storm surges inundate coastal floodplains by tidal elevation rise in inland bays and ports, and backwater flooding through coastal river mouths. Severe winds associated with low-pressure systems cause an increase in tide levels and water surface elevations. Storm systems also generate large waves that run up and flood coastal areas. The combined effects create storm surges that affect the beach, marsh, and low-lying floodplains. Shallow offshore depths can cause storm driven waves and tides to pile up against the shoreline and inside bays.

The morphology of the continental shelf also influences the level of surge in a particular area. A shallow slope off the coast, like what is found off the coast of Maryland, will allow a greater surge to inundate coastal communities.

Magnitude of storm surge is measured in feet above the normal tide level.

Sea Level Rise

Sea level rise will impact all coastal planning areas in the County to some extent, but areas of vulnerability to sea level rise for the County overall are not expansive. The Sea Level Rise Strategic Plan Update, Phase 1 Vulnerability & Risk Assessment (2023) has identified planning Region 9 as the most vulnerable to sea level rise in the County. For purposes of local plan alignment, the 2025 HMP update considers the same future SLR scenarios for Anne Arundel County that are included in the 2023 Strategic Plan. These include 2050, 2065, and 2100 SLR scenarios. These future scenarios are based on the 2022 Global and Regional Sea Level Rise Scenarios for the United States. The additional analysis conducted for Region 9 includes the 2050 scenario plus the 1-percent annual chance flood hazard scenario. Table 3.3.2-1 shows SLR Inundation Levels at Mean Higher High Water.

Regional Sea Level Rise Rates

Regional rates of SLR deviate from global trends as a function of regional factors such as vertical land movement, changes in ocean currents, and changes in gravitational forces from ice mass loss. The 2022 report projections provide a range of regional SLR values for each of the five global scenarios; the report provides a low, medium, and high value representing the 17th, 50th, and 83rd percentile. This risk assessment applies the medium value for all cases and selected the values from the NOAA tidal gauge located at Annapolis, MD.

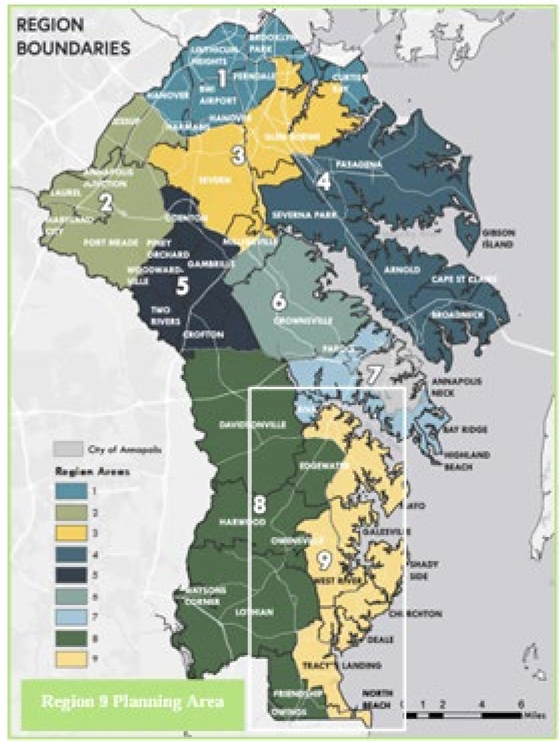
Source: 2023 Sea Level Rise Strategic Plan Update

Table 3.3.2-1 Sea Level Rise Inundation Levels at Mean Higher High Water

Time Frame	SLR Increment (ft)	Elevation of MHHW	Elevation of 1% Annual Chance Storm Surge
2050	1.6	2.31	8.11
2065	2.54	3.21	9.01
2100	5.35	6.02	11.82

Source: Sea Level Rise Strategic Plan Update, 2023

Figure 3.3.2-1 Anne Arundel County Region Planning Areas
Source: Sea Level Rise Strategic Plan Update, 2023



The Sea level Rise Strategic Plan determines that flood risk to Region 9 (identified as having some of the most vulnerable communities such as Shady Side, Churchton, and Mayo) is among the highest in the County. Region 9 was a focus of this study for higher level analysis due to the evidence over the past decade of increased flood risk from climate change factors such as extreme weather events and relative sea level rise. The current 2023 model which informed the report indicates a significant rise in sea level risk (i.e., shoreline changes and increased flood extents) from 2050 to 2100 in Region 9.

Additionally, Regions 4 and 7 also demonstrate high risk levels to sea level rise. Communities such as Pasadena, Broadneck, and Annapolis Neck show significant acreage could be inundated by 2100. It is recommended that neighborhoods in these regions, such as Lake Shore, Gibson Island, Pinehurst Harbor, Bay Ridge, Highland Beach, Round Bay, and Fishing Creek Farms, to name only a few examples, undergo further planning for coastal resiliency actions.

Region 6, the Crownsville area, is also noteworthy in the various SLR scenarios, particularly in the lower lying shoreline areas of Indian Creek and Herald Harbor. Shoreline portions of the Davidsonville area, as well as Glen Burnie, Ferndale, and Curtis Bay, overlapped multiple regions and presented potential vulnerabilities under these scenarios. Region 2 and Region 5 were the only regions that did not present significantly in the flood extents for the sea level rise scenarios (although riverine flooding due to extreme weather events exacerbated by climate change is still a factor for consideration in those areas).

3.3.2.3 Past Occurrences

<u>Coastal Flooding</u>

The NCEI Storm Events database indicates there have been 75 coastal flooding events to impact Anne Arundel County between 1998 and 2024. Table 3.3.2-2 summarizes these events.

Table 3.3.2-2 Coastal Flooding Events Anne Arundel County 1998–2024

Date	Death	Injury	Property Damage ($)
02/04/1998	0	0	50.00K
06/28/2006	0	0	0.00K
10/28/2006	0	0	0.00K
01/25/2010	0	0	0.00K
09/30/2010	0	0	0.00K
10/01/2010	0	0	0.00K
03/10/2011	0	0	0.00K
04/16/2011	0	0	0.00K
05/18/2011	0	0	0.00K
06/17/2011	0	0	0.00K
10/13/2011	0	0	0.00K
06/02/2012	0	0	0.00K
06/06/2012	0	0	0.00K
09/18/2012	0	0	0.00K
10/30/2012	0	0	0.00K
04/30/2014	0	0	0.00K
10/03/2014	0	0	0.00K
10/04/2014	0	0	0.00K
10/04/2015	0	0	0.00K
10/05/2015	0	0	0.00K
01/10/2016	0	0	0.00K
02/09/2016	0	0	0.00K
02/09/2016	0	0	0.00K
02/24/2016	0	0	0.00K
10/01/2016	0	0	0.00K
10/24/2017	0	0	0.00K
03/06/2018	0	0	0.00K
03/07/2018	0	0	0.00K
04/16/2018	0	0	0.00K
04/16/2018	0	0	0.00K
09/09/2018	0	0	0.00K
09/10/2018	0	0	0.00K
09/11/2018	0	0	0.00K
09/21/2018	0	0	0.00K
11/26/2018	0	0	0.00K
08/26/2019	0	0	0.00K
09/07/2019	0	0	0.00K
09/14/2019	0	0	0.00K
10/11/2019	0	0	0.00K
10/11/2019	0	0	0.00K
10/12/2019	0	0	0.00K
10/13/2019	0	0	0.00K
10/16/2019	0	0	0.00K
10/31/2019	0	0	0.00K
11/18/2019	0	0	0.00K
12/31/2019	0	0	0.00K
04/05/2020	0	0	0.00K
04/13/2020	0	0	0.00K
04/30/2020	0	0	0.00K
11/15/2020	0	0	0.00K
11/30/2020	0	0	0.00K
12/25/2020	0	0	0.00K

Table 3.3.2-2 Coastal Flooding Events Anne Arundel County 1998–2024

Date	Death	Injury	Property Damage ($)
10/28/2021	0	0	0.00K
09/30/2022	0	0	0.00K
12/15/2022	0	0	0.00K
03/13/2023	0	0	0.00K
04/29/2023	0	0	0.00K
06/05/2023	0	0	0.00K
09/23/2023	0	0	0.00K
11/21/2023	0	0	0.00K
12/18/2023	0	0	0.00K
01/09/2024	0	0	80.00K
03/09/2024	0	0	0.00K
03/27/2024	0	0	0.00K
04/12/2024	0	0	0.00K
04/19/2024	0	0	0.00K
04/24/2024	0	0	0.00K
5/12/2024	0	0	0.00K
8/9/2024	0	0	0.00K
9/21/2024	0	0	0.00K
9/23/2024	0	0	0.00K
9/23/2024	0	0	0.00K
9/25/2024	0	0	0.00K
9/28/2024	0	0	0.00K
Totals	**0**	**0**	**130K**

Source: NOAA NCEI Storm Events Database

There are no reported injuries or deaths associated with coastal flooding according to the NCEI Database. There is minimal recorded property damage associated with coastal flooding: $130,000. The most recent and damaging event occurred January 9, 2024. This was the third highest crest on record at the Annapolis Tide Gauge only surpassed by the surge from Tropical Storm Isabel in 2003 and the Chesapeake - Potomac hurricane of 1933. Recorded locations of damage include the Annapolis Maritime Museum and the Storm Brother's Ice Cream Factory.

Although not included in the NCEI Database under Coastal Flooding events for Anne Arundel County, perhaps the most significant coastal flooding event in the past ten years occurred on September 19, 2003, because of Hurricane Isabel. On September 18, 2003, Isabel made landfall on the North Carolina coast. Its huge wind field was already piling water up into the southern Chesapeake Bay. By the time Isabel moved into central Virginia, it had weakened and was downgraded to a tropical storm. Isabel's eye tracked well west of the Bay, but the storm's 40 to 50 mph sustained winds pushed a bulge of water northward up the Bay and its tributaries, producing a record storm surge. The western shore Counties of the Chesapeake Bay and along the tidal tributaries of the Potomac, Patuxent, Patapsco and other smaller rivers experienced a storm surge reaching five to nine feet above normal tides. In many locations, Isabel's surge was higher than the previous record storm known as the Chesapeake-Potomac Hurricane of 1933. Over 2,000 people were evacuated from their homes. In Maryland alone, 472 homes and buildings were destroyed, and 3,260 had major damage. Extensive damage occurred to Maryland's shoreline, which rarely sees storms of this intensity (Source: NOAA NCEI Storm Event database). See Section 3.3.4, Hurricane, Tropical Storm, Nor'easter, for a description of the wind damage in Anne Arundel County associated with Hurricane Isabel. On September 19, 2003, a Presidential-Disaster Declaration was declared for the entire State of Maryland. In Anne

Arundel County, FEMA initially estimated damages from the storm totaled approximately $500 million

Storm Surge

Not every tropical cyclone or storm produces significant storm surge, but any storm with strong enough winds capable of pushing water onshore can create some level of storm surge. Most notable storm surges are associated with hurricanes or very powerful tropical storms. Historic occurrences of storm surge/tide as recorded within the NCEI Storm Events Database are included on Table 3.3.2-3.

Table 3.3.2-3 Storm Surge/Tide Events Anne Arundel County 1998–2024

Date	Death	Injury	Property Damage ($)
9/5/1999	0	0	0.00K
4/21/2000	0	0	0.00K
4/27/2000	0	0	0.00K
1/15/2006	0	0	25.00K
9/1/2006	0	0	0.00K

Tropical storm Isaias, August 4, 2020, is the most recent example of storm surge impacting the County. The storm surge associated with the tropical system contributed to road closures, power outages, partial EOC activation, and impacts to some assisted living facilities.

Most recently, according to the Office of Emergency Management, Tropical Storm Debby caused moderate coastal flooding and storm surge. The water level at the Annapolis Tide Gauge was 4.54 feet. The storm and associated storm surge caused road closures and resulted in an enhanced EOC activation. Reported impacted communities included Pasadena, Shadyside, Deale, and Mayo Beach Park.

In total, Anne Arundel County has experienced at least 7 reported storm surge/tide events in the last 26-year period.

Sea Level Rise

Sea level rise is an ongoing hazard which occurs gradually over time. As such, there is no event history for sea level rise. However, we know from data such as tide gauges that sea levels in Maryland have risen about a foot in the last century, which is more than twice the global average. According to Sea-Level Rise Projections for Maryland 2023, the state will have experienced a foot of sea level rise from 2000 to 2050 – up to a foot and a half by 2050. More can be expected at locations such as Annapolis and Cambridge, which are experiencing faster subsidence than other areas in the state.

3.3.2.4 Probability of Future Coastal Hazard Occurrence

Coastal Flooding

The probabilities for the most significant coastal flooding are closely related to occurrences of tropical storms and hurricanes that produce storm surge in the Chesapeake Bay. As discussed in Section 3.3.4, the average return period for all hurricanes (Categories 1 through 5) is slightly less than 50 years, and for major hurricanes (Categories 3-5) it is greater than 97 years. Because they are less severe (i.e. below a category 1 hurricane), tropical storms are by general definition more likely to occur and impact the County. Climate change will play a part in increasing the frequency and intensity of future coastal flooding events.

Table 3.3.2-4 Coastal Flood Events – 1998-2024

# Of Events	Injuries	Deaths	Damages	Frequency
75	0	0	130K	2.88

Table 3.3.2-5. Description of Significant Events in Anne Arundel County from 2019 – 2024

Event & Date	Description
October 28, 2021	A strong pressure gradient between low pressure over the Ohio Valley and strong high pressure over Quebec, CA resulted in a strong southeast onshore flow that brought the highest water levels to the Chesapeake Bay region and Tidal Potomac River since Tropical Storm Isabel in September 2003. Annapolis NOS tide gauge experienced moderate coastal flooding for four consecutive high tide cycles starting on the 28th and lasting through the 30th. Peak crest was 4.9 ft MLLW late on the 29th at 1024 PM LST. Extensive coastal flooding was observed in the city of Annapolis and the area of Shady Side with around 3.5 ft of inundation. Significant beach erosion and damage to piers and marinas were observed along the shore. The 4.9 ft crest was the 4th highest crest on record since water level records began there in 1928.
April 29, 2023	A strengthening ENE onshore flow resulted in anomalies of 1.5 ft or greater along the Potomac River shoreline of St. Mary's County resulting in moderate coastal flooding on April 28th and the 30th. Strong onshore flow up to 30 knots resulted in moderate coastal flooding at Straits Point with water anomalies of 1.5 to 2 ft above astronomical levels. A Coastal Flood Warning was issued early on the 28th with up to 17.6 hours of lead time.
December 18, 2023	A strong coastal 984 mb low pressure system caused fresh water and coastal flooding to areas along and east of I-95. 2 to 4 inches of rain were reported across the region causing moderate freshwater flooding across the area and raised water levels up to 2 ft above ground causing moderate coastal flooding at Annapolis and Straits Point. This system also set new record low pressure readings across the Carolinas and produced storm to hurricane force winds offshore. A strong coastal low-pressure system raised water levels 1 to 2 ft above normal causing moderate coastal flooding at the City of Annapolis MD. The Annapolis National Ocean Service (NOS) station crested at 3.44' at 812 AM EST on Dec 18th 2023. Lead time for this event was only 0.4 hours. Gusty NE winds prevented higher water levels than points farther south.
January 9, 2024	A strong area of low pressure tracked from the mid Mississipi River Valley on Jan 9th to the Northeast U.S. Jan 10th. A very strong pressure gradient ahead of the low-pressure center resulted in a long period of strong southerly winds gusting up to 55 mph that raised water levels to major levels at several locations along the western shore of the Chesapeake Bay. The Annapolis National Ocean Service (NOS) tide gauge crested at 5.1' MLLW (3.7' MHHW) at 224 AM EST on Jan 10th which was just above the major flood threshold of 5' MLLW. This was the third highest crest on record at Annapolis only surpassed by the surge from TS Isabel in 2003 and the Chesapeake - Potomac hurricane of 1933. There were many reports of coastal flooding throughout the County. The City of Annapolis declared a state of emergency as flood damage shut down many businesses. This opened up grant funding for small businesses and non-profits that were impacted by the severe flooding. The Annapolis Maritime Museum took 18

Table 3.3.2-5. Description of Significant Events in Anne Arundel County from 2019 – 2024

Event & Date	Description
	inches of water into their building. The museum remained closed until Feb 3 after a three-week recovery period. The Storm Brother's Ice Cream Factory indicated that they would be closed a month or two and damage cost around $60k. Lead time for this event was 22.7 hours.

Storm Surge

In total, Anne Arundel County has experienced at least 7 reported storm surge/tide events in the last 26-year period. This means about 0.27 storm surge events occur annually, or roughly one storm surge event every four years.

Climate change is expected to significantly increase the severity of storm surges due to rising sea levels. This means that even a moderate storm surge event will be higher and reach further inland, thus creating more widespread flooding and damage in coastal areas. The Sea-level Rise Projections for Maryland by 2023 report provides the following example: the storm surge from Hurricane Isabel inundated about 2.2 km^2 of Baltimore, causing $29 million in damages. Assuming sea level rose roughly similar to the Current Commitments (SSP2-4.5) projections, surge from a storm with a similar track would inundate 5.1 km^2 in 2050 and 9.2 km^2 in 2100, causing damages of $100 million and $150 million in 2003 dollars, respectively.

Sea Level Rise

As indicated in Table 3.3.2-1, sea level in Maryland is expected to rise 1.6 feet by 2050. This is similar to projections from the Sea-Level Rise Projections for Maryland 2023 which indicate 1 to 1.5 foot of sea level rise is very likely by 2050.

3.3.2.5 Coastal Hazard Risk Assessment

According to the 2021 State of Maryland Hazard Mitigation Plan, Anne Arundel County is considered high risk for coastal hazards. Coastal areas assessed as having the highest risk to coastal hazards include Anne Arundel, Baltimore, Calvert, Charles, Dorchester, Prince George's, Queen Anne's, St. Mary's, Somerset, and Worcester counties, as well as the City of Baltimore, City of Annapolis, and Ocean City. Loss estimations indicate that Anne Arundel, Baltimore, and Prince George's counties as well as the City of Baltimore have the highest critical facility building value and content losses.

The County's 2025 HMP update also considers coastal hazards as high risk, particularly with the inclusion of sea level rise as a sub-hazard. The high-risk rating is based upon geographic location, total past occurrences, probability of future occurrences, and impacts to people, structures, systems, and resources. Low-lying coastal areas are especially at risk, particularly in Region 9. Impacts to people, structures, systems, and resources are further identified in section 3.3.2.7.

3.3.2.6 Coastal Hazard in Highland Beach

Due to its coastal location, Highland Beach is at risk of coastal flooding, storm surge, and sea level rise. However, based on the lack of recorded past occurrences, the Town is not regularly impacted by coastal hazards. Except for the shoreline (i.e., Highland Beach), most of the Town is outside the category 1 storm surge inundation area, sea level rise 1–2-foot inundation area, and the FEMA flood Zone V. Documented flooding from storm surge events in Highland Beach are presented in Appendix G.

This is not to say that the Town will not experience coastal hazard impacts moving forward, but in the context of other areas in the County, such as communities in low-lying coastal communities in Region 9, the overall vulnerability to coastal hazards is moderate in Highland Beach. The Sea Level Rise Strategic Plan Update recommends that Highland Beach, among other communities, undergo additional planning and analysis to determine increased coastal hazard risk due to climate change and sea level rise.

3.3.2.7 Impacts to People, Structures, Systems, and Resources

Coastal hazard events impact people, structures, systems, and other resources in many ways. These impacts have been described in this section primarily through historical event narratives for the County. The following sections highlight the most likely impacts the County and its communities will face based on previously observed impacts combined with forecasting for future conditions such as climate change and sea level rise.

People

Persons and property located near the coast of the Chesapeake Bay are most vulnerable to coastal hazards such as flooding or storm surge in the County. Loss of life and property, reduced recreation opportunities, loss of environmental quality, and alteration of traditional coastal uses are just a few of the detrimental impacts of shoreline erosion and coastal flooding. Major flooding can cause multiple deaths, completely shut down critical facilities and businesses.

Coastal flooding usually occurs with some warning. The greatest impact would be in those areas of the County that are adjacent to the Chesapeake Bay. Since many of the County's residents live near the shore, there is the potential for considerable loss of human life, and the economic effects may be widespread. According to the NCEI there have been no injuries or deaths from coastal flooding in Anne Arundel County. For Anne Arundel County, approximately $2.1 million has been reported in property damages related to this hazard, although the figure is likely much greater because the NCEI database is based on open sources of information that are not always reliable.

Coastal Hazards
The Public's Perspective

A survey conducted during the 2025 plan update asked County residents their level of concern for hazards identified in the plan.

46.75% of respondents indicated that they are "very concerned" with this hazard. Another 19.48% indicate they are "concerned". This hazard, specifically coastal flooding, is the number one (1) hazard of most concern.

79.33% of respondents indicated that they have seen an "increase" in the frequency or intensity of coastal hazards including coastal flooding over the last 10 years.

31.78% of respondents indicate that a coastal hazard event such as coastal flooding has caused damage to their residential or commercial property.

The Sea Level Rise Strategic Plan Update identified the total acreage of flood extent under three different SLR scenarios for each community in all of the County's region planning areas. These results are included in Figure 3.3.2-2.

Figure 3.3.2-2 Flood Extents in County Communities for each SLR Scenario

Source: Sea Level Rise Strategic Plan Update, 2023

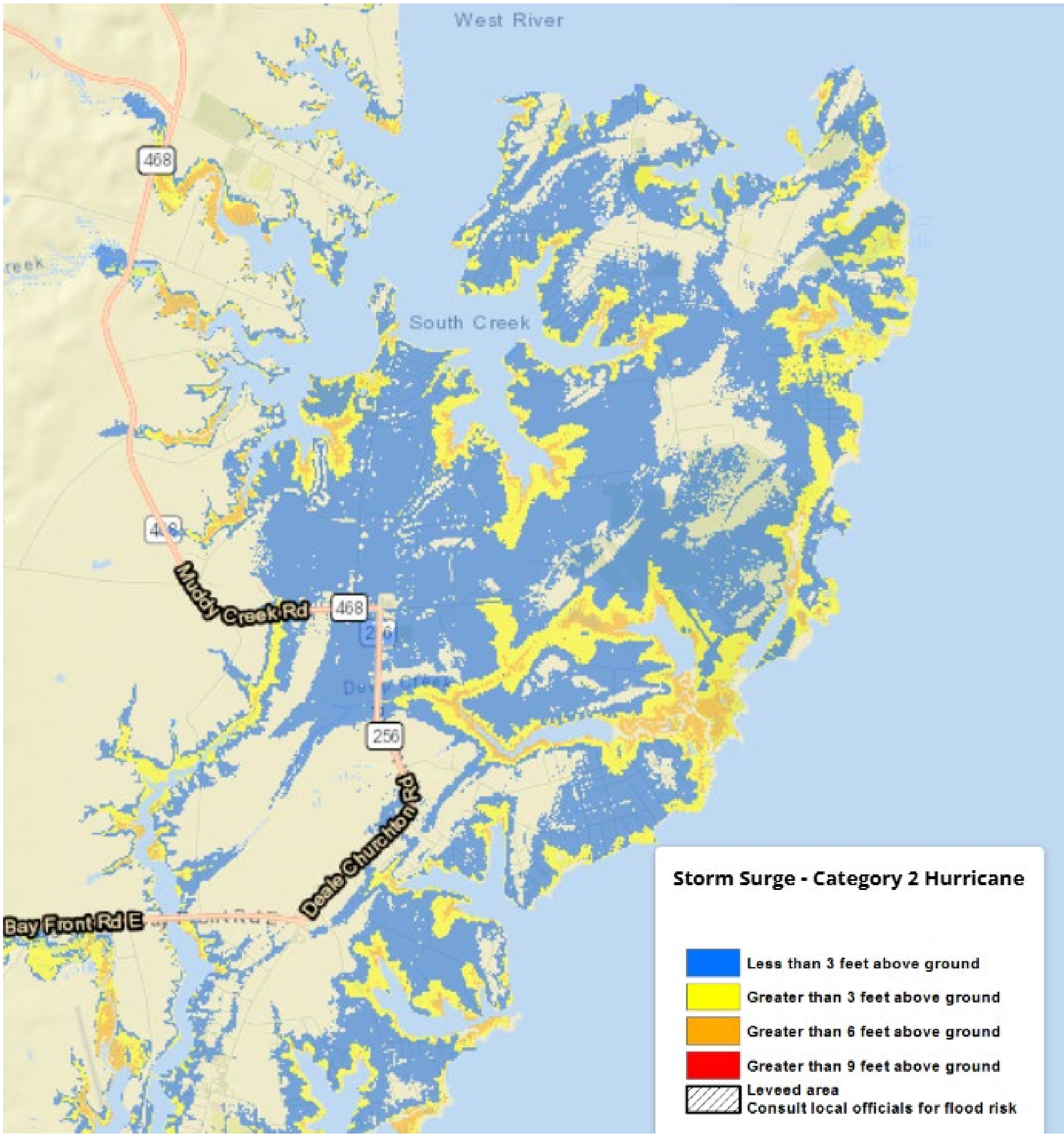
REGION PLANNING AREA	COMMUNITY	Acreage of Flood Extent		
		2050 SLR Scenario	2065 SLR Scenario	2100 SLR Scenario
9	**MAYO**	**32.88**	**79.47**	**497.55**
	SHADY SIDE	20.81	62.87	465.03
	CHURCHTON	11.99	42.18	390.62
	GALESVILLE	14.58	53.87	228.88
	DEALE	15.13	39.36	268.32
	WEST RIVER	8.19	29.49	164.27
	TRACYS LANDING	7.09	19.52	124.05
	EDGEWATER	12.47	28.45	109.36
	NORTH BEACH	1.73	15.69	61.15
	FRIENDSHIP	0.17	0.35	4.06
4	**PASADENA**	**68.02**	**145.73**	**598.43**
	BROADNECK	23.36	66.63	358.38
	SEVERNA PARK	15.91	37.10	128.33
	ARNOLD	11.62	25.97	101.85
	GIBSON ISLAND	8.28	28.36	82.16
	CAPE ST CLARE	10.54	22.48	69.30
	MILLERSVILLE	3.97	9.12	33.89
7	**ANNAPOLIS NECK**	**38.27**	**77.25**	**328.43**
	BAY RIDGE	8.39	28.11	144.10
	ANNAPOLIS	10.59	23.75	87.29
	RIVA	3.48	7.48	24.82
	HIGHLAND BEACH	0.3	1.62	6.40
6	CROWNSVILLE	20.34	57.10	221.04
8	DAVIDSONVILLE	10.9	29.08	100.01
1,3	GLEN BURNIE	23.31	43.55	124.96
	CURTIS BAY	11.79	25.04	92.19
	FERNDALE	0.00	0.00	0.16
3	SEVERN	0.00	0.00	0.40

Region 9 has the most communities and land in acres impacted, but other regions and communities are facing threats of flooding from sea level rise. The top communities for all regions in order of most impacted to least impacted include Mayo (9), Pasadena (4), Annapolis Neck (7), Crownsville (6), Davidsonville (8), Glen Burnie (1), and Severn (3).

The most impacted area in the County to coastal hazards is Region 9, particularly the Mayo Peninsula and the Deale Shady Side Peninsula. Region 9 overall is rural in nature and the population density is largely 100 to 499 people per square mile. The Mayo Peninsula has a population density of about 1,000 to 4,999 people per square mile. However, some areas have a higher density with 5,000 to 9,999 people per square mile. At its peak, some parts of the Mayo peninsula had population densities greater than 10,000. The Deale Shady Side peninsula also has a higher population density, with some communities having 1,000 to 4,999 people per square mile. Higher population densities in hazard areas mean more people can be negatively impacted by coastal hazards. Population centers of high density also typically have more development, including public services and infrastructure.

In addition to sea level rise, people in the Deale Shady Side Peninsula are at a higher risk of impacts from storm surge due to the geographic extent of inundation areas throughout the peninsula. Figure 3.3.2-3 depicts category 2 storm surge inundation area for the peninsula. As shown, this hazard impacts nearly all the peninsula. Communities of people with higher population densities would be most affected by coastal hazards such as storm surge. It is important to note that in addition to storm surge, the peninsula is also impacted by coastal flooding and is within sea level rise inundation areas.

Figure 3.3.2-3 Deale Shady Side Peninsula – Storm Surge
Source: NOAA Coastal Flood Exposure Mapper



Social Vulnerability

Social vulnerability refers to the demographic and socioeconomic factors (such as poverty, lack of access to transportation, and crowded housing) that adversely affect communities that encounter hazards and other community-level stressors. These stressors can include natural or human-caused disasters (such as tornadoes or chemical spills) or disease outbreaks (such as COVID-19).

To determine social vulnerability and sea level rise vulnerability, Hazus analysis was conducted along the Region 9 coastline that considered areas of higher social vulnerability (CDC Social Vulnerability Index 2022) and the 2050 sea level rise projection scenario plus the 1 percent annual chance flood scenario. Coastal areas where these conditions meet were mapped along with at-risk residential and commercial structures. Loss estimates are included for each vulnerable location.

Areas of highest social vulnerability and sea level rise vulnerability include:

1. Woodland Beach, Oak Bluff (Census Tract 70103)
2. Selby-on-the-Bay (Census Tract 701202)
3. Pine Whiff Beach (Census Tract 701104)

Woodland Beach, Oak Bluff

A total of 241 at-risk structures are within the 2050 sea level rise projection plus the 1% annual chance flood scenario study area and the CDC Social Vulnerability Index low-medium level of vulnerability (census tract 701103). The table below provides the number of structures per occupancy type. This location and structures are shown on Map 3.3.2-1.

Table 3.3.2-6 Region 9 At-Risk Structures Occupancy Types in Low-Medium Overall Social Vulnerability

General Occupancy	Hazus Specific Occupancy Type	# of At-Risk Structures
COM - Commercial	COM2-Wholesale Trade	1
RES - Residential	RES1-Single Family Dwelling	240
	Total	**241**

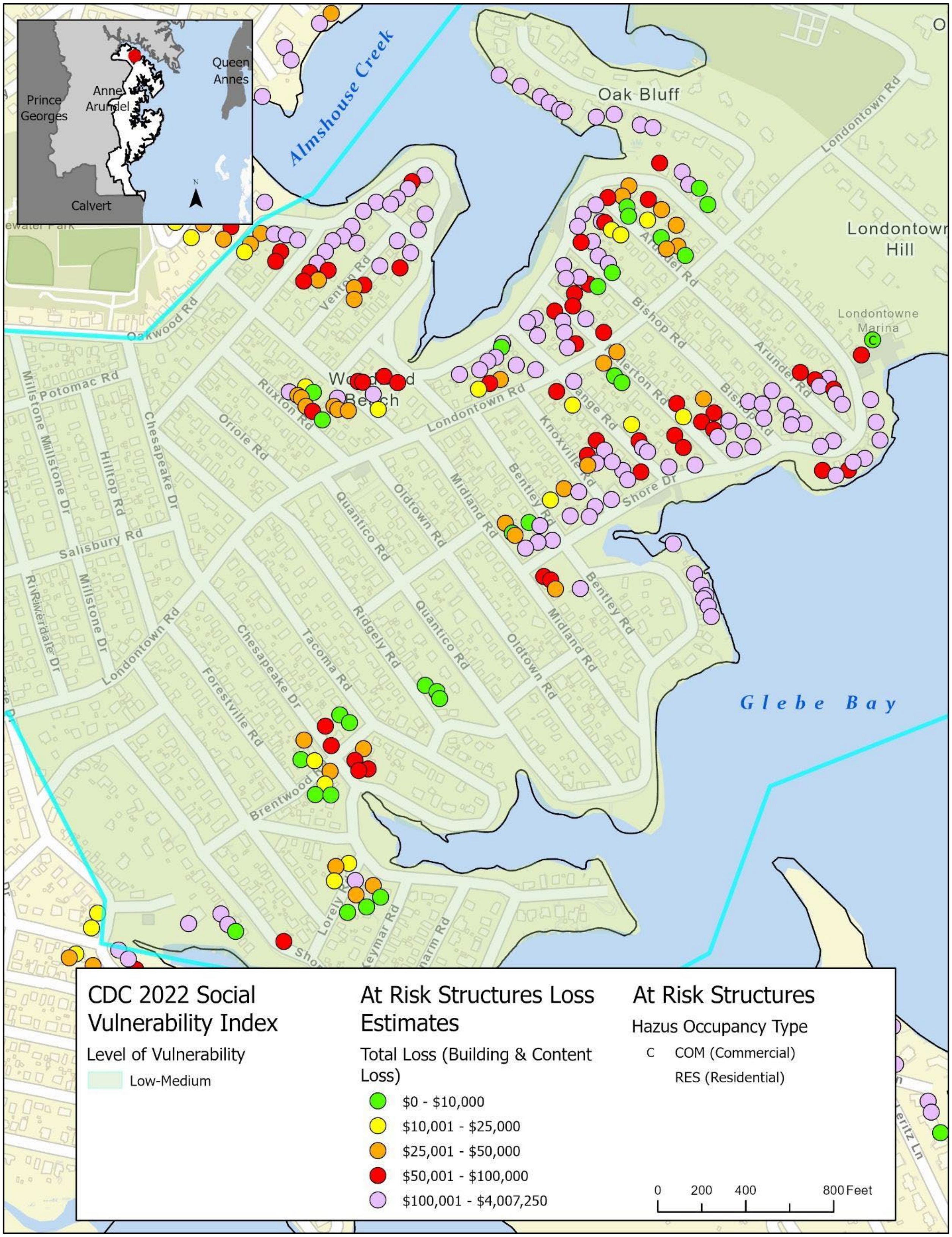
Building and content loss using 2050 sea level rise projection plus the 1% annual chance flood scenario for the low-medium level of vulnerability area (census tract 701103) total is $36,345,790. The total loss estimation is comprised of building loss and content loss by occupancy type on the table and map, below.

Table 3.3.2-7 Region 9 At-Risk Structures Loss Estimations

General Occupancy	Hazus Specific Occupancy Type	Building Loss	Contents Loss	Inventory Loss	Total Loss
COM - Commercial	COM2-Wholesale Trade	$0	$0	$0	$0
RES - Residential	RES1-Single Family Dwelling	$24,259,166	$12,086,624	$0	$36,345,790
	Total	**$24,259,166**	**$12,086,624**	**$0**	**$36,345,790**

Note: Structural and content loss are dependent upon foundation type and/or the First Flood Elevations (FFE). Therefore, structures exposed to the minimum flood depths may have content loss only or both structural or content loss or neither.

Map 3.3.2-1 Woodland Beach, Oak Bluff (Census Tract 70103) At-Risk Structures



Selby-on-the-Bay

A total of 588 at-risk structures are within the 2050 sea level rise projection plus the 1% annual chance flood scenario study area and the CDC Social Vulnerability Index low-medium level of vulnerability (census tract 701202). The table below provides the number of structures per occupancy type. This location and structures are shown on Map 3.3.2-2.

Table 3.3.2-8 Region 9 At-Risk Structures Occupancy Types

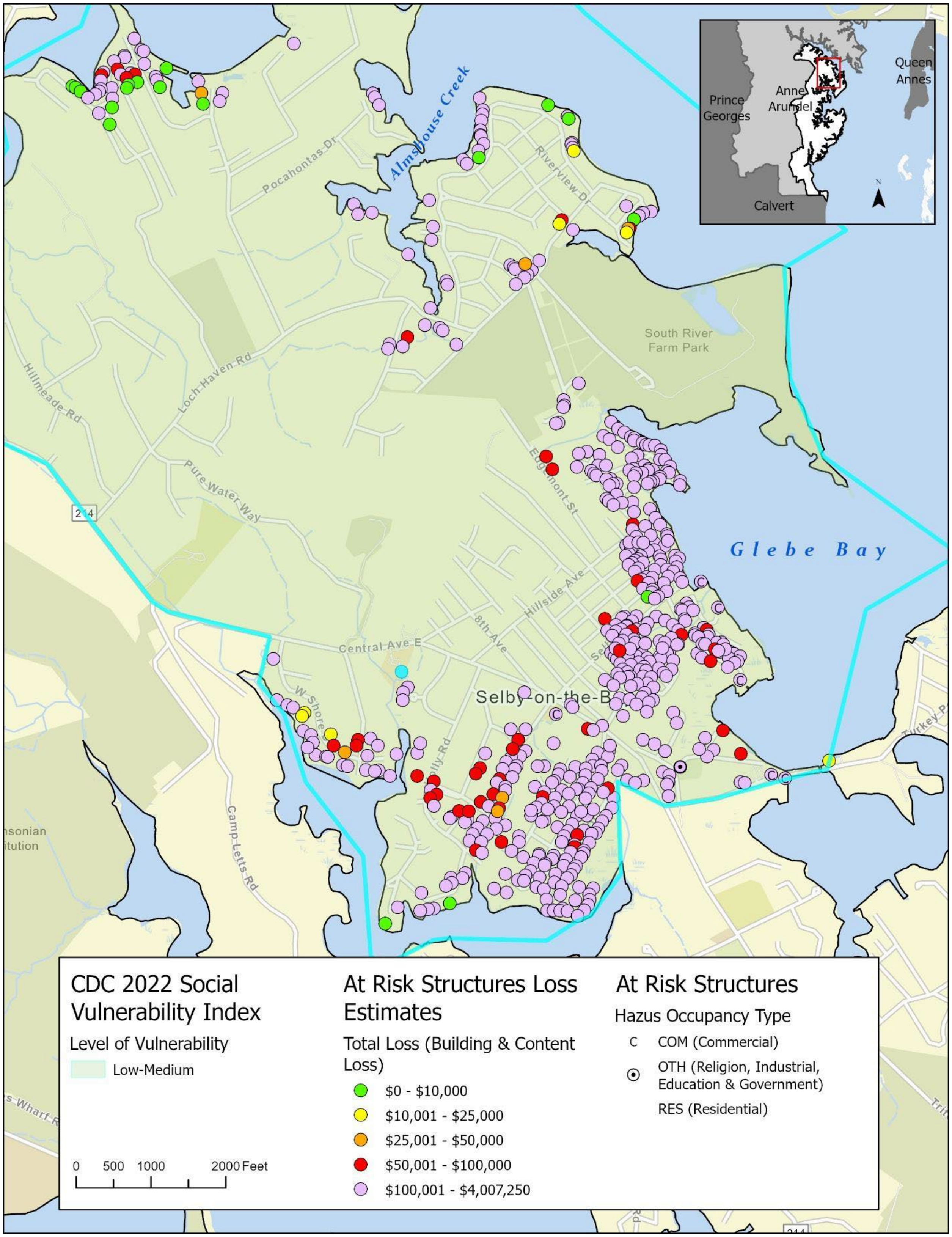
General Occupancy	Hazus Specific Occupancy Type	# of At-Risk Structures
COM - Commercial	COM1-Retail Trade	1
	COM2-Wholesale Trade	2
	COM4-Professional/Technical Services	2
	COM8-Entertainment & Recreation	1
OTH - Other	EDU1-Grade Schools	1
RES - Residential	RES1-Single Family Dwelling	580
	RES3D-Multi-dwellings (10 to 19 units)	1
	Total	**588**

Building and content loss using 2050 sea level rise projection plus the 1% annual chance flood scenario for the low-medium level of vulnerability area (census tract 701202) total is $161,556,548. The total loss estimation is comprised of building loss and content loss by occupancy type on the table and map, below.

Table 3.3.2-9 Region 9 At-Risk Structures Loss Estimations

General Occupancy	Hazus Specific Occupancy Type	Building Loss	Contents Loss	Inventory Loss	Total Loss
COM - Commercial	COM1-Retail Trade	$86,293	$332,068	$517,648	$936,009
	COM2-Wholesale Trade	$226,076	$527,298	$273,142	$1,026,516
	COM4-Professional/Technical Services	$404,512	$485,764	$0	$890,276
	COM8-Entertainment & Recreation	$55,471	$86,157	$0	$141,628
OTH - Other	EDU1-Grade Schools	$86,512	$572,336	$0	$658,848
RES - Residential	RES1-Single Family Dwelling	$104,637,751	$52,220,044	$0	$156,857,795
	RES3D-Multi-dwellings (10 to 19 units)	$637,095	$408,381	$0	$1,045,476
	Total	**$106,133,710**	**$54,632,048**	**$790,790**	**$161,556,548**

Map 3.3.2-2 Selby-on-the-Bay (Census Tract 701202) At-Risk Structures



Pine Whiff Beach

A total of 51 at-risk structures are within the 2050 sea level rise projection plus the 1% annual chance flood scenario study area and the CDC Social Vulnerability Index low-medium level of vulnerability (census tract 701104). The table below provides the number of structures per occupancy type. This location and structures are shown on Map 3.3.2-3.

Table 3.3.2-10 Region 9 At-Risk Structures Occupancy Types

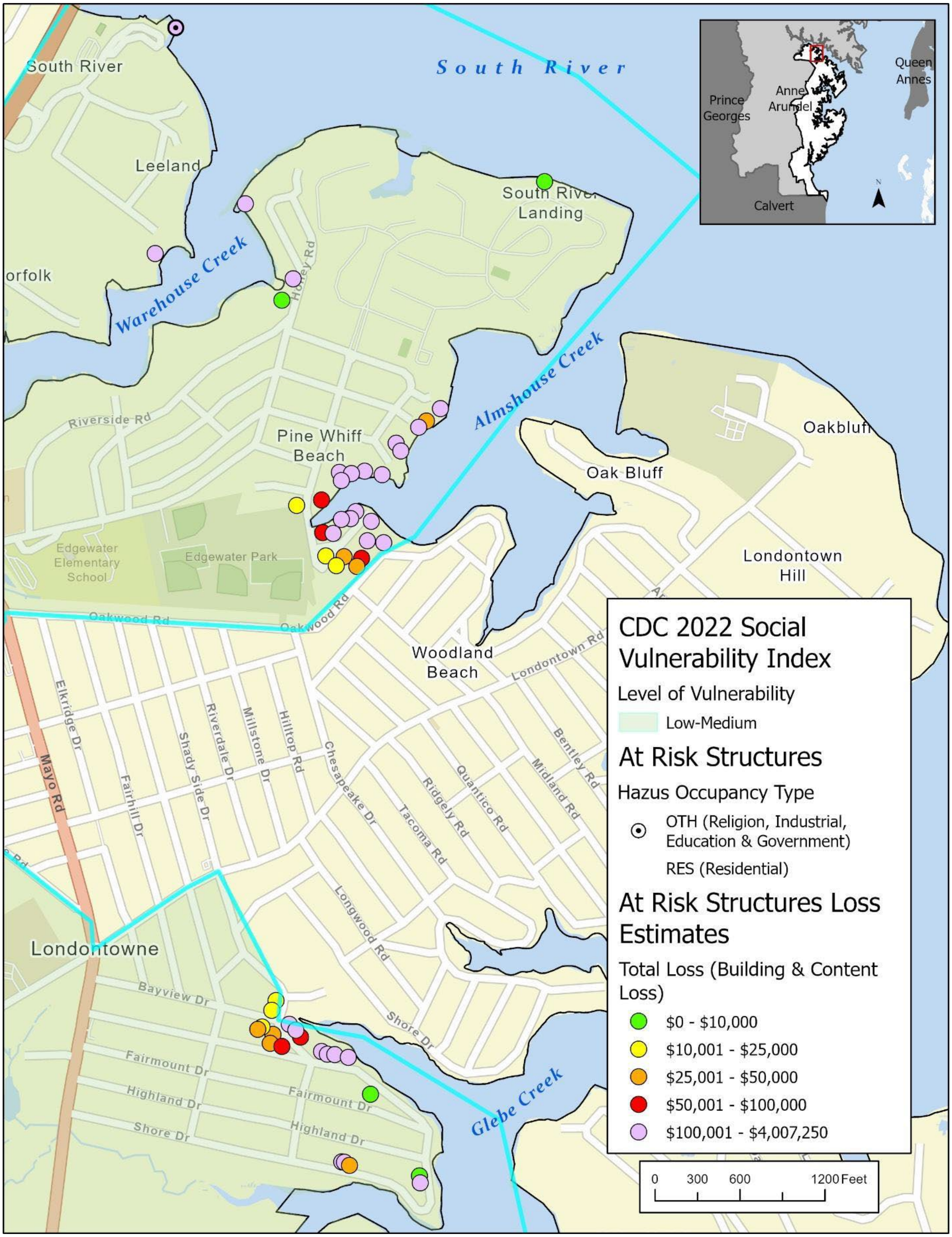
General Occupancy	Hazus Specific Occupancy Type	# of At-Risk Structures
OTH - Other	IND2-Light	1
RES - Residential	RES1-Single Family Dwelling	50
	Total	**51**

Building and content loss using 2050 sea level rise projection plus the 1% annual chance flood scenario for the low-medium level of vulnerability area (census tract 701104) total is $11,933,148. The total loss estimation is comprised of building loss and content loss by occupancy type on the table and map, below.

Table 3.3.2-11 Region 9 At-Risk Structures Loss Estimations

General Occupancy	Hazus Specific Occupancy Type	Building Loss	Contents Loss	Inventory Loss	Total Loss
OTH - Other	IND2-Light	$ 257,159	$ 746,863	$ 80,264	$1,084,286
RES - Residential	RES1-Single Family Dwelling	$ 7,256,199	$ 3,592,663	$0	$10,848,862
	Total	$7,513,358	$4,339,526	$80,264	$11,933,148

Map 3.3.2-3 Pine Whiff Beach (Census Tract 701104) At-Risk Structures



Structures

The three flood hazard zones within the coastal Special Flood Hazard Area (SFHA) are zones VE, AE, and AO. Critical facilities and community lifelines were assessed to determine which are within these coastal SFHA zones and thus more vulnerable to coastal flooding. Table 3.3.2-12 includes facilities and lifelines found to be within this hazard area.

Table 3.3.2-12 Community Lifelines Vulnerable to Coastal Flooding (Within Coastal SFHA Zones)

Community Lifeline	Facility Type	Facility Name	Address	City	SFHA	Flood Depth
Hazardous Materials	Fixed HazMat Storage Sites	Anchor Yacht Basin Acquisitions, LLC	1048 Turkey Point Road	Edgewater	Zone AE	1.7
		Atlantic Marina on the Magothy	2010 Knollview Dr	Pasadena	Zone AE	1.7
		HARBOUR COVE MARINA	5910 Vacation Lane	Deale	Zone AE	5.0
		Northrop Grumman Systems Corporation	2005 Argiro Drive	Naval Academy	Zone AE	3.2
		Selby Bay Marina	931 Selby Boulevard	Edgewater	Zone AE	4.9
		Ventnor Marina LLC	8070 Ventnor Road	Pasadena	Zone AE	2.1
Water Systems	Sewer Pump Stations	Bay Ridge # 08 SPS	17 River Dr	Annapolis	Zone AE	6.4
		Highland Beach # 02 SPS	1455 Chesapeake Ave	Annapolis	Zone AE	1.6
		Bay Ridge # 07 SPS	42 E Lake Dr	Annapolis	Zone AE	1.9
		Arundel on the Bay # 04 SPS	1319 Fishing Creek Rd	Annapolis	Zone AE	2.5
		Arundel on the Bay # 01 SPS	1337 Magnolia Ave	Annapolis	Zone AE	1.7
		Arundel on the Bay # 02 SPS	3500 Rockway Ave	Annapolis	Zone AE	2.0
		Arundel on the Bay # 03 SPS	3313 Shore Dr	Eastport	Zone VE	1.8
		River View SPS	3085 Riverview Rd	Riva	Zone AE	4.3
		Cape St John # 03 SPS	3033 Friends Rd	Annapolis	Zone AE	4.0
		Krapish SPS	3030f Old Riva Rd	Riva	Zone AE	3.9
		Little Cypress Creek SPS	271 Cypress Creek Rd	Severna Park	Zone AE	3.5
		Colchester SPS	506 Lymington Rd	Severna Park	Zone AE	4.0
		Whitehurst SPS	480 White Cedar Ln	Severna Park	Zone AE	1.6
		Round Bay # 02 SPS	106 Severn River Rd	Severna Park	Zone AE	2.7

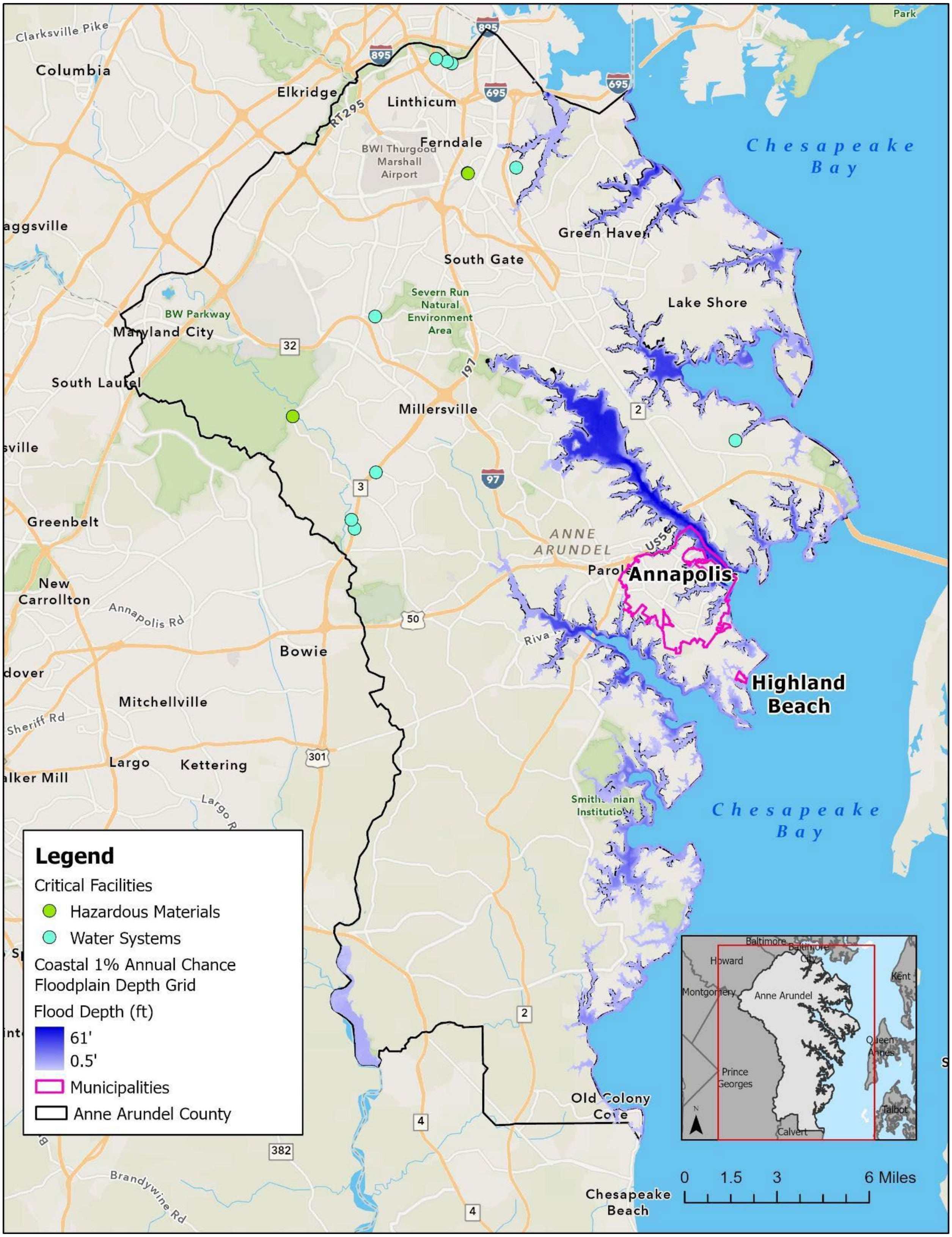
Table 3.3.2-12 Community Lifelines Vulnerable to Coastal Flooding (Within Coastal SFHA Zones)

Community Lifeline	Facility Type	Facility Name	Address	City	SFHA	Flood Depth
		Cedarhurst SPS	1187f Holly Ave	Shady Side	Zone AE	0.5
		Cape Anne SPS	5636 Battee Dr	Churchton	Zone AE	2.4
		River Club SPS	3940 W Shore Dr	Edgewater	Zone AE	0.5
		Turkey Point # 03 SPS	1267 Turkey Point Rd	Edgewater	Zone AE	1.9
		Holly Hills 1 SPS	3824 Twin Oak Dr	Edgewater	Zone AE	0.5
		Carrs Ridge # 02 SPS	3901 Rhode Harbor Rd	Edgewater	Zone AE	3.7
		Selby # 04 SPS	924 Holly Ave	Edgewater	Zone AE	1.1

Source: Anne Arundel County Office of Emergency Management 2025 Critical Facility and Community Lifeline Database

In total, 27 critical facilities and community lifelines are within the coastal SFHA. These facilities are all either fixed hazmat storage sites or sewer pump stations. On average, these facilities have a 1 percent annual chance depth of flooding of about 2.8 feet. These critical facilities and lifelines are mapped on Map 3.3.2-4, following.

Map 3.3.2-4 Community Lifelines Vulnerable to Coastal Flooding



Critical facilities and community lifelines within the hurricane storm surge inundation area (category 1- 5) were also identified. Table 3.3.2-13 includes information for facilities within storm surge inundation area, including facility type, number of facilities, and estimated improvement value.

Table 3.3.2-13 Community Lifelines Within Hurricane Storm Surge Inundation Areas

FEMA Community Lifeline	Facility Type	Number of Facilities	Estimated Improvement Value ($)
Communications	Telecommunication Tower	3	61,311,700
Food, Hydration, Shelter	Schools	7	17,323,600
	Warming & Cooling Center	1	795,500
Hazardous Materials	Fixed Hazmat Storage Site	38	131,291,700
Health and Medical	Health Center	2	8,261,600
Safety and Security	Fire & EMS	3	901,100
Transportation	Light Rail Station	1	-
Water Systems	Sewer Pump Stations	156	44,842,500
	Water Storage Tower	1	-
	WTP	1	-
	WWTP	1	-
Total:	**-**	**214**	**264,727,700**

Source: Anne Arundel County Office of Emergency Management 2025 Critical Facility and Community Lifeline Database

In total, 214 critical facilities and community lifelines are within storm surge inundation areas. Of these, 41 are within the category 1 storm surge inundation area, 69 are within category 2 storm surge inundation area, 47 are within category 3 storm surge inundation area, and 57 are within the category 4 storm surge inundation area. Those facilities within the category 1 and 2 storm surge inundation area are likely to be negatively impacted by storm surge more frequently than other facilities. However, due to the changing climate and sea level rise, it is likely that more severe storms will create greater storm surge inundation, which will impact those facilities in Category 3 and higher.

Systems

Coastal hazards such as coastal flooding, storm surge, and sea level rise significantly impact local systems by damaging infrastructure like roads, bridges, and buildings, disrupting transportation networks, impacting water supplies, affecting local economies, displacing communities, and damaging critical ecosystems that provide protection from storms, all of which can lead to significant economic and social disruption in coastal areas.

Systems vulnerable to coastal hazards would be those within coastal flood zones, storm surge inundation areas, and/or sea level rise inundation areas. Critical facilities and community lifelines within these hazard areas have been identified.

Table 3.3.2-13 includes critical facilities and community lifelines within hurricane storm surge inundation areas (category 1 through 5). Systems vulnerable to storm surge include communications (telecommunication towers), transportation (light rail station), and water systems (primarily sewer pump stations, but also water storage towers, WTP, and WWTP). These three systems have a combined estimated improvement value of $106,154,200.

In terms of roads and bridges, the Nuisance Flood Plan identifies 15 flood prone roads where flooding at high tides unrelated to a storm event has been observed. Computer modeling has identified 154 road segments that are at risk of flooding under current conditions.

In terms of sea level rise, potentially impaired roads were identified for Region 9. These roadways were assessed using three sea level rise scenarios as shown in Table 3.3.2-14.

Table 3.3.2-14 Region 9 Impaired Roads by Type (miles)

Road Type	2050 Sea Level Rise Scenario	2065 Sea Level Rise Scenario	2100 Sea Level Rise Scenario
Collector	0.51	0.64	7.24
Local	0.11	0.55	23.00
Minor Arterial	0.14	0.23	1.12
Principal Arterial	0.47	0.47	0.47
Total	**1.23**	**1.90**	**31.83**

Source: 2023 Sea Level Rise Strategic Plan Update

Under the 2050 scenario, an estimated 1.2 miles of roadway in Region 9 is expected to be impaired by sea level rise. The bulk of impaired roadway under the 2050 scenario is principal arterial.

Most of the local roads that appear vulnerable are individual segments right along the coast, and their potential inundation would not result in cutting off an entire community. Partial inundation of MD 214 could impact access to the lower end of the Mayo peninsula. There are several local roads in the communities of Arundel on the Bay, Oyster Bay, and Shady Side that could become completely inundated.

Natural, Historic, and Cultural Resources

Anne Arundel County is home to thousands of significant historic sites, archaeological sites, cemeteries, and Scenic & Historic Roads that warrant preservation. The County provides protection to these cultural resources through its Code (see Article 17-6-501 to 504). Over the centuries, human settlement has been focused on the shorelines and watersheds of the Chesapeake Bay, so hundreds of these sites are vulnerable to sea level rise. Documentation and survey efforts continuously add to the inventories of these sites. The number and type of cultural resources at risk to sea level rise are shown in Table 3.3.2-15.

Table 3.3.2-15 Cultural Resources at Risk to Coastal Hazards (Coastal flooding, Sea Level Rise)

Resource Type	2050 SLR Scenario 0-2.31 ft Inundation	2065 SLR Scenario 3.21 ft Inundation	2100 SLR Scenario 6.02 ft Inundation
Archaeological Sites	318	361	427
Historic Sites and Districts	67	71	84
Cemeteries*	10	12	23
# Scenic and Historic Roads (linear feet)	2 (91.33 ft = 0.017 miles)	4 (120.9 ft = 0.023 miles)	11 (3004.2 ft = 0.57 miles)
Total Count	**397**	**448**	**545**

Source: 2023 Sea Level Rise Strategic Plan Update
** This data count reflects only verified cemeteries. Many unverified and reportedly moved cemeteries requiring further condition assessment and evaluation are not included in this tally.*

According to the 2023 Sea Level Rise Strategic Plan Update, most archaeological sites at risk to sea level rise and storm surge are Native American, pre-contact sites, as well as early colonial and 19th century. Additionally, it should be considered that many unsurveyed areas of high archaeological potential are also endangered. By far, the majority of endangered and documented historic sites and districts are found in Region 9 and Region 4, including National Register sites like Historic Londontown, Hancock's Resolution, and Normans Retreat. Notable historic districts included Fort Smallwood, Galesville, Sherwood Forest, Gibson Island, Bay Ridge, Columbia Beach, and the Cumberstone Road Historic Area.

Vulnerable cemeteries in the County are primarily historic family cemeteries dating to the 19th century or even earlier, but the SLR flood scenarios also include a few church cemeteries (including Galesville UM Church Cemetery, St. Matthews UM Church Cemetery, and Asbury Town Neck UM Church). More than half of the cemeteries identified at risk are located in Region 9. Region 7 and Region 4 also have cemeteries at risk (although three of the cemeteries in the database should be noted as outside of County jurisdiction within the City of Annapolis – USNA Cemetery, Cedar Bluff Cemetery, and St. Anne's Cemetery).

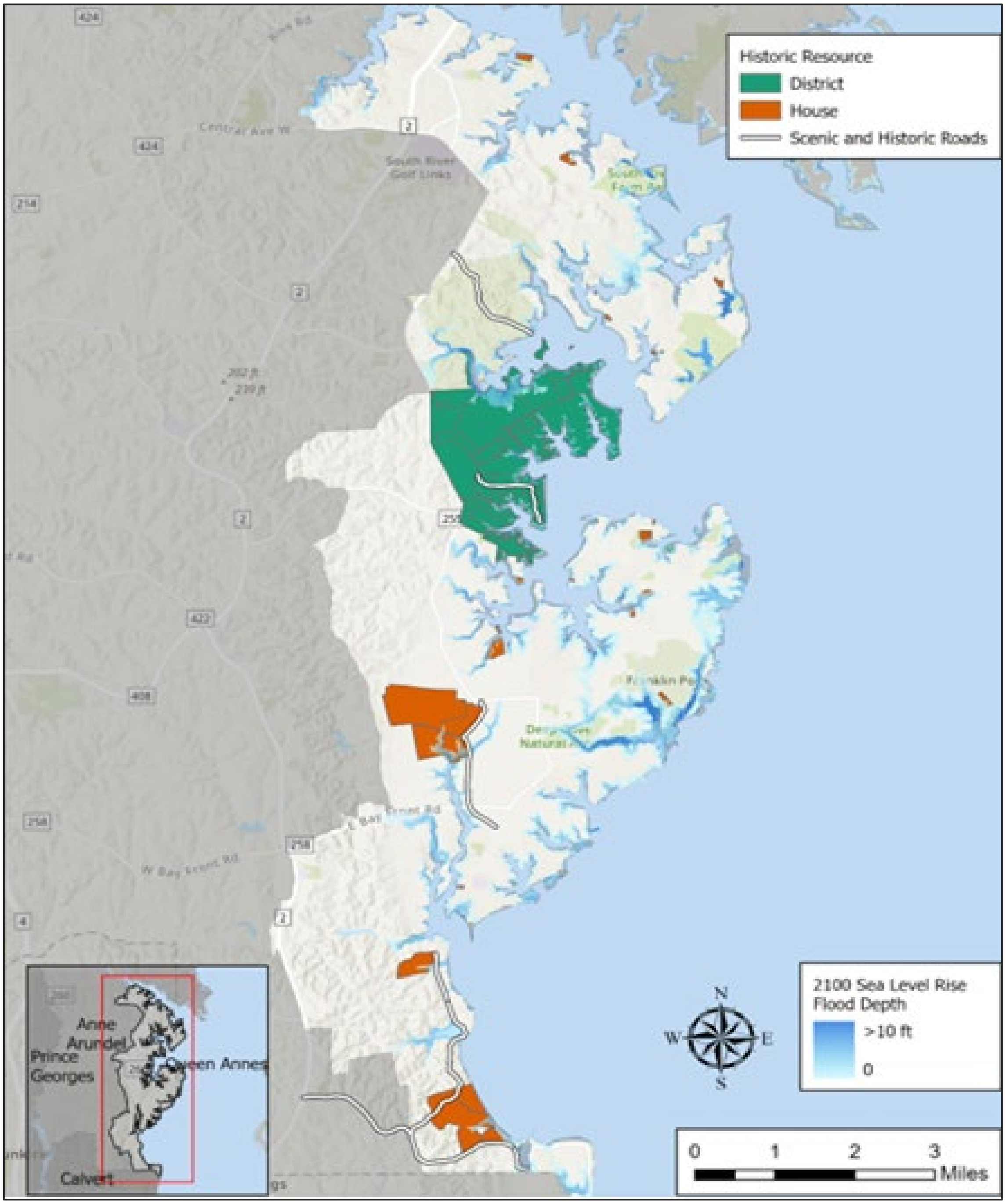
Scenic and historic roads of immediate concern were in Regions 4 and 6, but later scenarios also include Region 9. The Sea Level Rise bathtub inundation model shows only two Scenic and Historic roads being impacted by 2050:

- St. Margarets Rd. on Pleasant Plains
- Defense Hwy.

Concerns in 2065 are drawn to River Road in Region 6, with models suggesting increased flooding impacts along the edge of Round Bay in Herald Harbor. In Region 4, significant inundation may be seen by 2100 in a small residential subdivision in Severna Park on the other side of Round Bay, which contains Riverview Rd., Ridout Rd., and Round Bay Rd.

Vulnerable historic and cultural resources were further identified for Region 9, given that it is the most vulnerable region in the County to coastal hazards. Historic districts, houses, and roads have been mapped for Region 9. These are shown in Figure 3.3.2-4.

Figure 3.3.2-4 Historic & Cultural Resources in Region 9
Source: Sea Level Rise Strategic Plan Update, 2023



Community Activities

Community activities are integral to Anne Arundel County's economy and impacts to these activities due to coastal flooding may cause disruptions to the County's ability to thrive. Coastal flooding may impact systems and structures that are necessary for community activities to proceed such as road blockages and/or power system disruptions. Examples of community activities negatively impacted by coastal hazards included, but are not limited to:

- The Fish of Jug Bay Annual Citizen Science/Kayak Experience is held at the Emory Waters Nature Preserve in Lothian, MD. The event typically happens in late September and consists of participants utilizing kayaks to paddle along the marsh edges of the Patuxent River to observe wildlife and plant life. Coastal Flooding would affect this event's ability to proceed even in miniscule amounts.
- The Annual Josh Roach Memorial Golf Tournament is held at the Compass Pointe Golf Course in Pasadena, MD. The event happens at the end of September in an area susceptible to coastal flooding making it vulnerable to cancellation due to such a hazard.
- The Fall Equinox Hike offers a beginner friendly hike through the Jug Bay Wetlands Sanctuary. This event would be adversely affected by Coastal Flooding due to its location.
- The Lifeline 100 Bicycle event is an annual event that offers scenic 65- and 100-mile County tours with water views and historic sites. There is also an option for 15- and 30-mile flat, paved trail rides, and a free bike rodeo along with a family fun ride for children. The event takes place in early October and would be heavily affected by a coastal flooding hazard event.

3.3.2.8 Future Land Use and Development Trends

Coastal hazards primarily occur through storm surge associated with tropical systems, rising sea levels, and high tides. Also associated with coastal flooding is coastal erosion (Section 3.3.12) and dam failure (Section 3.3.3). Generally, tropical systems may impact any portion of Anne Arundel County, however coastal communities and development are more likely to be negatively impacted by flooding associated with storm surge, and high winds.
In Anne Arundel County, development in coastal areas in or adjacent to storm surge are most likely to be negatively impacted. As mapped, the eastern coastal areas of the County are impacted by storm surge. The County's GDP (Plan2040) Planned Land Use Map shows that dominant land use types in the coastal areas and peninsulas of the County consist of conservation, parks and open space, and residential low-density development.

The County's peninsulas are within the Peninsula Development Policy Area, while inner areas along rivers are Neighborhood Preservation Development Policy Areas. Peninsula Development Policy Areas are those where development is limited to infill and redevelopment that must be compatible with existing neighborhood character and also take into consideration salt-water intrusion and vulnerability to sea level rise.

Some portions of Neighborhood Preservation Development Policy Areas are also impacted by storm surge, although to a lesser extent. These areas are not intended for substantial growth or land use change, and development is limited to infill, accessory dwelling units, and redevelopment consistent with existing character.

The area with the greatest vulnerability to hurricane storm surge is the peninsula including Shady Side down to Deale. Nearly all of this peninsula is within the category 1 storm surge area, and much of it is within category 2 and 3 storm surge areas. Most of the existing land use in this area is residential low density, residential low-medium density, and parks and open space. There are some villages with high residential density, including Deale. Substantial new development is not prioritized in this area, and only infill and redevelopment that matches existing neighborhood character is encouraged by policy. It should also be noted that much of this area is within Growth Tier 1A, which means these areas are served by public sewer service, but are located outside of Targeted Development, Redevelopment, or Revitalization Areas.

3.3.2.9 Future Conditions

Based on the frequency of historic occurrences as well as rising sea levels, the future probability of increased coastal hazard events in Anne Arundel County is highly likely. According to the Fifth National Climate Assessment (NCA5), all coastal hazards are increasing due to accelerating sea level rise and changing storm patterns. According to the NCA5:

> *"The severity and risks of coastal hazards across the Nation are increasing (very likely, high confidence), driven by accelerating sea level rise and changing storm patterns, resulting in increased flooding, erosion, and rising groundwater tables. Over the next 30 years (2020 to 2050), coastal sea levels along the contiguous U.S. Coasts are expected to rise about 11 inches (28 cm), or as much as the observed rise over the last 100 years (likely, high confidence). In response, coastal flooding will occur 5-10 times more often by 2050 than 2020 in most locations, with damaging flooding occurring as often as disruptive "high tide flooding" does now if action is not taken (very likely, high confidence).*

Coastal impacts on people and ecosystems are increasing due to climate change. The assessment states:

> *"Climate change – driven sea level rise, among other factors, is affecting the resilience of coastal ecosystems and communities (very likely, high confidence). The impacts of climate change and human modifications to coastal landscapes, such as seawalls, levees, and urban development, are both limiting the capacity of coastal ecosystems to adapt naturally and are compounding the loss of coastal ecosystem services (very likely, high confidence). Proactive strategies are necessary to avoid degraded quality of life in the coastal zone, as the combination of reduced ecosystem services and damage to the built environment from exacerbated coastal hazards increasingly burdens communities, industries, and cultures (very likely, high confidence)."*

According to Sea-level Rise Projections for Maryland 2023, historic data collected from the Annapolis tide gauge indicates that sea level rise is anticipated to increase, but is unlikely to exceed, by 0.48 meters or 1.56 feet by 2050 ("Current Commitments" emissions scenario, 83rd percentile). Under the same emissions scenario, sea level is expected to increase, but unlikely to exceed, 1.11 meters or 3.63 feet by 2100.

Nuisance flooding is also expected to increase in Maryland's coastal communities, including Anne Arundel County. By 2050, minor nuisance flooding is expected to occur about 50 or more days per year. Table 3.3.2-16 illustrates the increased frequency of flooding events in Maryland

Future Storm Surge and Sea Level Rise

There is scientific consensus that global warming has increased the severity of tropical storms and the amount of associated rainfall. There is medium to high consensus that both will increase with 2°C of warming. Combined with increased storm intensity and severity, sea level rise will multiply the damages and threats to human life from storm surges that ride above the higher waves.

The combined effects of climate change on sea-level rise and tropical storm intensity will greatly increase flooding frequency along the U.S. Atlantic and Gulf coasts, with a once in 100-year flood level experienced at least once in a decade by the end of this century.

Source: Fifth National Climate Assessment

by 2050 under the Interagency Intermediate scenario, with relative sea-level rise of 0.39 m from 2005.

Table 3.3.2-16 Changes in Frequency of Minor, Moderate, And Major Flooding Under The Interagency Intermediate Sea-Level Rise Scenario

Flooding Threshold	Elevation above MHHW	2020	2050
Minor	0.52 m/1.70 ft	2-5 events per year	50 events per year
Moderate	0.82 m/2.69 ft	20-30% annual chance	5 events per year
Major	1.19 m/3.90 ft	2-5% annual chance	20-30% annual chance

Source: Sea-level Rise Projections for Maryland 2023

Note: Anne Arundel County is currently in the process of updating its Nuisance Flooding Plan for 2025.

3.3.2.10 Considerations for the Next Planning Cycle

Future monitoring, evaluation, and updating of this Plan should consider the following factors related to coastal hazards

- Have any coastal hazard (coastal flooding or storm surge) events occurred since this Plan was adopted?
- Has any new scientific research or methodology changed the ability to predict coastal hazards or assess risk and vulnerability?
- Has new local analysis of sea level rise or coastal flooding been conducted for planning regions in the County?
- Has there been any significant change in the population, built environment, natural environment, or economy that could affect the risk or vulnerability to coastal hazard events?
- Is there any new evidence related to the impacts of climate change that could affect the level of risk or vulnerability to these events?
- Have sea level rise predictions changed (if at all) during the planning period?

3.3.3 Dam Failure and Release

3.3.3.1 Description of the Dam Failure and Release Hazard

Per Maryland COMAR 26.17.04.02 states a Dam is defined as a any obstruction, wall, or embankment, together with its abutments and appurtenant works, if any, in, along, or across any stream, heretofore or hereafter constructed for the purpose of storing or diverting water or for creating a pool upstream of the dam, as determined by the Administration. Most dams in Maryland consist of an earthen embankment to store water and a combination of spillways designed to pass water safely around or through the facility.

Dam failures can result from a variety of causes including lack of maintenance, improper design or construction, the effects of large storms, seismic activity, and terrorism. Significant rainfall can quickly inundate an area and cause floodwater to overwhelm a reservoir. If the spillway of the dam cannot safely pass the resulting flows, water will begin flowing in areas not designed for such flows and failure may occur.

Dams are typically ranked by hazard potential classification that is determined by the infrastructure and property damage downstream if a dam failure were to occur. The three hazard potential classifications include high hazard (H), significant (S), and low (L) and are defined as follows:

- **High Hazard Dams:** Probable loss of life; major increases in existing flood levels at houses, buildings, major interstates and state roads with more than six lives in jeopardy.
- **Significant Hazard Dams:** Possible loss of life, significant increased flood risks to roads and buildings with no more than two houses or six lives in jeopardy.
- **Low Hazard Dams:** Loss of life is unlikely; minor increases to existing flood levels at road and buildings.

High and Significant Hazard dams are required to have an Emergency Action Plan (EAP), which is a formal document that describes procedures to minimize the risk of loss of life and property damage when potential emergency conditions threaten a significant and high hazard potential dam. Individuals and agencies are responsible for the execution of EAPS involving the dam owners, local government, emergency response agencies, and Maryland’s Dam Safety Program.

The dam owner is responsible for the safe operation, maintenance, and inspection of the dam and must prepare, and review annually, an EAP to conform to the law and guidelines established by the Maryland Department of the Environmental Dam Safety Program. The owner submits the EAP for review and approval by MDE. Every EAP is tailored to site specific conditions, as well as the requirements of the owner, agency or organization that operates or regulates use of the dam, and to the emergency response organizations that will respond to the emergency. Anne Arundel County maintains the EAPs for County-owned and operated dams, as identified in Table 3.3.3-1.

3.3.3.2 Location and Extent of the Dam Failure and Release Hazard

There are 557 active dams in Maryland, ranging in height from 6 feet to 296 feet in height. The majority of Maryland's dams are earth fill or earth and rock fill embankment structures. There are also several large concrete and "slab and buttress" dams such as Liberty, Prettyboy and

Brighton that provide storage for drinking water. The Maryland Department of the Environment (MDE) website[1] indicates that as of August 2024 there are:

- 107 high hazard dams
- 136 significant hazard dams
- 314 low hazard dams
- 80 inactive (breached) dams

According to MDE Inventory of Dams and the National Inventory of Dams (NIDS), there are 35 dams in Anne Arundel County – none have high hazard potential. Table 3.3.3-1 provides an inventory of all dams in the County, including the name, primary purpose, emergency action plan status, owner, and hazard potential classification.

Table 3.3.3-1 Dams in Anne Arundel County

Dam Name	Primary Purpose	Emergency Action Plan	Owner Name	Hazard Potential Classification
Aisquith Farm Dam (Breckenridge Way)	Stormwater Management	Not Required	Anne Arundel County Pace	Low
Annapolis Mall SWM Pond	Stormwater Management	Not Required	Anne Arundel County Pace	Low
Annapolis Plaza Dam, JR Plaza Pond	Stormwater Management	Not Required	JR Annapolis Plaza	Low
Annapolis Reservoir	Recreation	Yes	City of Annapolis	Significant
Anne Arundel Community College SWM Dam	Stormwater Management	Not Required	AA County DPW	Low
Burba Lake Dam	Fire Protection, Stock, Or Small Fish Pond	Yes	Fort Meade	Significant
BWI Pond B12	Flood Risk Reduction	Yes	BWI	Significant
Chartwell Country Club Dam	Irrigation	Yes	Chartwell Country Club	Significant
Cox Creek DMFC	-	Not Required	MDOT Maryland Port Administration	Low
Cristal Global Hawkins Point Plant Settling Basins	Flood Risk Reduction	Not Required	Cristal Global Hawkins Point Plant	Low
Crofton Farms Regional SWM Pond	Flood Risk Reduction	Not Required	AA County DPW	Low
Eisenhower Golf Course Dam	Irrigation	Not Required	AA County DPW	Low
Fort Meade Water Supply	Water Supply	Not Required	U.S. Army – Fort Meade	Low
Gateway Village Parole Town Center Dam	Stormwater Management	Not Required	Retail Properties of Aerica, Inc.	Low

[1] *https://mdewin64.mde.state.md.us/WSA/DamSafety/*

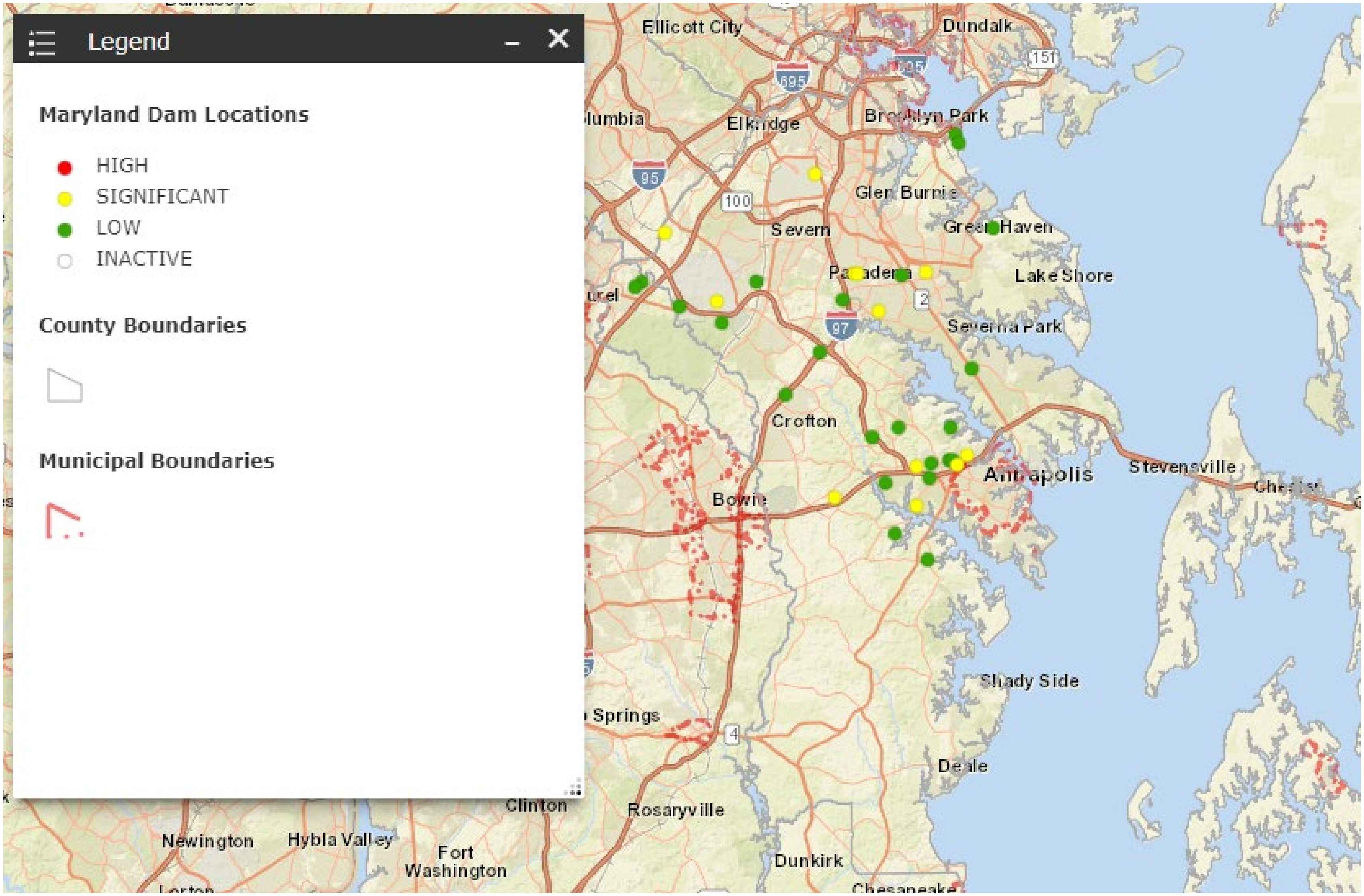
Table 3.3.3-1 Dams in Anne Arundel County

Dam Name	Primary Purpose	Emergency Action Plan	Owner Name	Hazard Potential Classification
Harry S. Truman Pkwy Park N Ride SWM Pond	Flood Risk Reduction	Yes	MD DOT State Highway Administration	Significant
Heritage Harbour (Mastline Drive)	Recreation	Not Required	Heritage Harbour Comm Assoc	Low
Jennifer Road Swm Route 50 and Route 2 (SHA BMP 020259)	Flood Risk Reduction	Yes	MD DOT State Highway Admin	Significant
Jessup Prison Dam	Recreation	Yes	MD House of Corrections	Significant
Lake Allen Dam	Recreation	Not Required	US FISH AND WILDLIFE SERVICE	Low
Lake Median	Other	Not Required	MD DOT State Highway Admin	Low
Lake of The Pines (Tarnans Branch Crossing)	Recreation	Yes	AA County DPW	Significant
Lake Waterford Dam	Water Supply	Yes	Anne Arundel Co-Lake Waterford Park	Significant
Millersville Post Office Dam	Stormwater Management	Not Required	-	Low
Park Retreat Swm Pond	Flood Risk Reduction	Not Required	Anne Arundel County	Low
Riva Trace Community Pond	Irrigation	Yes	Riva Trace Council Inc.	Significant
Rock Creek Dredge Disposal	Flood Control	Not Required	AA County DPW	Low
Route 97 SHA BMP	Stormwater Management	Not Required	MD DOT State Highway Admin	Low
Russett Center Lower Dam / Pond #1	Flood Risk Reduction	Not Required	AA County DPW	Low
Russett Center Upper Dam / Pond #2 (Ridgemere Crossing)	-	Not Required	AA County DPW	Low
Saefern Dam	Recreation	Not Required	Saefern Saddle and Yacht Club	Low
Seven Oaks Swm Dam	Flood Risk Reduction	Not Required	AA County DPW	Low
Shipleys Crossing North Dam 1 (Galiot Dr)	Flood Risk Reduction	Yes	Shipleys Crossing Homeowner Association	Significant
Shipleys Crossing North Dam 2 (Wherry Ct)	Flood Risk Reduction	Yes	Shipleys Crossing Homeowner Association	Significant

Table 3.3.3-1 Dams in Anne Arundel County

Dam Name	Primary Purpose	Emergency Action Plan	Owner Name	Hazard Potential Classification
South River Colony Parcel A Swm Lake	Flood Risk Reduction	Not Required	AA County DPW	Low
Windgate Swm Dam 3 (Burtons Cove Way)	-	Yes	Windgate Condominium Board of Directors	Significant

Figure 3.3.3-1 Locations of Dams in Anne Arundel County
(Source: Maryland Dam Inventory, [MDE Dam Safety])



3.3.3.3 Past Occurrences

According to damsafety.org, hundreds of dam failures have occurred throughout U.S. history. These failures have caused immense property and environmental damage and have taken thousands of lives. As the nation's dams age and population increases, the potential for deadly dam failures grows. Anne Arundel County does not have a significant history of dam failures, but the risk of a dam failure is not non-existent. According to the National Performance of Dams Program, which maintains a database of failures for all dams listed in the National Inventory of Dams, 34 dam-related incidents have occurred in the entire state of Maryland since 1929. **One** of these events occurred in Anne Arundel County, at the Annapolis Mall SWM Pond on March 4, 1993. The dam incident description is as follows:

"The complete failure of the dam was likely due to piping of embankment fill from along the large, corrugated steel pipe spillway conduit. The dam was about one year old when the pipe collapsed during a storm when the pool reached a level of about the 10-year flood. The dam has been rebuilt with concrete pressure pipe spillway. Reservoir status: Drained. Minor damage occurred to a roadway below the dam, and there was significant environmental damage to the tidal wetlands below it. This is a low hazard dam."

3.3.3.4 Probability of Future Dam Failure and Release Events

The 2012 and 2018 County HMPs indicated there had been no failures of high hazard dams over the past 30 years (according to the Maryland Department of the Environment). A thorough search of open sources for the 2025 HMP update showed this is still the case, that there have been no recent dam failures in Anne Arundel County since the failure of a low hazard potential dam in 1993.

Based on the very low number of past dam failures in the County, the probability of future failures is also considered very low. However, changes in climate change and increasing storm events may be more problematic for low hazard dams because they are designed for smaller storms that are becoming more frequent.

Provided that adequate engineering and maintenance measures are in place, dam failures are unlikely in the County. The presence of structural integrity and inspection programs significantly reduces the potential for major dam failure events to occur. However, there are 3 significant hazard potential dams identified on Table 3.3.3-1 that are over fifty years old since they were completed. These dams include Burba Lake, Annapolis Reservoir, and Lake Waterford Dam. Because of their age and possible worsened climate-influenced storms, in time the dams may need retrofitting work. For example, spillways may need to be enlarged to account for higher intensity rainfall, aging components need to be replaced, and encroaching trees need to be removed from spillway areas and groin areas.

3.3.3.5 Dam Failure and Release Risk Assessment

Dam Failure was ranked as a "Low" risk hazard for the County during the 2025 plan update. The State Hazard Mitigation Plan ranks dam failure as "Medium" risk for Anne Arundel County.

According to FEMA, dams can fail for several reasons, including overtopping caused by floods, acts of sabotage, upstream dam failure (i.e., the failure of another nearby dam), structural failure of materials used in dam construction, or earthquakes. FEMA acknowledges three primary types of risk associated with high hazard potential dams, which include the following:

Incremental Risk: The risk (likelihood and consequences) to the pool area and downstream floodplain occupants that can be attributed to the presence of the dam should the dam breach prior or after overtopping, or undergo component malfunction or misoperation, where the consequences considered are over and above those that would occur without dam breach. The consequences typically are due to downstream inundation, but loss of the pool can result in significant consequences in the pool area upstream of the dam.

Non-Breach Risk: The risk in the reservoir pool area and affected downstream floodplain due to ‘normal’ dam operation of the dam (e.g., large spillway flows within the design capacity that exceed channel capacity) or ‘overtopping of the dam without breaching’ scenarios.

Residual Risk: The risk that remains after all mitigation actions and risk reduction actions have been completed. With respect to dams, FEMA defines residual risk as “risk remaining at any time” (FEMA, 2015, p A-2). It is the risk that remains after decisions related to a specific dam safety issue are made and prudent actions have been taken to address the risk. It is the remote risk associated with a condition that was judged to not be a credible dam safety issue.

To prevent or reduce the probability of a failure, professional engineers periodically inspect existing dams. The State of Maryland has been assuring the safety of dams since 1934 through a permit and inspection program. Maryland Department of the Environment’s (MDE) Dam Safety Program ensures all dams in Maryland are designed, constructed, operated and maintained safely to prevent dam failures and the consequences of failure. MDE’s responsibilities include conducting inspections of dams based on their hazard classification issuing permits for construction, repairs or for modifying dam structures; conducting construction inspections and working with dam owners and emergency management professionals to develop and exercise Emergency Action Plans to be used in the event of dam failure (Source: MDE – Dam Safety Program).

Periodic safety inspections are performed through MDE’s Dam Safety Program. High hazard dams are inspected every year. Significant hazard dams are inspected every three years. Low hazard dams are inspected every five to seven years. Dam owners are also expected to informally inspect their dam on an annual basis and before/after significant storm events.

3.3.3.6 Dam Failure and Release in Highland Beach

There are no dams in or near Highland Beach, and thus no risk of dam failure hazard. Potential impacts are negligible.

3.3.3.7 Impact to People, Structures, Systems, and Resources

Dam failure and release has the potential to impact people, structures, systems, natural, historic & cultural resources, and community activities in Anne Arundel County. The following sections examine the vulnerability of, and likely impacts to, these systems based on previously observed impacts (i.e., none) combined with forecasting for future conditions.

People

When a dam fails it causes cascading effects such as flooding downstream that can cause death, injury, and illnesses relating to water-borne diseases and standing water. As a result of flooding, people might have to evacuate and be displaced from their homes.

People are more vulnerable to dam failure in Anne Arundel County if they are within the inundation area for any dam. However, those persons and property most vulnerable to dam failure are those within the inundation area of adjacent high hazard potential dams: Liberty Dam and T. Howard Duckett Dam.

According to the EAP completed for Duckett Dam, a major flood caused by a sudden breach of this dam would impact homes and businesses, highways, bridges and wastewater treatment facilities. In terms of Anne Arundel County, the following communities could be impacted by flooding caused by the failure of this dam: Maryland City (pop. ~18,669), Odenton (pop. ~45,585), Crofton (pop. ~29,878), and Davidsonville (pop. 8,744).

Duckett Dam is currently in the process of receiving improvements to address the vulnerability highlighted during a dam safety evaluation. The dam is being fortified with additional concrete walls along each side to hold back potential flood waters – the walls will be 10 feet high at the da m and slowly taper to 6 feet high as the wall moves inland on both sides. This project has been ongoing since May 2012. More information is available from WSSC Water.

Liberty Dam. Source: Liberty Dam Emergency Action Plan.

According to the EAP completed for Liberty Dam, a major flood caused by the sudden breach of this dam would impact over 2,300 homes, 180 businesses, and 16 major roadways. The total population at risk to a dam failure is 9,185 people, of which 1,286 are aged 65 and up, and 166 are a vulnerable population. In terms of Anne Arundel County, about 25.37 miles of roadway are at risk, or about 0.85% of total roads.

Parts of Pumphrey are within the inundation area for Liberty Dam. The estimated number of people at risk due to inundation caused by the Liberty Dam at Pumphrey is 5,317. Upon examining all the census tracts that are within the inundation area for Liberty Dam, including Pumphrey, it is estimated that about 18,797 people are potentially at risk from inundation caused by dam failure.

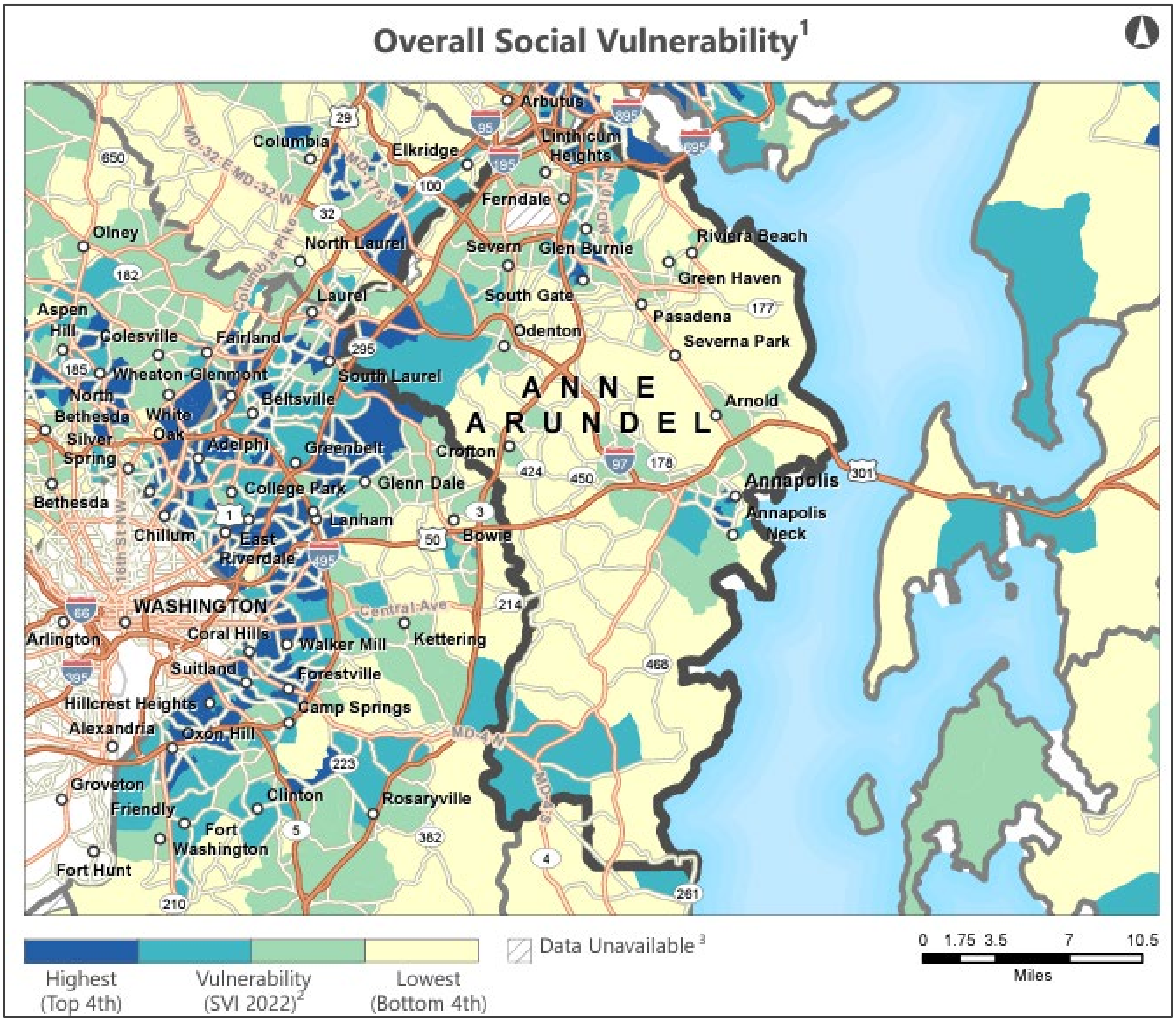
For both HHPDs, the specific risk to life and property including potentially impacted properties, distance downstream from the dam, and estimated time of travel are included within each EAP. This risk is monitored by the owners and operators of each dam through sensors and other monitoring devices and systems. In the event of a dam failure, emergency procedures and required actions to warn and evacuate the at-risk population are undertaken with local government, emergency management and public safety officials, and Maryland's Dams Safety program. In the event of an imminent failure and a failure of the dam owner to take necessary action, Maryland law allows Maryland Department of Environment (MDE) to take charge of a dam to protect life and property.

The Office of Emergency Management (OEM) will participate in workshops and other training and exercise events with HHPDs and other dams that impact Anne Arundel County. OEM will coordinate with other local jurisdictions and Maryland's Dam Safety Program to address any deficiencies of HHPDs on Anne Arundel County.

Finally, socially vulnerable groups, as depicted in Figure 3.3.3-2, tend to have greater exposure to hazards, therefore are disproportionately impacted. Census tracts with overall high social vulnerability in the County (as per the CDC's Social Vulnerability Index) include:

- West – near Maryland City
- North – near Pumphrey
- North – near Arbordale and Woods Edge

Figure 3.3.3-2 Overall Social Vulnerability in Anne Arundel County
(Source: CDC Social Vulnerability Index, 2022)



Parts of Pumphrey are within the inundation area for Liberty Dam. Parts of Maryland City and surrounding areas are within the inundation area for Duckett Dam.

Dam Failure and Release
The Public's Perspective

A survey conducted during the 2025 plan update asked County residents their level of concern for hazards identified in the plan.

45.89% of respondents indicated that they are "not concerned" with dam failure. Only 3.2% of respondents were "very concerned".

91.97% of respondents indicated that they have seen "no change" in the frequency or intensity of the dam failure hazard over the last 10 years.

Less than 1% of respondents indicate that a dam failure event has caused damage to their residential or commercial property.

The majority of the unincorporated areas of the County have low and moderate-low social vulnerability. The census tract including Highland Beach has no areas of high social vulnerability. As with any hazard that had a potential to impact the County and its municipalities, considerations for socially vulnerable members of the community must be made. This is particularly true of public information announcements and disaster preparedness information.

From an economic standpoint, the economic cost of a dam failure can be significant. Depending on the location of the dam failure, recovery cost may not only impact the immediate area but also adjacent jurisdictions. Recovery cost could include repair for flooded structures, improvement to impaired roads and infrastructure, and so on. Damaged or destroyed businesses could lead to long-term closures and temporary or permanent loss of jobs. Another economic impact is the cost of dam rehabilitation or repair. If a dam failure occurred in a farming community, agricultural lands could be damaged if inundated, which leads to loss of function and/or inventory to agricultural businesses.

Structures

Anne Arundel County has no high hazard potential dams within its boundary. However, structures within the County could be impacted by the failure of two high hazard dams in adjacent jurisdictions; these dams' inundation areas overlap with areas within the County. Critical structures within the inundation areas of Liberty Dam or Duckett Dam would be impacted by a dam failure event. Inundation areas for these dams are shown on Map 3.3.3-1 and include County critical facilities that are within the inundation areas. These facilities are vulnerable to negative impacts from the failure of either one of these high hazard potential dams. Critical structures within these inundation areas are also listed in Table 3.3.3-2.

Table 3.3.3-2 Anne Arundel County Critical Structures within Adjacent High Hazard Dam Inundation Areas

FEMA Community Lifeline	Facility Type	Facility Name	Address	Dam Inundation Area
Hazardous Materials	Fixed HazMat Storage Sites	Airgas USA, LLC	608 Nursery Rd	Liberty Dam Inundation Area

In the event of flash flooding due to dam failure, hazardous materials could be released if their containers spill or break or if floodwater enter tanks and force out hazardous materials. In the case of Airgas Puritan Medical, hazardous materials would likely include industrial, medical, and/or specialty gases.

Additionally, as listed in Table 3-3.3.1, Anne Arundel County has 13 significant hazard potential dams, 2 of which are owned and operated by the County. These dams include:

- Lake of The Pines (Tarnans Branch Crossing)
- Lake Waterford Dam

Emergency Action Plans for each of these significant hazard dams were referenced to determine structures (i.e., residents or businesses) which are vulnerable to dam failure (i.e., structures within these dam's inundation areas).

A major flood caused by a sudden breach of the Lake of the Pines dam is estimated to inundate 16 homes, and two highways.

A major flood caused by a sudden breach of the Lake Waterford dam is estimated to inundate 1 home, 0 businesses, and 3 local roads. These homes and businesses are located east of Lake Waterford Park Dam.

Systems

In the event of a dam failure at one of the adjacent high hazard potential dam sites, the following critical water, transportation, and communications systems were identified as within the damn inundation areas, Table 3.3.3-3.

Telecommunications towers can be damaged by flooding, causing service outages and disruptions to emergency response efforts. Flooding may impact commuter and light rail transportation by causing service disruption, station flooding, and damage to rail infrastructure. Cascading disruptions can occur in complex transportation networks, where a localized failure (in this case caused by flooding due to dam failure) of the system can disrupt the ability of thousands of people to get where they need to go. Flooding from dam failure can impact pump stations in several ways, including: damage to pumps, infiltration, and backwards flow. Steps to protect pump stations from flooding include equipping them with high level shutoffs, exterior input sensors, and flood proof top hatches.

Table 3.3.3-3 Anne Arundel County Critical Systems within Adjacent High Hazard Dam Inundation Areas

FEMA Community Lifeline	Facility Type	Facility Name	Address	Dam Inundation Area
Communications	Telecommunication Towers	Nextel Cell Tower NE	3600 Laurel Fort Meade Rd	Duckett Dam Inundation Area
		Sprint Cell Tower NE	2101 Patuxent River Rd	Duckett Dam Inundation Area
		AT&T Cell Tower N	832 Oregon Ave	Liberty Dam Inundation Area
Transportation	Light Rail Stations	Nursery Road Light Rail Station	6825 Baltimore Annapolis Blvd	Liberty Dam Inundation Area
	MARC Station	BWI MARC Station	2 Amtrak Way	Liberty Dam Inundation Area
Water Systems	Sewer Pump Stations	Harbor Valley SPS	5662 Harbor Valley Dr	Liberty Dam Inundation Area
		Barbers Trailer Court SPS	413 Kokomo Ct	Duckett Dam Inundation Area
		Patapsco Park SPS	200 Shenandoah Ave	Liberty Dam Inundation Area

Table 3.3.3-3 Anne Arundel County Critical Systems within Adjacent High Hazard Dam Inundation Areas

FEMA Community Lifeline	Facility Type	Facility Name	Address	Dam Inundation Area
		Patapsco SPS	6816 Baltimore Annapolis Blvd	Liberty Dam Inundation Area
		Ridgeway Manor S SPS	-	Liberty Dam Inundation Area
		Linthicum / Shipley SPS	834 Hammonds Ferry Rd N	Liberty Dam Inundation Area
		Riverwalk At Crofton SPS	1304 Foggy Turn	Duckett Dam Inundation Area
		Furnace Avenue BWI (Private)	-	Liberty Dam Inundation Area
		Stoney Run BWI (Private)	-	Liberty Dam Inundation Area
	Water Pump Stations	Nursery Rd Wbs	-	Liberty Dam Inundation Area

Additionally, roadways impacted by County-owned/operated significant hazard potential dams are identified in EAPs.

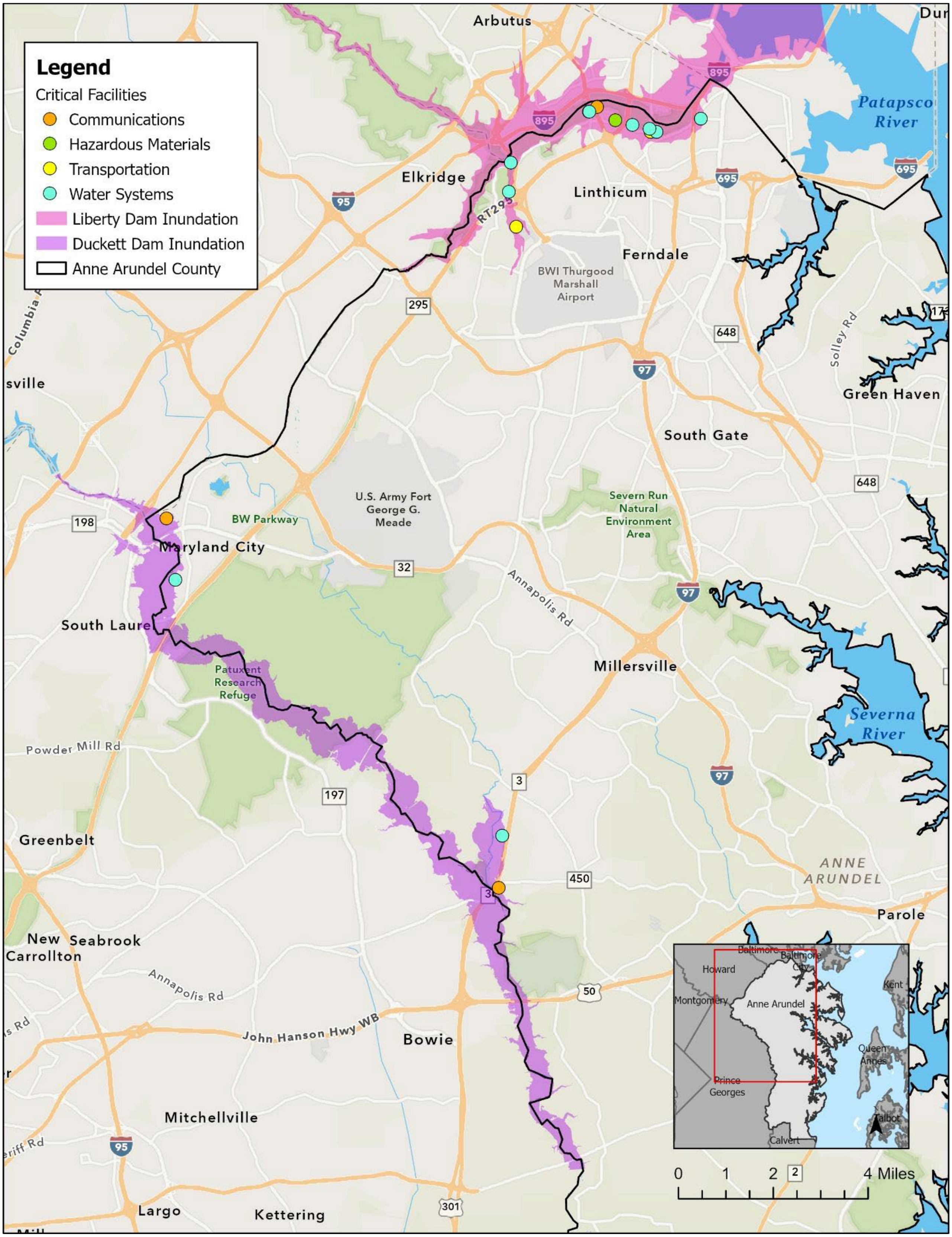
For the Lake of the Pines dam, one roadway is included within the dam's EAP as being impacted by flooding caused by a sudden failure:

- Rutland Road (980 feet downstream from dam)
- Tarnans Branch Crossing (adjacent)

For the Lake Waterford Dam, three roadways are included within the dam's EAP as being impacted by flooding caused by a sudden failure:

- MD Route 648 (50 feet downstream from dam)
- Old Mill Road (100 feet downstream from dam)
- Catherine Avenue (2500 downstream from dam)

Map 3.3.3-1 Anne Arundel County Critical Facilities within Adjacent High Hazard Dam Inundation Areas



Natural, Historic and Cultural Resources

The National Register of Historic Places was used to assess the vulnerability of natural, historic, and cultural resources to dam failure. Resources that are within the County's two adjacent high hazard potential dams, Liberty Dam and Duckett Dam, were determined to be most vulnerable to flooding from dam failure.

Historic structures identified within the Liberty Dam inundation area (DSS-WISE: sunny day – normal pool scenario) include:

- Lawyers Hill Historic District
- Elkridge Prehistoric Village Archaeological Site

Natural resources within the Liberty Dam inundation area include:

- Patapsco Valley State Park
- Pumphrey Park
- Riverside Playground
- Riverside Park

Historic structures identified within the Duckett Dam inundation area (DSS-WISE: sunny day – normal pool scenario) include:

- Laurel Railroad Station
- Baltimore-Washington Parkway
- Katcef Archaeological Site
- Beck Northeast Site

Natural resources within the Duckett Dam inundation area include:

- Laurel Park
- Patuxent Environmental Science Center
- Pride Finance NRMA
- Globe Comm NRMA
- Davidsonville Park
- Renditions Golf Course
- Patuxent River Park

Community Activities

Activities that have value to the community most likely to impacted by dam failure are those that occur in the inundation areas of dams, especially high hazard potential dams. These include Liberty Dam and Duckett Dam, as shown on Map 3.3.3-1.

Much of the inundation area for the County's two high hazard dams is floodplain with little to no development. County or community parks and recreation areas that may host community activities or events that are within the dam inundation zones of Liberty and Duckett dams are identified in the previous section.

Online resources to watch for community activities include the County's Programs and Activities, Recreation and Parks calendar, as well as the County Events calendar. Additionally, social media accounts for the County and those created by citizens are a primary source of local event information. The top 10 most popular recreational activities or amenities in Anne Arundel County include the Annual Park Pass, Dogs in the Park, Concerts in the Parks, Park Pavilion Rentals, Water Access, Swimming Access, Kayaking Trips, Cartop Boat Launch, Boat Ramps, and Fishing.

3.3.3.8 Future Land Use and Development Trends

It is unlikely that future development (as guided by the General Development Plan, Plan2040) in Anne Arundel County will change the risk or vulnerability associated with the dam failure hazard.

The County does not have any high hazard potential dams within its jurisdiction, however there are two high hazard potential dams that are adjacent to the County which could have a negative impact on current or future development. Development within the inundation areas of Liberty Dam and Duckett Dam would be impacted by a failure event. While these dams are not operated within the County, parts of their inundation areas are within the County, as shown on Map 3.3.3-1.

The Liberty Dam inundation areas follow the northern border of Anne Arundel County, and a failure would potentially impact communities and development along the Patapsco River. Much of the area within the inundation area is undeveloped floodplain, but there are instances where potential development is adjacent or close enough to the floodplain to be impacted. According to the GDP, future development in this dam's inundation area is mostly parks and open space or industrial. Much of this area falls into the "neighborhood preservation" development policy area, this includes existing residential communities and natural areas that are not intended for substantial growth or land use change.

The Duckett Dam inundation area follows the County's mid-western border along the Patuxent River. Much of the current and future development along the Patuxent within or adjacent to the inundation area is parks and open space, rural, or conservation land use. Much of this area falls into the "rural and agricultural" development policy area, which is characterized by large-lot residential areas, farms, and very limited commercial or industrial areas outside of the PFA.

To avoid further increasing vulnerability to a dam failure event, land development and zoning regulations should continue to limit development in these areas. MDE recommends reviewing development and zoning around and downstream of low hazard dams and small ponds to ensure that "hazard creep" does not occur as people move into areas that could be flooded by a currently low hazard dam failure

3.3.3.9 Future Conditions

Major dam failures are very unlikely in Anne Arundel County based on the low number of past incidents and the lack of high hazard potential dams. The presence of structural integrity and inspection programs significantly reduces the potential for major dam failure events to occur, but significantly older dams are more likely to experience problems.

The construction, operation, maintenance, modification, and abandonment of dams is regulated and monitored by the Maryland Department of Environment Dam Safety program. Dams are evaluated based on categories such as slope stability, undermining seepage, and spillway adequacy. The presence of structural integrity and inspection programs significantly reduces the potential for major dam failure events to occur.

Dam Emergency Action Plans drafted in accordance with the Federal Guidelines for Dam Safety identify the risk related information include the inundation area and the time lapse between failure and flooding reaching specific destinations downstream. The County and its municipalities have low potential to be affected by dam failure, but the possibility exists and therefore it is essential to have emergency planning procedures.

3.3.3.10 Considerations for Next Planning Cycle

Future monitoring, evaluating, and updating of this Plan should consider the following factors related to dam failure:

- Have dam failure events occurred in the planning area since the adoption of 2025 HMP update?
- Did dam failure events take place in areas adjacent to the planning area that impacted the planning area by virtue of their being located upstream of the planning area?
- Has any new scientific research or methodology changed the ability to predict dam failure events or assess risk and vulnerability?
- Have there been significant changes in the population, built environment, natural environment, or economy that could affect the risk or vulnerability to dam failure?
- Is there new evidence related to the impacts of climate change that could affect the level of risk or vulnerability to dam failure?
- Has any new funding source for dam failure research or the repair, removal, or rehabilitation of dams become available?

3.3.4 Hurricane, Tropical Storm, and Nor'easter

The Hurricane, Tropical Storm, and Nor'easter section includes the following sub-topics:

1. Description of Hurricane, Tropical Storm, and Nor'easter
2. Location, Extent, Magnitude
3. Past Occurrences
4. Probability of Future Hurricane, Tropical Storm, and Nor'easter Events
5. Hurricane, Tropical Storm, and Nor'easter Risk Assessment
6. Hurricane, Tropical Storm, and Nor'easter Hazards in Highland Beach
7. Impacts to People, Structures, Systems, and Resources
8. Future Land Use and Development Trends
9. Future Conditions
10. Consideration for the Next Planning Cycle

3.3.4.1 Description of Hurricane, Tropical Storm, and Nor'easter

Hurricanes, tropical storms, and typhoons, collectively known as tropical cyclones, are among the most devastating naturally occurring hazards in the United States. They present flooding, storm surge, and high wind hazards to the communities that they impact. A **hurricane** is defined as a low-pressure area of closed-circulation winds that originates over tropical waters. A hurricane begins as a tropical depression with wind speeds below 39 mph. As it intensifies, it may develop into a tropical storm, with further development producing a hurricane.

Nor'easters are extra-tropical storms that derive their strength from horizontal gradients in temperature. These storms form because of a drastic drop in temperature as cold, arctic air flows south where it collides with warmer air moving northward. This tends to cause the storm to begin to revolve. Winds around the storm center carry warm, moist air from over the Gulf Stream, up and over the colder inland air. The air rises, cools, and snow begins to fall. Winds around the Nor'easter's center can become intense, with wind gusts that exceed hurricane force in intensity. The wind builds large waves that batter the coastline and sometimes pile water inland causing major coastal flooding and severe beach erosion. Unlike a hurricane, which usually comes and goes within one tide cycle, the Nor'easter can linger through several tides, each one piling more and more water on shore and into bays and dragging more and more sand away from beaches.

3.3.4.2 Location, Extent, Magnitude

Hurricane risk in the United States extends along the entire east coast from Maine to Florida, the Gulf Coast (including Florida, Alabama, Louisiana, and Texas), and Hawaii. The southeastern U.S. and Gulf Coast are at greatest risk based on historical storm tracks and the warmer waters of the Gulf of Mexico and Atlantic Ocean. Risks associated with hurricanes include wind and flooding from storm surges. The multi-component nature of the hazard means that all areas of Anne Arundel County are subject to the effects of hurricanes, including high winds, flooding, and storm surge. In the middle Atlantic region, Maryland and Anne Arundel County are at moderate risk from Hurricanes, Tropical Storms, and Nor'easters.

The severity of hurricanes and tropical storms is measured primarily by wind velocity, flooding, and storm surge. Hurricane severity is expressed in numbered categories. Hurricanes are classified as Categories 1 through 5 based on central pressure, wind speed, storm surge height, and damage potential. As shown in Table 3.3.4-1 the Saffir/Simpson Hurricane Wind Scale is used to classify storms by numbered categories.

Table 3.3.4-1Saffir/Simpson Hurricane Wind Scale

Category	Central Pressure	Sustained Winds	Storm Surge	Damage Description
1	>980 mbar	74–95 mph	4–5 ft	**Minimal.** Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	965–979 mbar	96–110 mph	6–8 ft	**Moderate.** Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3	945–964 mbar	111–130 mph	9–12 ft	**Extensive.** Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4	920–944 mbar	131–155 mph	13–18 ft	**Extreme.** Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5	<920 mbar	>155 mph	>18 ft	**Catastrophic.** A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Source: NOAA National Hurricane Center

Tropical cyclones, a general term for tropical storms and hurricanes, are low pressure systems that usually form over the tropics, referred to as “cyclones” due to their rotation. Tropical cyclones are among the most powerful and destructive meteorological systems on earth. In terms of impact, high winds, heavy rain, lightning, tornados, hail, and storm surge are all associated with tropical cyclones. In addition, as tropical cyclones move inland, they can cause severe flooding, downed trees and power lines, and structural damage.

Nor’easters may occur any time of the year but are more frequent and strongest between September and April. These storms usually develop between Georgia and New Jersey within 100 miles of the coastline and generally move north or northeastward. Nor’easters typically become most intense near New England and the Canadian Maritime Provinces.

The East Coast of North America provides an ideal breeding ground for Nor’easters. During winter, the polar jet stream transports cold Arctic air southward across the plains of Canada and the U.S., and eastward toward the Atlantic Ocean, as warm air from the Gulf of Mexico and the

Atlantic tries to move northward. The warm waters of the Gulf Stream help keep the coastal waters relatively mild during the winter, which in turn helps warm the cold winter air over the water. This difference in temperature between the warm air over the water and cold Arctic air over the land is the area where Nor'easters are born.

Generally, factors that influence magnitude or severity of tropical cyclones are included in Table 3.3.4-2. These include such factors as wind velocity, storm surge height, coastal shape, storm center velocity, nature of coast, previous storm damage, and human activity.

Table 3.3.4-2 Factors that Influence the Severity of Coastal Storms

Factor	Effect
Wind Velocity	The higher the wind velocity the greater the damage.
Storm Surge Height	The higher the storm surge the greater the damage.
Coastal Shape	Concave shoreline sections sustain more damage because the water is driven into a confined area by the advancing storm, thus increasing storm surge height and storm surge flooding.
Storm Center Velocity	The slower the storm moves, the greater the damage. The worst possible situation is a storm that stalls along a coast, through several high tides.
Nature of Coast	Damage is most severe on low-lying island barrier shorelines because they are easily over washed by wave action.
Previous Storm Damage	A coast weakened by even a minor previous storm will be subject to greater damage in a subsequent storm.
Human Activity	With increased development, property damage increases and more floating debris becomes available to knock down other structures.

3.3.4.3 Past Occurrences

As part of the 2025 HMP update, several data sources were researched to identify historical hurricanes and tropical storms that have impacted the mid-Atlantic region and Anne Arundel County. The NCEI Storm Event database indicated there were four tropical storms impacting Anne Arundel County between 1950 and 2024. The first event, Hurricane Floyd, occurred in September 1999 and the second event, Hurricane Isabel, occurred in September 2003 – both events were downgraded to tropical storm status by the time they impacted the County. Late in 2012, Hurricane Sandy impacted nearly the entire east coast of the U.S., including Anne Arundel County.

The NCEI database appears to omit numerous tropical storm events that have impacted the area, many of which occurred prior to 1999. Some of the missing events include Tropical Storms Bertha, Dean, and Diane. Note that recent changes to the NCEI database appear to eliminate much of the historical data, particularly before the 1990s.

Table 3.3.4-3 summarizes significant recorded hurricane and tropical storm events as included in the NCEI Storm Events Database.

Table 3.3.4-3 Significant Tropical Cyclone Events in Anne Arundel County, 1998 – 2024

Event & Date	Event Description
September 16, 1999	Hurricane Floyd caused significant damage in Anne Arundel County which qualified the County for FEMA disaster assistance. Tidal flooding was reported along the Chesapeake Bay while tides pushed 2 to 3 feet above normal. The highest rainfall reports included 11.60 inches in Annapolis, 11.11 inches in Ridge, 11.10 inches at Cape St. Claire.

Table 3.3.4-3 Significant Tropical Cyclone Events in Anne Arundel County, 1998 – 2024

Event & Date	Event Description
	In Anne Arundel County, 5 trains with over 1000 passengers were stranded for up to 7 hours just north of BWI airport by a mudslide, water, and trees covering the tracks. At 9:30 AM EDT on the 16th, a tractor-trailer was blown over on the Chesapeake Bay Bridge. A wind sensor on the bridge recorded a gust of 81 MPH at 11:55 AM. Winds gusted to 66 MPH at Thomas Point Lighthouse, 56 MPH at the Naval Academy in Annapolis, 48 MPH at Brooklyn Park, and 43 MPH at Baltimore/Washington International Airport. Over 77,000 customers lost power after hundreds of trees and power lines were downed. It took over a week to restore power to all customers. Several hundred roads were closed by downed trees and high water. County officials reported 350 flooded basements and 2 water rescues. Some basement walls collapsed, including one in a 15-unit townhouse structure. Shady Side and Bay Side beaches along the Patapsco River were flooded by torrential rains. The County fair was shut down for the first time in its 47-year history. An ailing historical landmark, the Liberty Tree at St. John's College in Annapolis, was also dealt a final blow by the hurricane. In Baltimore, evacuation orders were issued for businesses near the confluence of Jones Falls and Western Run after both streams overflowed their banks. The water submerged a used car lot and washed out a bridge on Maisel Street near Morrell Park. Winds gusted to 62 MPH on Television Hill. Officials reported 750 downed trees across the city, including 35 which damaged homes. Up to 91,000 customers lost power, and the outage led to the release of 24 million gallons of raw sewage into Jones Falls.
September 18, 2003	Hurricane Isabel made landfall originally on the North Carolina coast but had later been downgraded to a tropical storm by the time it reached central Virginia. The Maryland western shore counties of the Chesapeake Bay and along the tidal tributaries of the Potomac, Patuxent, Patapsco and other smaller rivers experience a storm surge reaching 5 to 9 feet above normal tides. In many locations, Isabel's surge was higher than the previous record storm known as the Chesapeake-Potomac Hurricane of 1933. For coastal properties below 10 feet MSL exposed to wave action, much damage was wrought. Over 2,000 people were evacuated from their homes. Maryland saw 472 homes and buildings destroyed, 3,260 with major damage and over 3,600 more affected. Extensive damage occurred to Maryland's shoreline which rarely sees storms of this intensity. The Chesapeake Bay Foundation estimates that 43,000 tons of silt and millions of pounds of nitrogen and phosphorus and millions of gallons of raw sewage washed into the bay during Isabel. Water surrounded many of the buildings on the U.S. Naval Academy in Annapolis. The flooding caused $116 million in damage. FEMA was estimating up to $500 million in total damage to Anne Arundel County from the storm. In Anne Arundel County, 196,000 out of a possible 211,000 customers lost power. While most people had their power back in a week, some locations took up to two weeks. Many injuries and 3 fatalities occurred from carbon monoxide poisoning from people improperly running generators in their houses. Other injuries were related to chain saws and the clean-up of debris.

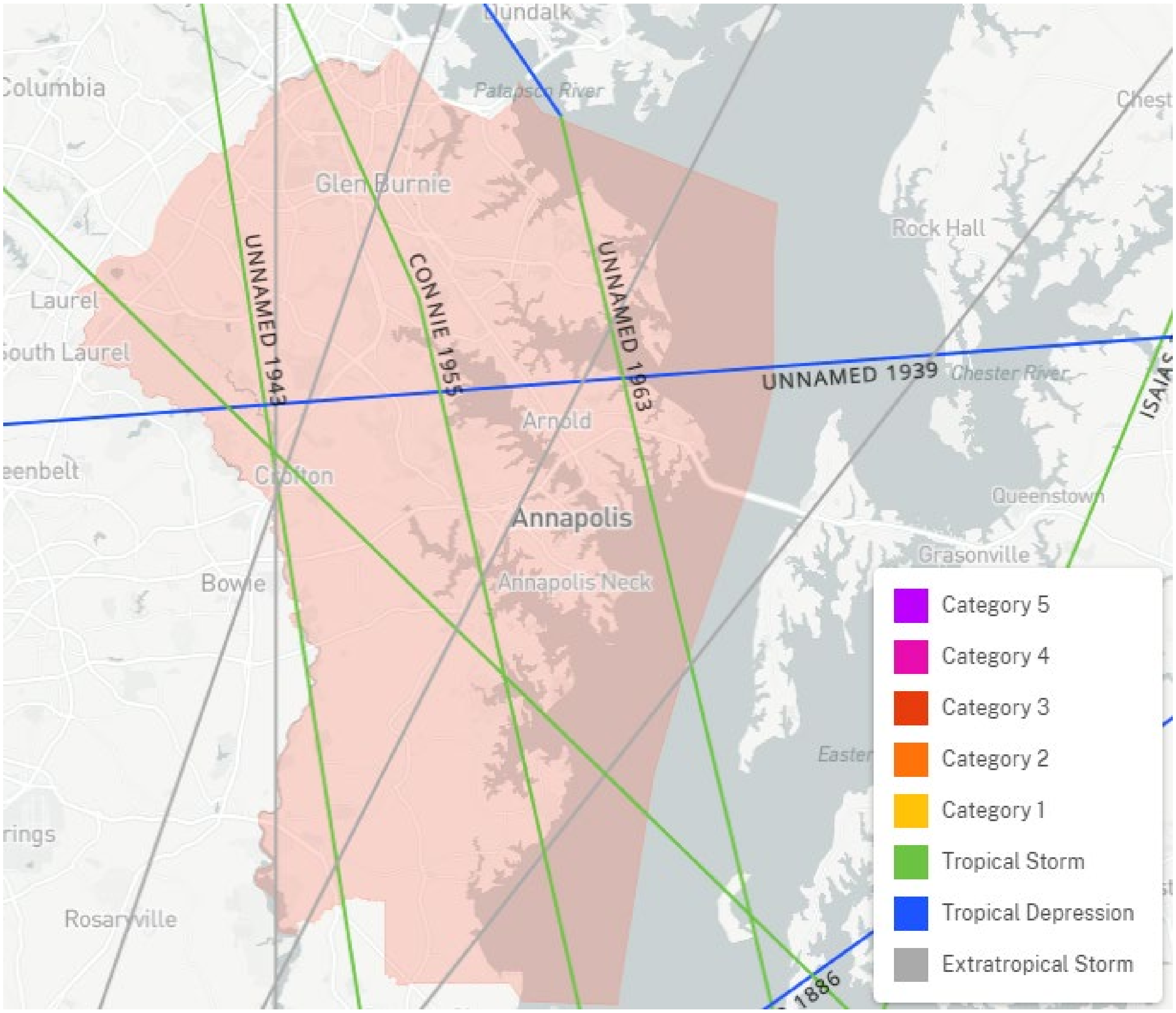
Table 3.3.4-3 Significant Tropical Cyclone Events in Anne Arundel County, 1998 – 2024

Event & Date	Event Description
August 27, 2011	Hurricane Irene tracked up the Mid-Atlantic Coast during the evening hours of the 27th through the early morning hours of the 28th. Irene passed by just to the east of Ocean City, Maryland during the early morning hours of the 28th. The minimum central pressure was 958 millibars and maximum sustained winds were 80 mph, making Irene a category one hurricane. Irene produced tropical storm conditions across portions of Maryland near and east of the Interstate 95 Corridor. The worst conditions were near the Chesapeake Bay. The highest rainfall totals were around twelve inches across St Mary's County. Widespread power outages were reported across eastern Maryland along with numerous trees down. Total damage from Irene was over $10 million. Hundreds of trees were down throughout the County. A couple hundred roads were closed due to downed trees, including US 50 near the Severn River Bridge and along Ritchie Highway in Severna Park. Numerous trees fell into homes. The total number of homes damaged was 58.
2025 PLAN UPDATE	
August 4, 2020	Tropical Storm Isaias moved up the east coast, passing through southern Maryland on the morning of Tuesday, August 4th, 2020, spawning several tornadoes as well as flooding rain and tropical storm force winds. Storm total rainfall ranged from 2 to 4 inches near Interstate 95 to as much as 9 inches in Calvert County east of Interstate 95. The heavy rain led to numerous incidents of flooding and flash flooding, especially near and east of Interstate 95. The highest sustained wind of 46 knots was reported at Bishops Head and the highest peak gust of 63 knots was also reported at Bishops Head. There were three tornadoes associated with Isaias over southern Maryland and there were also numerous reports of downed trees from tropical storm force winds, especially near and east of Interstate 95. A storm surge of 1 to 2 feet occurred along the western shore of Chesapeake Bay and the shore of the Tidal Potomac River. This resulted in minor tidal flooding in Washington DC. Sustained winds of 39 mph reported at the U.S. Naval Academy ASOS (KNAK) at 7:56 AM EST, with a peak wind gust of 56 mph at 8:07 AM EST. Isolated reports of trees down across the County, but no significant damage reported.

Source: NCEI Storm Event Database

Figure 3.3.4-1 shows historic tropical cyclones (i.e., hurricanes and tropical storms) tracks through or near the State of Maryland. As is shown, there are no Category 1 through Category 5 hurricane tracks that have passed through Anne Arundel County in recent history. The County is most usually impacted by tropical storms and tropical depressions.

Figure 3.3.4-1 Historic Maryland Tropical Cyclone Tracks
Source: https://coast.noaa.gov/hurricanes/. As of January 2025.



A query of the National Hurricane Center (NHC) revealed additional tropical cyclone events not included in the NCEI (primarily events occurring before 1999). Counting the nine tropical storms reported by the NHC and the four from the NCEI database, Anne Arundel County has experienced a total of 13 tropical storms since 1950. Based on approximately 75 years of historical data from the NHC and NCEI, the probability of future tropical cyclones impacting Maryland and Anne Arundel County is moderate, averaging approximately one event every six years, or roughly 0.18 events annually.

As noted previously in this section, Hurricane Isabel made landfall along the North Carolina Coast. The storm was downgraded to a tropical storm by the time it reached Maryland. Isabel's eye tracked well west of the Chesapeake Bay, with sustained winds of 40 to 50 mph. Although most of the damage was related to storm surge, high winds from Isabel still resulted in moderate wind damage. The NCEI database indicated that Patuxent Naval Air Base recorded wind gusts of 69 MPH and Quantico Marine Base recorded a wind gust of 78 MPH. Unofficial wind gust readings of up to 110 MPH were reported but not confirmed. Wind damage to trees in the area was extensive and widespread to the region. Soil moisture was high from previous rains making it easier for trees to uproot. Also, the trees were still in full canopy, which acted like a sail to catch the wind. High winds caused trees to fall on electrical and utility wires taking out power and phone service. Trees also fell on roads, cars, and homes. In Anne Arundel County, 196,000 out of a possible 211,000 customers lost power (Source: NOAA/NCEI database). See the flood hazard section for a description of the flood damage in Anne Arundel County associated with Hurricane Isabel.

In 2012, Hurricane Sandy tracked up the east coast of the U.S. and had devastating consequences for New York City in particular. Anne Arundel County experienced high winds and some coastal flooding, but effects and damage were limited, particularly compared to other locations on the east coast.

The NCEI database does not specifically track historical Nor'easters, and in fact, historical occurrences of nor'easter events are difficult to track. Nor'easters are likely included as part of other hazard event types, such as tropical storms or winter weather. Both event types are well-documented throughout this plan. For purposes of this section, no historical occurrences of tropical cyclone events were defined as nor'easters within their event narratives included by the NCEI.

Recently, the Northeast region was impacted by a nor'easter occurring March 20 through 22, 2018. This nor'easter was dubbed "Four'easter" by some outlets because the region had already been struck by three previous nor'easters on March 1-3, 6-8, and 12-15. In total, the storm brought significant snowfall to the area – up to 18 inches in some locations.

In Maryland, the March 2018 nor'easter brought heavy snow to areas that very rarely receive heavy snowfall so late in March. Schools in Baltimore were closed on March 21 due to the storm. MARC Train and MTA commuter bus service were both suspended on March 21. Several accidents were reported across the state due to the snow. A school bus driver in Frederick County had to be removed after the bus slid off a roadway due to wintry conditions. No one was injured in the incident.

3.3.4.4 Probability of Future Events

The probability of hurricane or tropical storm events can be determined based on historical occurrences by determining the annual hazard rate of occurrence. Based on past events detailed in section 3.3.4.3, it can be determined that Anne Arundel County will experience at least 0.18 tropical cyclone events a year going forward, or one event every six years. Refer to Table 3.3.4-4.

Table 3.3.4-4. Annualized Frequency of Hurricane, Tropical Storm, and Nor'easter Events in Anne Arundel County, 1950 to 2024

# Of Events	Injuries	Deaths	Property Damage ($)	Annual Frequency
13	0	0	4.42M	0.18

Source: NCEI Storm Event Database & National Hurricane Center

Colorado State University developed a new methodology for calculating tropical cyclone impacts to counties along the east coast. According to the Tropical Cyclone Impact Probabilities table, the average probability of a hurricane impact to Maryland was 11%, while the average probability of a major hurricane impact was 1%. These future probabilities for hurricanes and tropical storms would apply to Anne Arundel County.

In addition to annualized frequency based on available NCEI data, Figures 3.3.4-2 and 3.3.4-3 show the expected return frequencies and wait times for all hurricanes and major hurricanes, respectively. Return frequency is analogous to probability, and the figures indicate that Anne Arundel County may be impacted by a hurricane of some magnitude about every 50 years, and a major hurricane (categories 3-5) less than once every 100 years (the graphic indicates >97 years). Tropical storms will presumably occur more frequently because they are less severe. In fact, storm history shows clearly that many hurricanes decay to tropical storms before they reach Maryland.

Figure 3.3.4-2 All Hurricane Event (Categories 1-5) Return Frequencies (a) and Wait Times (b)
Source: Hurricanes of the North Atlantic, Elsner, James, and Kara, A. Birol, Oxford University Press, 1999

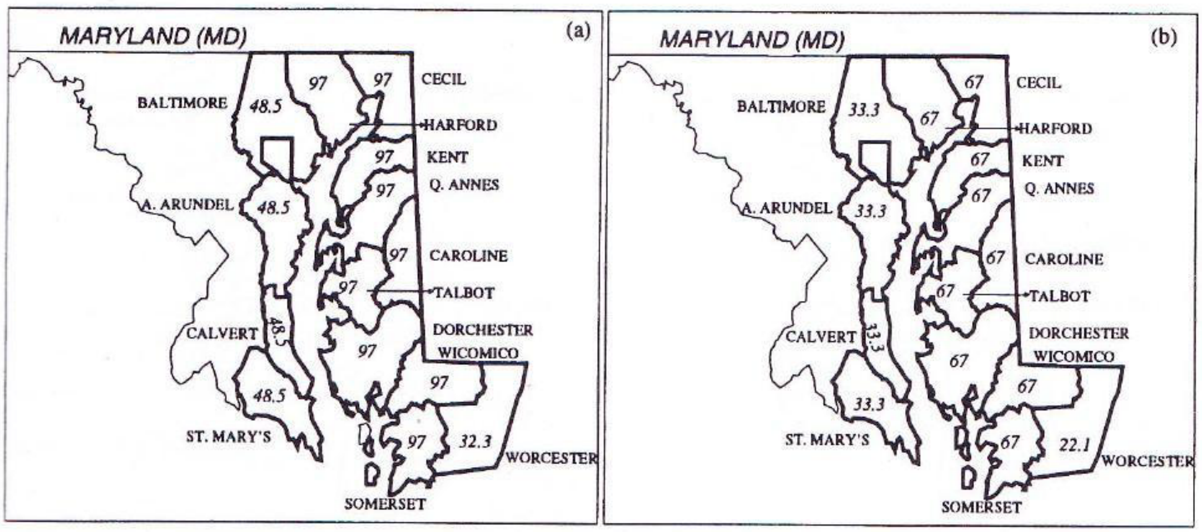
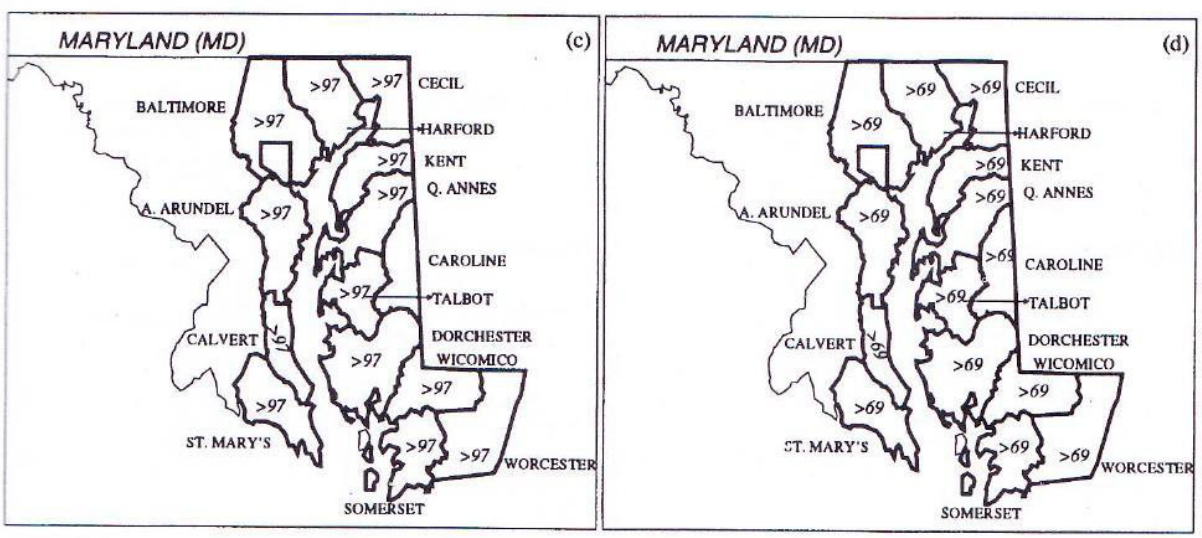


Figure 3.3.4-3 Major Hurricane Event (Categories 3-5) Return Frequencies (c) and Wait Times (d)
Source: Hurricanes of the North Atlantic, Elsner, James, and Kara, A. Birol, Oxford University Press, 1999



3.3.4.5 Hurricane, Tropical Storm, and Nor'easter Risk Assessment

The primary risks associated with tropical storms include storm surge flooding, heavy rainfall leading to inland flooding, destructive winds, potential tornadoes, high waves, rip currents, coastal erosion, and damage to infrastructure. Storm surge is often considered the most dangerous aspect due to its potential for widespread inundation along the coastline. Therefore, people and property within either the Special Flood Hazard Area (SFHA) or storm surge inundation areas of the County are at increased risk to the negative impacts of storm surge.

Note: Risk and impacts to critical facilities and community lifelines related to storm surge are included within the Coastal Hazards section of this plan.

According to FEMA's National Risk Index, Anne Arundel County's risk rating for the hurricane hazard is "relatively moderate." This means that 83% of counties within Maryland have a lower risk index than Anne Arundel County. Values for expected annual loss, including buildings, agriculture, and population are included in section 3.3.4.7.

3.3.4.6 Hurricane, Tropical Storm, and Nor'easter in Highland Beach

Highland Beach is subject to effects from both surge and high winds related to hurricanes and tropical storms. However, as discussed above in the flood subsection, there are few structures in the FEMA-identified V-zone SFHA. As shown on the effective FIRM (Flood section) about a third of the land area in Highland Beach appears to be in the SFHA, much of it in V-zone. However, most of the small amount of development in the Town is outside this zone, and thus the hazard should be considered relatively minor.

As noted in the Flood hazard section, Highland Beach has no properties on the NFIP Repetitive Loss (RL) list. Many of the properties that are on the list had claims from Tropical Storm Isabel (2003), but Highland Beach is not among them, which provides some evidence that there is minimal surge risk here, except in the most severe potential events. However, this should not be considered definitive, because it is possible that there was flooding during Isabel, but that there were no claims submitted to the NFIP, or that policy holders may have submitted too few (or such low dollar amounts) of claims over time that they did not appear on the RL list. The HMPC reviewed NFIP claims as part of the 2025 HMP update and found no RL claims for Highland Beach. Because of its position on the coast of the Bay, Highland Beach is more exposed to the effects of high winds than are the inland parts of the County. There are no open-source records that can be consulted to identify past wind damages (private insurance covers losses, and the information is proprietary). It is reasonable to assume that structures in Highland Beach have about the same level of exposure as other coastal areas of the County, and that the housing stock is likely somewhat older than much of the remainder of the County. This suggests that the vulnerability of these structures is comparatively high, although without detailed engineering study it is difficult to quantify the risk.

There are no open-source records that indicate Highland Beach had any significant damage (wind or surge) from Hurricane Sandy. Documented flooding form hurricane events in Highland Beach are presented in Appendix G.

3.3.4.7 Impacts to People, Systems, and Resources

Hurricanes, tropical storms, and nor'easter events impact people, structures, systems, and other resources in many ways. These impacts have been described in this section primarily through historical event narratives for the County. The following sections highlight the most likely impacts the County and its communities will face based on previously observed impacts combined with forecasting for future conditions such as climate change and sea level rise.

People

Hurricanes, tropical storms, and nor'easters can significantly impact people by causing widespread destruction to property, disrupting essential services like power and water, leading to potential loss of life due to storm surge, flooding, and strong winds, causing economic disruption, and triggering significant emotional distress due to the threat and aftermath of the storm; particularly impacting vulnerable communities with limited resources to prepare and recover.

Aside from property damage and infrastructure disruptions that are covered in the following sections, there are a few psychological impacts associated with these hazards events. Hurricanes, tropical storms, and nor'easters can create anxiety and stress, trauma, and displacement of people and loss of community. These impacts can be felt by individuals and populations in both the short and long term.

Vulnerable populations include coastal residents and businesses, low-income communities, and the elderly and disabled. All people in low-lying coastal areas are more vulnerable to storm surge and high wind associated with these hazards.

Hurricane, Tropical Storm, Nor'easter
The Public's Perspective

A survey conducted during the 2025 plan update asked County residents their level of concern for hazards identified in the plan.

39.87% of respondents indicated that they are "very concerned" with this hazard. Another 37.77% indicate they are "concerned". This hazard is the number two (2) hazard of most concern. Coastal flooding is number one (1), which is tied to this hazard.

55.70% of respondents indicated that they have seen an "increase" in the frequency or intensity of hurricane and tropical storms over the last 10 years.

43.93% of respondents indicate that a hurricane, tropical storm, and/or a nor'easter event has caused damage to their residential or commercial property.

Structures

Storm surge and high wind associated with hurricanes and tropical systems could damage critical infrastructure and community lifelines in the County. According to the County's Critical Facility and Community Lifeline Database, 214 critical facilities and/or lifelines are within a hurricane category 1-5 storm surge inundation area. These facilities are more at risk to negative impacts such as property damage due to their location in the inundation areas. Table 3.3.4-5 includes more details of these facilities.

Table 3.3.4-5 Community Lifelines Within Hurricane Storm Surge Inundation Areas

FEMA Community Lifeline	Facility Type	Number of Facilities	Estimated Improvement Value ($)
Communications	Telecommunication Tower	3	61,311,700
Food, Hydration, Shelter	Schools	7	17,323,600
	Warming & Cooling Center	1	795,500
Hazardous Materials	Fixed Hazmat Storage Site	38	131,291,700

Table 3.3.4-5 Community Lifelines Within Hurricane Storm Surge Inundation Areas

FEMA Community Lifeline	Facility Type	Number of Facilities	Estimated Improvement Value ($)
Health and Medical	Health Center	2	8,261,600
Safety and Security	Fire & EMS	3	901,100
Transportation	Light Rail Station	1	-
Water Systems	Sewer Pump Stations	156	44,842,500
	Water Storage Tower	1	-
	WTP	1	-
	WWTP	1	-
Total:	**-**	**214**	**264,727,700**

Of these critical facilities and lifelines, a total of 104 are within major hurricane category inundation zones (i.e., category 3 or greater). These facilities are most at risk for hurricane and tropical storm wind and storm surge. These facilities are included in Table 3.3.4-6.

Table 3.3.4-6 Community Lifelines Within Major (Cat 3+) Hurricane Storm Surge Inundation Areas

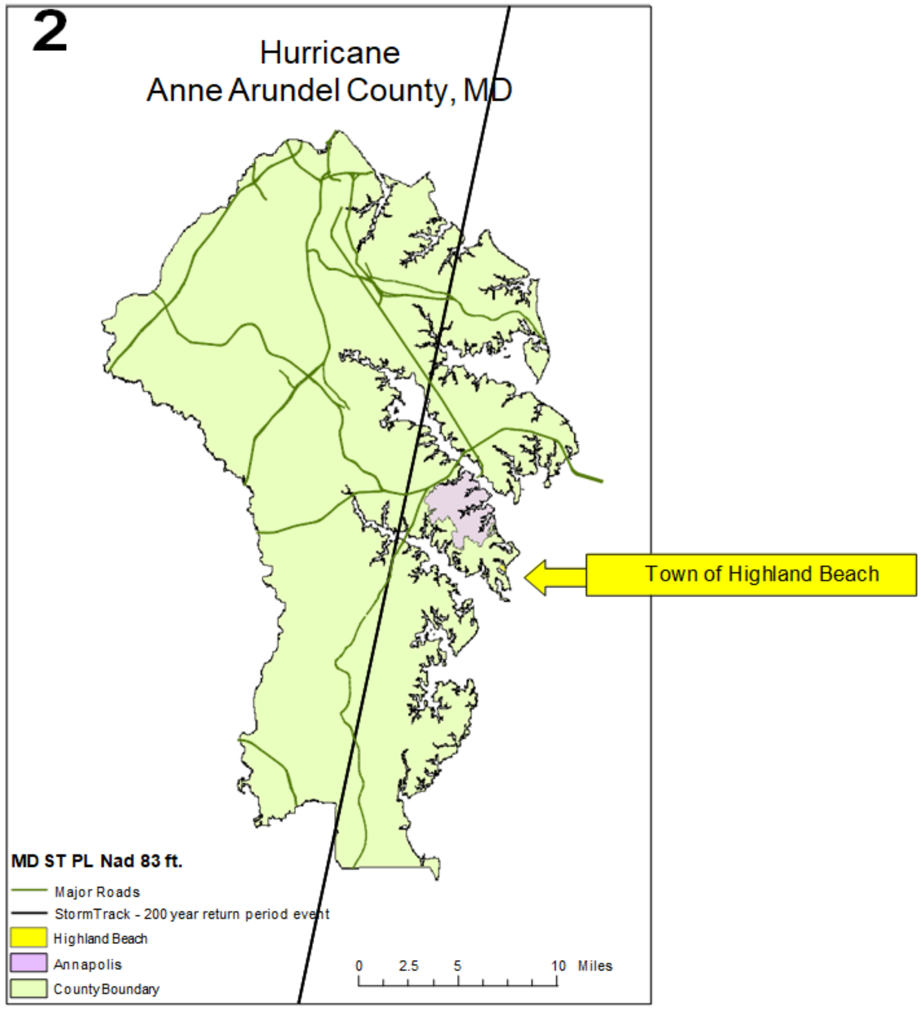
FEMA Community Lifeline	Facility Type	Number of Facilities	Estimated Improvement Value ($)	Facility Details
Communications	Telecommunication Tower	2	14,763,700	Nextel Cell Tower NE, Sprint Cell Tower N
Food, Hydration, Shelter	School	3	14,693,600	Eastport Elementary, Shady Side Elementary, Deale Elementary
	Warming & Cooling Shelter	1	795,500	Deale South County Community Library
Hazardous Materials	Fixed Hazmat Storage Site	18	63,580,600	-
Health and Medical	Health Center	2	8,261,600	AAMC Community Clinic – Morris Blum, Shady Side
Safety and Security	Fire & EMS	2	519,700	Deale Fire Co. 42, USNA Fire Co. 46
Transportation	Light Rail Station	1	-	Nursery Road Light Rail Station
Water Systems	Sewer Pump Stations	75	41,634,600	-
Total:	**-**	**104**	**144,249,300**	**-**

The County's original HMP used a HAZUS-based process to model a 200-year probabilistic storm passing just west of Annapolis (as illustrated in Figure 3.3.4-4). Wind damage from a storm of this magnitude would potentially create a loss of $795,708,709 to building and contents. Such a storm could potentially put the entire population of the County at risk. All critical facilities and community lifelines have the potential to be impacted by this hazard.

Note: the potential loss value from the 2018 HMP was inflated to the indicated amount using the U.S. Bureau of Labor Statistics on-line inflation calculator. Dollar inflation was calculated for the year 2024.

Figure 3.3.4-4 Anne Arundel County: HAZUS Hurricane Potential Track Scenario With a 200-year Return Period

Source: Anne Arundel County Office of Emergency Management



Systems

The entirety of the County's systems and infrastructure is potentially vulnerable to hurricanes, tropical storms, and nor'easters due to their large geographic extent. These systems are especially vulnerable if they are in low-lying coastal areas or hurricane storm surge inundation areas. Systems are negatively impacted by high winds and storm surge especially. More about the impacts to systems due to flooding and storm surge is available in the flood section and coastal hazard section, respectively. As shown in Table 3.3.4-6, the County's water system (i.e., sewer pump stations specifically) is the highest impacted system in terms of total locations within the storm surge inundation area. Additionally, several health and fire and EMS facilities are within the storm surge inundation area. In the case of a severe tropical storm, these systems are likely to be impacted if the storm generates storm surge in these locations. The at risk health and fire and EMS community lifelines are within the Deale-Shady Side Peninsula, which has been identified as especially at risk to the impacts of tropical systems and coastal hazards such as coastal flooding and storm surge.

Natural, Historic, and Cultural Resources

Due to the large nature of tropical systems such as hurricanes, most if not all the County's systems could be negatively impacted by hurricane wind or storm surge. The Maryland Inventory of Historic Properties lists over 800 historic resources within Anne Arundel County Government's jurisdiction, most of which are privately owned and fewer than a dozen are open to the public. Additionally, the County database counts more than 500 historic cemeteries. Anne Arundel County offers protection to these historic sites via Federal and State regulations as well as County legislation. A recent study completed by the Cultural Resources Section (Poulos et. al 2018) indicates that a number of potential, undocumented historic districts in the County (dating from the end of the 19th into the early 20th century) are waterfront beach communities located in vulnerable areas along the Chesapeake shoreline.

Community Activities

Community activities are integral to Anne Arundel County's economy and impacts to these activities due to hurricanes, tropical storms, or nor'easters may cause disruptions to the County's ability to thrive. Hurricanes, tropical storms, or nor'easters may impact systems and structures that are necessary for community activities to proceed such as road blockages and/or power system disruptions. Examples of community activities that could be impacted negatively hurricanes, tropical storms, or nor'easters include, but are not limited to:

- The Fish of Jug Bay Annual Citizen Science/Kayak Experience is held at the Emory Waters Nature Preserve in Lothian, MD. The event typically happens in late September and consists of participants utilizing kayaks to paddle along the marsh edges of the Patuxent River to observe wildlife and plant life. Hurricanes, tropical storms, or nor'easters would affect this event's ability to proceed even in miniscule amounts.
- The Annual Josh Roach Memorial Golf Tournament is held at the Compass Pointe Golf Course in Pasadena, MD. The event happens at the end of September in an area susceptible to hurricanes, tropical storms, or nor'easters making it vulnerable to cancellation due to such a hazard.
- The Fall Equinox Hike offers a beginner friendly hike through the Jug Bay Wetlands Sanctuary. This event would be adversely affected by hurricanes, tropical storms, or nor'easters due to its location.
- The Lifeline 100 Bicycle event is an annual event that offers scenic 65 and 100-mile County tours with water views and historic sites. There is also an option for 15 and 30-mile flat, paved trail ride, and a free bike rodeo. The event takes place in early October and would be heavily affected by hurricanes, tropical storms, or nor'easters hazard event.
- The African Heritage Festival is held at the Laurel Racetrack in Laurel, MD would be heavily affected by hurricanes, tropical storms, or nor'easters. The event is typically held at the end of August which falls within hurricane season making this event more susceptible to such a hazard.
- The Anne Arundel County Office of Personnel hosts the career fair mid-October at the Heritage Complex Building 2660 in Annapolis, MD. Potential loss of power or roadway blockages caused by hurricanes, tropical storms, or nor'easters would prevent access to this event – https://aaCountyfair.org/
- Renaissance Festival - https://rennfest.com/
- Annapolis Boat Shows - https://www.annapolisboatshows.com/

3.3.4.8 Future Land Use and Development Trends

Hurricanes, tropical storms, and nor'easters impact land use and development primarily through associated storm surge and high winds. Generally, tropical systems may impact any portion of Anne Arundel County, however coastal communities and development are more likely to be negatively impacted by flooding associated with storm surge, and high winds.

In Anne Arundel County, development in coastal areas in or adjacent to storm surge are most likely to be negatively impacted. As mapped, (see Coastal Hazards Section), the eastern coastal areas of the County are impacted by storm surge. The County's GDP (Plan2040) Planned Land Use Map shows that dominant land use types in the coastal areas and peninsulas of the County consist of conservation, parks and open space, and residential low-density development.

The County's peninsulas are within the "Peninsula" Development Policy Area, while inner areas along rivers are "Neighborhood Preservation" Development Policy Area. Peninsula Development Policy Areas are those where development is limited to infill and redevelopment that must be compatible with existing neighborhood character and take into consideration salt-water intrusion and vulnerability to sea level rise.

Neighborhood Preservation Development Policy Areas are also impacted by storm surge, although to a lesser extent. These areas are not intended for substantial growth or land use change, and development is limited to infill, accessory dwelling units, and redevelopment consistent with existing character.

The area with the greatest vulnerability to hurricane storm surge is the peninsula including Shady Side down to Deale. Nearly all of this peninsula is within the category 1 hurricane storm surge area, and much of it is within category 2 and 3 hurricane storm surge areas. Most of the existing land use in this area is residential low density, residential low-medium density, and parks and open space. There are some villages with high residential density, including Deale. Substantial new development is not prioritized in this area, and only infill and redevelopment that matches existing neighborhood character is encouraged by policy. It should also be noted that much of this area is within Growth Tier 1A, which means these areas are served by public sewer service, but are located outside of targeted development, redevelopment, or revitalization areas.

Finally, Nor'easters are less likely to negatively impact specific areas of the County, and therefore impacts are generally County-wide or isolated to specific regions of the County where the storm occurs. Still, coastal areas may be more frequently impacted by nor'easter events in the future, given climate change and an increase in frequency and intensity of storm events. Future conditions will be discussed more in the next section.

Coastal areas that experience flooding or high wind associated with tropical systems or nor'easters are typically tourist destinations, as well.

3.3.4.9 Future Conditions

Climate change is worsening hurricane impacts in the United States by increasing the intensity and decreasing the speed at which they travel. Scientists are currently uncertain whether there will be a change in the number of hurricanes, but they are certain that the intensity and severity of hurricanes will continue to increase. These trends are resulting in hurricanes being far more costly in terms of both physical damage and deaths. To avoid the worst impacts moving forward, communities in both coastal and inland areas need to become more resilient. (Source: Center for Climate and Energy Solutions).

Warmer sea surface temperatures intensify tropical storm wind speeds, giving them the potential to deliver more damage if they make landfall. Over the 39-year period from 1979-2017, the number of major hurricanes has increased while the number of smaller hurricanes has decreased. Based on modeling, the National Oceanic and Atmospheric Administration predicts an increase in Category 4 and 5 hurricanes, alongside increased hurricane wind speeds. Warmer sea temperatures also cause wetter hurricanes, with 10-15 percent more precipitation from storms projected. Recent storms such as Hurricane Harvey in 2017 (which dropped more than 60 inches in some locations), Florence in 2018 (with over 35 inches) and Imelda in 2019 (44 inches) demonstrate the devastating floods that can be triggered by these high-rain hurricanes.

According to a study published in the journal Science Advances, the number of hurricanes and typhoons rated as Category 3 storms and higher could double by the year 2050, due to climate change. Using computer modeling, as global air and water temperatures continue to rise due to excess greenhouse gas emissions, the increase in the number of major hurricanes and typhoons will affect a larger number of people.

The study states that climate change will increase the wind speeds of major hurricanes by as much as 20% over the next 28 years, as well as the overall frequency of Category 4 and 5 storms by more than 200% in some parts of the world. The study projected Miami to see a modest annual increase in probability of experiencing a major hurricane each year (from 3.6% at present to 4.0% by 2050), while Honolulu is forecasted to see more than double probability (from 4.0% to 8.6%) over the same span.

Considering scientists are uncertain whether climate change will lead to an increase in the number of hurricanes, there is more confidence that warmer ocean temperatures and higher sea levels are expected to increase their intensity and impacts. For the 21st century, some models project no change or a small reduction in the frequency of hurricanes, while others show an increase in frequency.

3.3.4.10 Considerations for the Next Planning Cycle

Future monitoring, evaluation, and updating of this Plan should consider the following factors related to hurricane, tropical storm, and nor’easter:

- Have any storm events occurred since this Plan was adopted?
- Has any new scientific research or methodology changed the ability to predict these storm events or assess risk and vulnerability?
- Has there been any significant change in the population, built environment, natural environment, or economy that could affect the risk or vulnerability to hurricane, tropical storm, or nor’easter events?
- Is there any new evidence related to the impacts of climate change that could affect the level of risk or vulnerability to these events

3.3.5 Drought

The Drought section includes the following sub-topics:

1. Description of Drought
2. Location, Extent, Magnitude
3. Past Occurrences
4. Probability of Future Drought Events
5. Drought Risk Assessment
6. Drought Hazards in Highland Beach
7. Impacts to People, Structures, Systems, and Resources
8. Future Land Use and Development Trends
9. Future Conditions
10. Considerations for Next Planning Cycle

3.3.5.1 Description of the Drought

A drought is an extended dry climate condition when there is not enough water to support urban, agricultural, human, or environmental water needs. It usually refers to a period of below normal rainfall but can also be caused by drying bores or lakes, or anything that reduces the amount of liquid water available. Drought is a recurring feature of nearly all the world's climactic regions.

Drought is a normal, recurrent feature of climate, although at times it is considered a random event. Its characteristics vary significantly from one region to another. Drought is a temporary condition; it differs from aridity, which is a permanent climate feature in regions with low rainfall.

Drought can have a widespread impact on the environment and the economy, depending upon its severity. Unlike other natural disasters, it typically does not directly result in loss of life or damage to property. However, drought can have indirect impacts on livelihoods and well-being that can lead, over the long term, to loss of life. Drought, as a persistent moisture deficiency, can lead to adverse impacts on vegetation, people, and animals. High temperatures, high winds, and low humidity can worsen drought conditions and leave areas more susceptible to wildfire. Human demands and actions can also hasten drought-related impacts.

The State of Maryland uses the U.S. Army Corps of Engineers definition of drought. It states, "droughts are periods of time when natural or managed water systems do not provide enough water to meet established human and environmental uses because of natural shortfalls in precipitation or stream flow." Droughts unfold at an almost imperceptible pace with beginning and ending times that are difficult to determine, and with effects that often are spread over vast regions. While maintaining water supplies for human use is an important aspect of drought management, drought can also have many other dramatic and detrimental effects on the environment and wildlife.

In order to monitor potential drought conditions in a uniform manner, the State uses four indicators of water sufficiency. The indicators are based on the amount of precipitation and the effect of the precipitation (or lack of precipitation) on the hydrologic system. These indicators include:

- Precipitation levels
- Stream flows
- Groundwater levels
- Reservoir storage

Indicators are evaluated by comparing current conditions to natural conditions within the period of record. In this way, it can be determined if a current deficit is within a commonly experienced range, or whether it is unusually large.

In order to monitor drought conditions across the State, Maryland Department of the Environment performs monthly evaluations of hydrologic indicators. The indicators—precipitation, stream flow, groundwater levels and reservoir storage—are used in conjunction with the condition of water supplies, status of utilities, temperature, season of year and other relevant factors. This method was endorsed by the Statewide Water Conservation/Drought Advisory Committee to measure the impact of a drought on a regional basis throughout the State.

Drought conditions are evaluated on a Statewide, regional, and County basis. This allows for varying hydrologic conditions across the State, and provide for the most flexibility when assessing and responding to drought conditions. In addition, monitoring of water supply problems at individual systems may impact drought declarations in specific areas of the State.

Data collection points for monitoring drought indicators are located throughout the State and must be analyzed collectively in order to assess the overall severity of drought. Indicators are evaluated at all levels. For instance, precipitation values are provided on a County-by-County basis. Values for individual counties will be averaged to achieve a mean value for a region (MDE Drought Status).

3.3.5.2 Location, Extent, & Range of Magnitude of Drought

Droughts may occur anywhere in the United States. Effects seen in different regions vary depending on normal meteorological conditions such as precipitation and temperature, as well as geological conditions such as soil type and subsurface water levels. Drought is possible throughout the planning area, but the data has revealed no significant drought history since 1950. The entire County is at some risk from drought events.

Drought does not have particular impacts in any one geographical section of the County. However, this hazard would have the greatest impact on the agricultural community. The economic impacts of this hazard cannot be evaluated geographically. Critical County infrastructure is unlikely to be affected by this hazard.

A drought’s severity depends on numerous factors, including duration, intensity, and geographic extent as well as regional water supply demands by humans and vegetation. The severity of drought can be aggravated by other climatic factors, such as prolonged high winds and low relative humidity. Due to its multi-dimensional nature, drought is difficult to define in exact terms and also poses difficulties in terms of comprehensive risk assessments. Drought can cause extensive damage to commercial and residential structures, foundations, framing and walls, agricultural crops, roads, bridges, pipelines, utilities, and railroads.

Precipitation amounts are evaluated based on the water year (beginning October 1). Water years are a natural dividing point for water supply as precipitation that falls in the first six months of a water year is analogous to putting money in the bank. A higher percentage of this rainfall or snowfall ends up recharging the groundwater system, which sustains the stream flows and groundwater levels during dry periods. Deficits during this time are more critical for later water levels than deficits during the growing season. If a precipitation deficit outside of the normal range exists at the end of a water year, the precipitation records will carry forward until a normal condition is reached. Because the significance of a precipitation deficit changes as the water year progresses, drought stages will trigger at different percentages of normal depending upon the date of evaluation. See Table 3.3.5-2 for the precipitation drought triggers.

Stream flow gages are used to measure stream flow. Using seven-day average flows, the median flow for an evaluation period is compared with low flows representing historical occurrence frequencies of 25%, 10%, and 5% for the same date for the period of record. A 25% frequency equates to a one-in-four-year occurrence, 10% frequency a one in 10-year occurrence and 5% frequency a one in 20-year occurrence.

Representative wells are used for monitoring groundwater levels. Groundwater conditions are evaluated on a monthly basis. The monthly levels are compared with values equivalent to the 25th, 10th, and 5th percentiles of historical records. The State of Maryland uses a staged process for defining drought conditions. Drought indicators are monitored on an ongoing, year-round basis, and drought status is determined on a variable timeframe according to drought stage (see Tables 3.3.5-1 and 3.3.5-2 below). The frequency of evaluation increases if the drought intensifies:

- Stage 1: Monthly
- Stage 2: Bi-weekly
- Stage 3: Weekly
- Stage 4: Weekly or as needed

Table 3.3.5-1 Drought Indicators

	Precipitation As % of Normal for Evaluation Period[1]	Streamflow as Percentile of Normal	Groundwater Levels as Percentile of Normal[2]	Reservoir Storage in Days
Stage 1 Normal	Refer to Table 3.3.5-2 below	>25	>25	>120
Stage 2 Watch		25	25	120
Stage 3 Warning		10	10	90
Stage 4 Emergency		5	5	60

[1] These values vary depending on the length of review period. For more detail see Table 3.3.5-2.
[2] At the 25th percentile, it means that historical streamflows or ground water levels are lower than this value only 25% of the time for the evaluation period. 10th and 5th percentiles represent increasingly lower streamflows or ground water levels and more severe drought events. Source: Maryland Department of the Environment

Table 3.3.5-2 Precipitation Triggers

Number of Months Analyzed	Normal (% of Normal Precipitation)	Watch (% of Normal Precipitation)	Warning (% of Normal Precipitation)	Emergency (% of Normal Precipitation)
3	>75.0	75.0	65.0	55.0
4	>80.0	80.0	70.0	60.0
5	>80.0	80.0	70.0	60.0
6	>80.0	80.0	70.0	60.0
7	>81.5	80.0	71.5	61.5
8	>82.5	82.5	72.5	62.5
9	>83.5	83.5	73.5	63.5
10	>85.0	85.0	75.0	65.0
11	>85.0	85.0	75.0	65.0
12	>85.0	85.0	75.0	65.0

Source: Maryland Department of the Environment

Another method of measuring drought severity is through the Palmer Drought Severity Index (PDSI). The PDSI uses mathematical equations that incorporate precipitation and temperature data to estimate evaporation, runoff, and soil moisture recharge; it measures the extent or magnitude of drought by evaluating the duration and intensity of long-term drought-inducing circulation patterns. Long-term drought is cumulative, with the intensity of drought during a month dependent upon that month's weather patterns plus the cumulative patterns of previous months. The hydrological impacts of drought take longer to develop. The fixed mathematical formulas can be applied retroactively to historical data, and the National Center for Environmental Information (NCEI) maintains a database of monthly PDSI dating to 1895. The PDSI drought classifications are based on observed drought conditions.

Table 3.3.5-3 Palmer Drought Severity Index (PDSI) Classifications

Drought Index	Drought Condition Classification						
	Extreme	Severe	Moderate	Normal	Moderately Moist	Very Moist	Extremely Moist
Z Index	-2.75 and below	-2.00 to -2.74	-1.25 to -1.99	-1.24 to +.99	+1.00 to +2.49	+2.50 to +3.49	N/A
Meteorological	-4.00 and below	-3.00 to -3.99	-2.00 to -2.99	-1.99 to +1.99	+2.00 to +2.99	+3.00 to +3.99	+4.00 and above
Hydrological	-4.00 and below	-3.00 to -3.99	-2.00 to -2.99	-1.99 to +1.99	+2.00 to +2.99	+3.00 to +3.99	+4.00 and above

Source: National Drought Mitigation Center. (n.d.). Measuring Drought. https://drought.unl.edu/ranchplan/DroughtBasics/WeatherandDrought/MeasuringDrought.aspx

In addition to the PDSI, the United States Drought Monitor produces maps based on a drought classification system that summarizes conditions and impacts in a format that is easy for the general public to understand. Drought intensity is classified from D0 (abnormally dry) to D4 (exceptional drought). The classifications identify the level of intensity using the associated descriptor and define possible impacts at the various stages of drought. In addition, the classifications integrate other drought monitoring tools within each drought category. This classification system is included on Table 3.3.5-4.

When geographic areas are classified as D0, they are considered "drought watch" areas because they are in one of the following conditions: drying out and possibly heading for drought; recovering from drought but not yet back to normal; or suffering long-term impacts of drought such as low reservoir levels.

Table 3.3.5-4 Drought Severity Classifications

Drought Severity	Return Period (Years)	Description Of Possible Impacts	Drought Monitoring Indices: Standardized Precipitation Index (SPI)	Drought Monitoring Indices: Palmer Drought Severity Index (PDSI)	Drought Monitoring Indices: USDM Drought Category
Abnormally Dry	3 to 4	Going into drought: short-term dryness slowing growth of crops or pastures; fire risk above average. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered.	-0.5 to -0.7	-1.0 to -1.9	**D0**
Moderate Drought	5 to 9	Some damage to crops or pastures; fire risk high; streams, reservoirs, or wells low, some water shortages developing or imminent, voluntary water use restrictions requested.	-0.8 to -1.2	-2.0 to -2.9	**D1**
Severe Drought	10 to 17	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed.	-1.3 to -1.5	-3.0 to -3.9	**D2**
Extreme Drought	18 to 43	Major crop and pasture losses; extreme fire danger; widespread water shortages or restrictions.	-1.6 to -1.9	-4.0 to -4.9	**D3**
Exceptional Drought	44+	Exceptional and widespread crop and pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells creating water emergencies.	Less than -2.0	-5.0 or less	**D4**

Source: National Drought Mitigation Center, 2023

3.3.5.3 Past Occurrences

The NCEI Storm Event database was queried for drought events as part of the 2025 HMP update. The database includes 12 reported droughts in Anne Arundel County between January 1997 and December 2024. All of these recorded drought events occurred between 1997 and 2007. These events are included on Table 3.3.5-5. The NCEI reported three events that caused agricultural damage totaling $1.67 million (which was all from one event, in 1998).

Current conditions (i.e. as of December 13, 2024) are such that 84.54% of the County meets the criteria for D2 – Severe Drought. In fact, drought conditions in the County have qualified for a Drought Disaster Designation (Number S5887) by the U.S. Secretary of Agriculture on November 25, 2024. The drought event began on November 19, 2024, and has not yet concluded as of this plan update. More information on the emergency disaster designation and declaration process is available here.

Based on these 13 historical events, it can be concluded that about 0.48 drought events occur annually in Anne Arundel County. From these previous occurrences, it is reasonable to assume that droughts will continue at this rate in Anne Arundel County with minimal overall impacts in terms of deaths, injuries, and property damage.

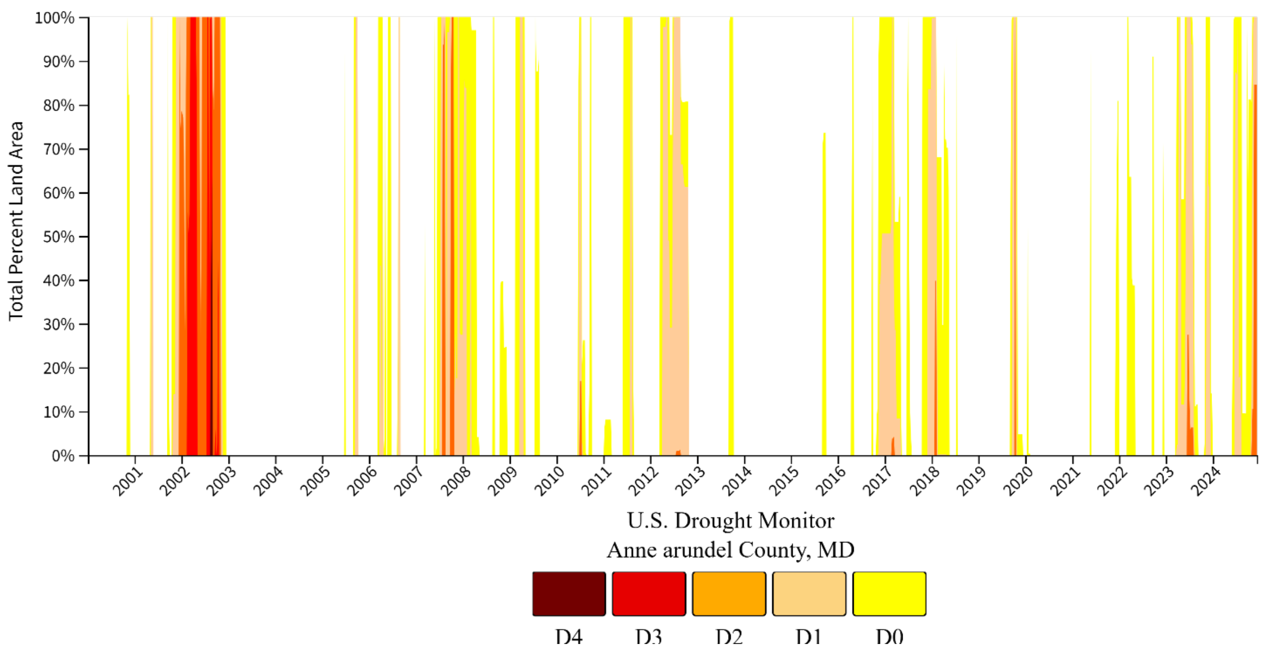
Table 3.3.5-5 Drought Events in Anne Arundel County from 1950 – 2024

Date	Deaths	Injuries	Property Damage ($)	Crop Damage ($)
07/01/1997	0	0	$0	$0
08/01/1998	0	0	$0	$0
10/01/1998	0	0	$0	$0
11/01/1998	0	0	$0	$1,670,000
12/01/1998	0	0	$0	$0
05/01/1999	0	0	$0	$0
06/01/1999	0	0	$0	$0
07/01/1999	0	0	$0	$0
08/01/1999	0	0	$0	$0
09/01/1999	0	0	$0	$0
08/01/2007	0	0	$0	$0
10/01/2007	0	0	$0	$0
Total:	**0**	**0**	**$0**	**$1,670,000**

Table 3.3.5-4 describes the severity of the historic drought conditions that are illustrated in Figure 3.3.5-1 below. Based on these metrics, Anne Arundel County has not experienced a D4: Exceptional drought or a D3: Extreme drought since 2002.

Figure 3.3.5-1 Drought Conditions in Anne Arundel County from January 2000 to December 2024

Source: NOAA NIDIS U.S. Drought Monitor, Drought.gov.



Drought events as recorded in the NCEI database and depicted in Figure 3.3.5-1 are described in greater detail in Table 3.3.5-6.

Table 3.3.5-6 Significant Drought Events in Anne Arundel County from 1950 – 2024

Date	Drought Description
July 1997	A heat wave lasting 7 days during a dry month detrimentally affected Maryland's farmland, damaging crop yields. Corn, hay, alfalfa, and soybeans were primarily affected resulting in declarations of agricultural states of emergency.
August 1998	In August 1998, the Baltimore region received just under one inch of rain, approximately three less inches than normal. Crop yields for corn and soybean were expected to decline by 30 to 40 percent and 20 percent, respectively. Around half of the surviving crops were rated between "fair" and "very poor."
October 1998	The time period spanning from July to October 1998 experienced concerningly low levels of rainfall that had not been recorded since 1930. Over these four months, the region received roughly 4.66 inches of rain. Additionally, October 1998 was marked the 5th driest October since 1871. In addition to abnormally low levels of rainfall, freshwater and groundwater levels in the area were recorded to be "below average" (cite NOAA). Crop damage continued through this month as over 80% of topsoil was rated "short" or "very short." Farmers resorted to decreasing feedings for livestock and to opt out of autumn plantings of wheat, barley, and rye.
Novembe r 1998	Between July and November 1998, a total of 5.79 inches of rain fell in the region, compared to the average of 17 inches that the area typically receives over this time frame. During this month, Anne Arundel County received only 1.11 inches of rain. Nearby reservoirs, tributaries, and rivers experienced a decline in water levels, including the Potomac River and the Pretty Boy Reservoir. The agriculture sector suffered a significant $40 million loss to the fall harvest, while farmers were unable to plant winter crops. Grains only grew half as much as they should have by this time. Anne Arundel experienced the third largest fire in the state, as a result of low moisture. Throughout the entire surrounding region, 173 wildfires burned 490 acres.
Decembe r 1998	Coupled with higher-than-average temperatures, the central and northern region of Maryland saw a great decline in water reserves of around 10 to 12 feet below average in Montgomery and Prince George County. Approximately 2,000 businesses and households depended on a short-term pipeline from Frostburg as the Potomac and Shenandoah River basins failed to fulfill the region's water needs.
May 1999	In May of 1999, Anne Arundel County received 1.3 inches of rain, while Baltimore/Washington International Airport recorded 1.72 inches of rain—2 inches less than normal. Water levels in the Potomac River and Chesapeake Bay were once again negatively impacted by dry periods in the region. In fact, the water flow around D.C. was merely 23% of the monthly average. Furthermore, the flow of water to the Chesapeake Bay recorded a historical low as it averaged at 43% of the monthly average. Animals and plants were negatively affected by the lack of fresh water, which increased the salinity levels of the water.
June 1999	June 1999 marked the second month since the previous year that unusually dry periods in Anne Arundel County and the surrounding region started, becoming the second driest year recorded in the area. Anne Arundel County's total rainfall for this month was 2.2 inches. Since July 1998, precipitation levels in the County were 15 inches under average.
July 1999	Throughout this month, 22 out of 31 days exceeded 90 degrees, while Anne Arundel County only received 2 inches of rain. Several events, like Frederick County's Great River Race, were canceled as water levels in the Potomac watershed continued to average significantly lower than normal.
August 1999	August 1999 rounded out an entire year of drought conditions in Anne Arundel and continued a pattern of minimal rain. Similarly to the previous month, Palmer Drought Index determined that Maryland was experiencing "extreme drought" conditions, while water flow into the Potomac River was recorded to be at a meager 11% of the monthly average. To mitigate damage, the Maryland Governor implemented mandatory water restrictions at the beginning of the month. Surprisingly, 6.6 inches of rain fell in Anne Arundel County between August 24th and August 26th— more than in any other month

Table 3.3.5-6 Significant Drought Events in Anne Arundel County from 1950 – 2024

Date	Drought Description
	since drought conditions began in August 1998. Unfortunately, the rain failed to replenish the aquifer supply as most of it became runoff and ended up in the river. The persisting drought caused considerable damage to the state's wildlife, as fish kills soared and key species of crabs, bottlenose dolphins, and oysters suffered population decline and displacement.
September 1999	September 1999 marked the last month of severe drought conditions that began in August 1998. Two hurricanes were largely responsible for ending the drought, as September 1999 turned out to be the second wettest recorded September in the region. In total, Anne Arundel County received 12.5 inches of rain, while Baltimore/Washington International Airport received 11.5 inches of rain, or 8.09 inches more than average. As water levels improved, water and open burning restrictions were lifted. In total, farmers in Maryland suffered $75 million in losses from the start of the drought.
August 2007	Drought conditions began in July and continued through the middle of August 2007. The agricultural sector was primarily affected, although estimated damages were not recorded.
October 2007	Drought conditions began at the beginning of October, as total rainfall declined dramatically but slightly recovered near the end of the month. Total estimates were not recorded.

Source: NCEI Storm Events Database

3.3.5.4 Probability of Future Drought Events

Based on past and recent history, Anne Arundel County clearly has a low probability of a drought event occurring in the future. Based on recorded drought events in the NCEI database, the County is likely to experience about 0.48 drought events annually.

3.3.5.5 Drought Risk Assessment

Impacts from drought in the planning area are primarily related to cascading effects on water supply and agriculture and the resulting increase in wildfires. Lack of rainfall during drought conditions affects water levels of groundwater, the main water source for Anne Arundel County. Many of the deep aquifers of the Patapsco, Patuxent and Aquia serving the County have experienced dangerously low levels in the past due to ongoing periods of drought. During these periods, many locations are forced to impose water restrictions, which could lead to economic impacts for the region. The most vulnerable residents are those in the more rural areas, many of whom draw their water supply from wells.

Short-term droughts can impact agricultural productivity, while longer-term droughts are more likely to impact not only agriculture but also water supply. Short- and long-term drought may lead to an increase in the incidence of wildfires, which might in turn lead to increased potential for landslides or mudflows once rain does fall.

3.3.5.6 Drought Hazards in Highland Beach

Highland Beach has about the same level of exposure and vulnerability to droughts as the rest of the County. There is low risk of human injury and/or death due to drought in the Town of Highland Beach; however, water shortages may impact vulnerable populations who are unable to plan for shortages or access alternate water sources. Extreme long-term drought may also impact food supplies.

3.3.5.7 Impacts to People, Structures, Systems, and Resources

Drought can cause considerable impacts to people, structures, systems, and activities in Anne Arundel County. Drought primarily negatively impacts agricultural land and farmers. However, the overall impact to the planning area from drought will most likely be low to moderate considering the frequency and magnitude of past occurrences. Impacts on people, structures, systems, resources, and community activities are considered in the following sections.

Drought
The Public's Perspective

A survey conducted during the 2025 plan update asked County residents their level of concern for hazards identified in the plan.

37.66% of respondents indicated that they are only "somewhat concerned" with drought. However, 31.17% of respondents indicated they are "concerned" with this hazard.

52.67% of respondents indicated that they have seen an "increase" in the frequency or intensity of the drought hazard over the last 10 years.

25.23% of respondents indicated that a drought event has caused damage to their residential or commercial property.

People

According to Drought.gov, 537,656 people in Anne Arundel County could be affected by drought. Drought usually occurs slowly with some warning. Human lives may not be lost, but lifestyles could be dramatically altered, and the economic effects felt Countywide. The NOAA database indicates that there are no known deaths or injuries from droughts in the planning area. As observed during significant droughts, low crop yields can alter livestock eating habits. Low crop and livestock production could lead to food shortages and worsen food security. An unstable agricultural industry can result in job loss and farmers could face dire financial hardships. Long-term droughts could displace communities if access to water is severely difficult. Restricted access to water could increase the risk of heatstroke when paired with high temperatures. Water-dependent industries, like fishing or water recreation, might be put on pause, resulting in financial losses.

Structures

Long periods of drought can weaken building foundations and result in structural damage. These damages can be expensive and difficult to repair. According to the 2021 Maryland Hazard Mitigation Plan, no critical facilities or state assets in Anne Arundel County are at risk of damage from drought.

Systems

Networks and systems are not typically vulnerable to droughts. Around $1.67 million in agricultural property damages were reported over the 12 drought events recorded on the NOAA database. These losses reflect a decline in crop quality and disruptions in planting cycles.

Natural, Historic, and Cultural Resources

Prolonged droughts can dramatically change ecosystems and cause wildlife loss. Environmental losses from drought are associated with damage to plants, animals, wildlife habitat, and air and water quality; forest and range fires; degradation of landscape quality; loss of biodiversity; and soil erosion. Some of the effects are short-term, and conditions quickly return to normal following the end of the drought. Other environmental effects linger for some time or may even become permanent. As most living beings are highly dependent on water, prolonged periods without it can have extremely detrimental effects on the health and condition of natural resources.

Community Activities

Anne Arundel County offers a variety of water-related sports and activities. Recreational fishing, cartop boating and indoor or outdoor public swimming facilities would likely be negatively impacted by significant droughts. Summer outdoor activities, like field hockey, soccer, lacrosse, and football would likely face delays, scheduling disruptions, or cancellations, particularly if they rely on grass fields.

3.3.5.8 Future Land Use and Development Trends

Drought primarily impacts farmers, ranchers, and communities which rely on agriculture due to the crop failures associated with significant and prolonged drought. Agricultural land covers much of Anne Arundel County's southwest land area. These areas are mostly part of the "rural and agriculture" development policy area. This policy area limits development to protect rural and agricultural heritage and economy and limit the costly extension of public facilities and services. Farmers and agriculture are also heavily impacted by drought due to its negative effects on water resources, specifically availability. River and groundwater levels can significantly diminish during a drought, which lessens availability for drinking, irrigation, and industrial uses.

According to the 2022 Census of Agriculture, Anne Arundel County has 454 of the 12,550 total farms in the state. This represents 3.6% of total farms in Maryland. Farms comprise 36,003 acres in Anne Arundel County or 17.2% of the total land acreage in the County. Total farm acres in Anne Arundel have increased by 33 since the previous census conducted in 2017. Droughts are projected to become more frequent and intense due to climate change, therefore expanding agricultural land uses in the County will have to take into consideration the negative consequences of a drought event.

Additionally, the ever-growing population of the County by 2045 might create a scenario where there is more competition for water resources during a drought. This increased competition for water due to drought conditions may disproportionately impact vulnerable populations, particularly low-income households.

Highland Beach lacks the agricultural land uses that are seen throughout the County. The Town is served by public sewer only. Residents that rely on well water in Highland Beach as do other communities on the Annapolis Neck coast are already being affected by a drawdown in the water table and saltwater intrusion. Drought would exacerbate the problems in the water table, resulting in more residents and well water supplies to be affected by saltwater intrusion. Therefore, future development in these areas, while projected to be very minimal, should consider impacts from drought hazard.

3.3.5.9 Future Conditions

Increasingly frequent drought conditions have long been forecasted as a consequence of warming temperatures. A study from the National Center for Atmospheric Research (NCAR) projects serious impacts as soon as the 2030's. Impacts by century's end could go beyond anything in the historical record.

Scientists use the Palmer Drought Severity Index to measure drought as introduced in Table 3.3.5-3. A positive score indicates wetter conditions, and a negative score indicates drier conditions; a score of zero is neither overly wet nor dry.

According to the NCAR study, the most severe drought in recent history, in the Sahel region of western Africa in the 1970s, had a PDSI of -3 or -4. By contrast, the study indicates that by 2100 some parts of the U.S. could see -8 to -10 PDSI. By the 2030's, the central and western U.S. could see average readings dropping to -4 to -6, the study projected. At present, most of the Northeast (including Maryland) is expected to see only slightly drier conditions by the end of the 2030's, that is, a decreasing PDSI of -0.5 to -1.0.

3.3.5.10. Considerations for the Next Planning Cycle

Future monitoring, evaluating, and updating of this Plan should consider the following factors related to drought:

- Have drought events occurred within the County since adoption of 2025 HMP update?
- Did drought events take place in other areas that impacted the County by virtue of proximity?
- Has new scientific research or methodology changed the ability to predict drought events or assess risk and vulnerability?
- Has there been significant change in the population, built environment, natural environment, or economy that could affect the level of risk or vulnerability to drought, including land use for agricultural purposes and water infrastructure?
- Is there new evidence related to the impacts of drought that could affect the level of risk or vulnerability to drought?

3.3.6 Earthquake

The Earthquake section includes the following sub-topics:

1. Description of Earthquake
2. Location, Extent, Magnitude
3. Past Occurrences
4. Probability of Future Earthquake Events
5. Earthquake Risk Assessment
6. Earthquake Hazards in Highland Beach
7. Impacts to People, Structures, Systems, and Resources
8. Future Land Use and Development Trends
9. Future Conditions
10. Considerations for Next Planning Cycle

3.3.6.1 Description of Earthquakes

An earthquake is a sudden release of energy from the earth's crust that creates seismic waves. Tectonic plates become stuck, putting a strain on the ground. When the strain becomes so great that rocks give way, fault lines occur. At the Earth's surface, earthquakes may manifest themselves by a shaking or displacement of the ground, which may lead to loss of life and destruction of property. The "size" of an earthquake is expressed quantitatively as magnitude, and local strength of shaking as intensity.

Earthquakes are primarily caused by the release of stresses accumulated as a result of the rupture of rocks along opposing fault planes in the earth's outer crust. These fault planes are typically found along the borders of the earth's tectonic plates. These borders generally follow the outlines of the continents, with the North American plate following the continental border with the Pacific Ocean in the west and the mid-Atlantic trench in the east. Earthquakes occurring in the mid-Atlantic trench usually pose little danger to humans. Although the greatest earthquake threat to North America lies along the Pacific Coast, there is some threat to the eastern United States from the Caribbean Plate.

The areas of greatest tectonic instability lie at the perimeters of the slowly moving plates. These locations are subject to strains from plates traveling in opposite directions and at different speeds. Deformation along plate boundaries causes strain in the rock and leads to a buildup of stored energy. When built-up stress exceeds the strength of the rocks, a rupture occurs. Rock on both sides of the fracture is snapped, releasing the stored energy and producing seismic waves that generate an earthquake.

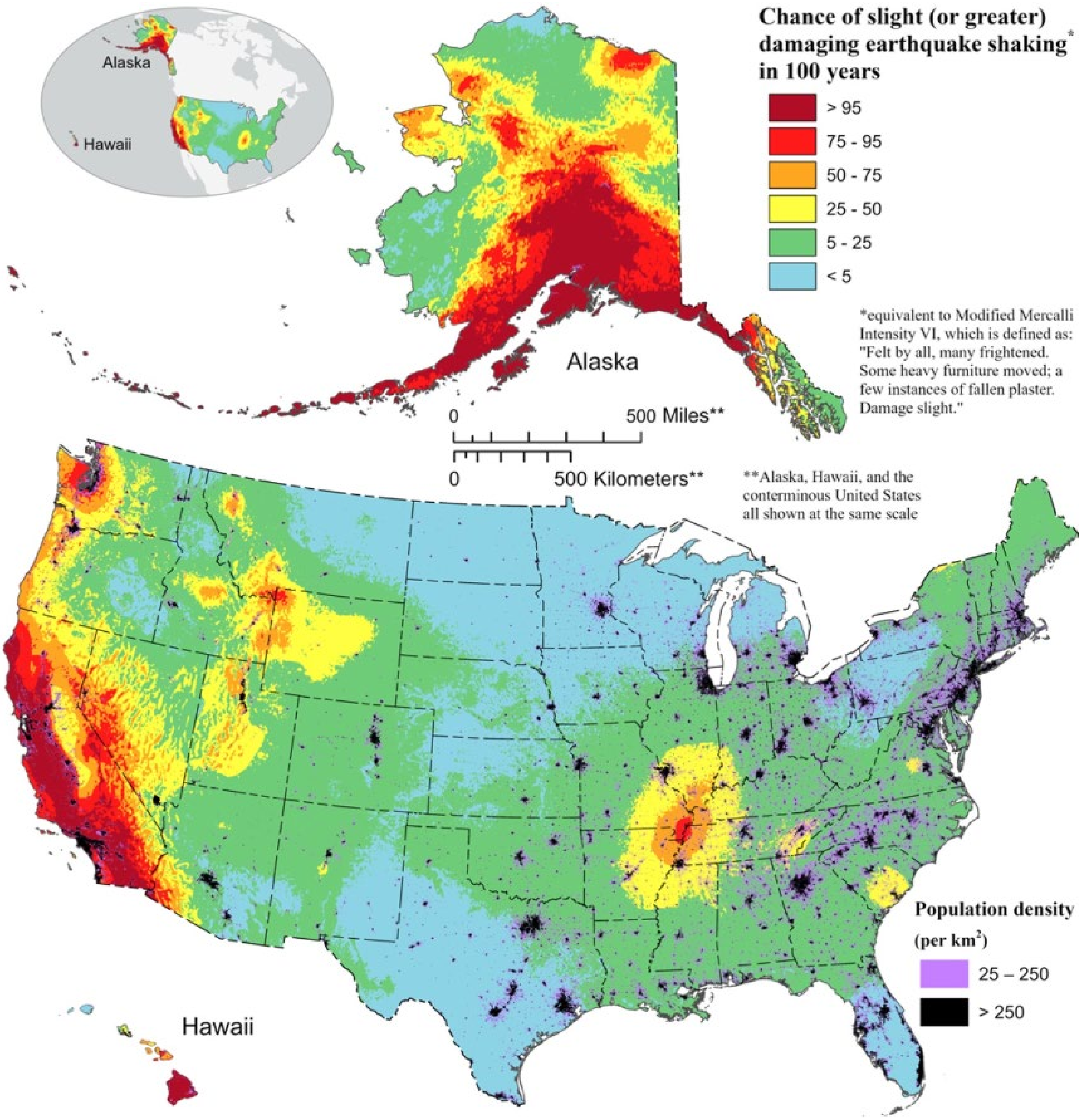
Ground shaking can lead to the collapse of buildings and bridges and disrupt gas lines, electricity, and phone service. Death, injuries, and extensive infrastructure and property damage are possible with this hazard. Some secondary threats caused by earthquakes may include fire, hazardous material release, landslides, flash flooding, and dam failure. Most property damage and earthquake-related deaths are caused by the failure and collapse of structures due to ground shaking. The level of damage depends upon the amplitude and duration of the shaking, features that are directly related to the earthquake's size, distance from the fault, location, and regional geology. Other damaging earthquake effects include landslides (the down-slope movement of soil and rock in mountain regions and along hillsides) and liquefaction, in which ground soil loses shear strength and thus the ability to support foundation loads. In the case of liquefaction, anything relying on the substrata for support can shift, tilt, rupture, or collapse.

3.3.6.2 Location, Extent, & Range of Magnitude of Earthquakes

The entire planning area is equally susceptible to the effects of earthquakes. Figure 6.3.3-1 displays the United States Geological Survey (USGS) seismic hazard model completed for 2023. The map shows the chance of a slight (or greater) damaging earthquake shaking to occur in the next 100 years. The majority of Maryland, including Anne Arundel County, falls in the 5-25% chance zone.

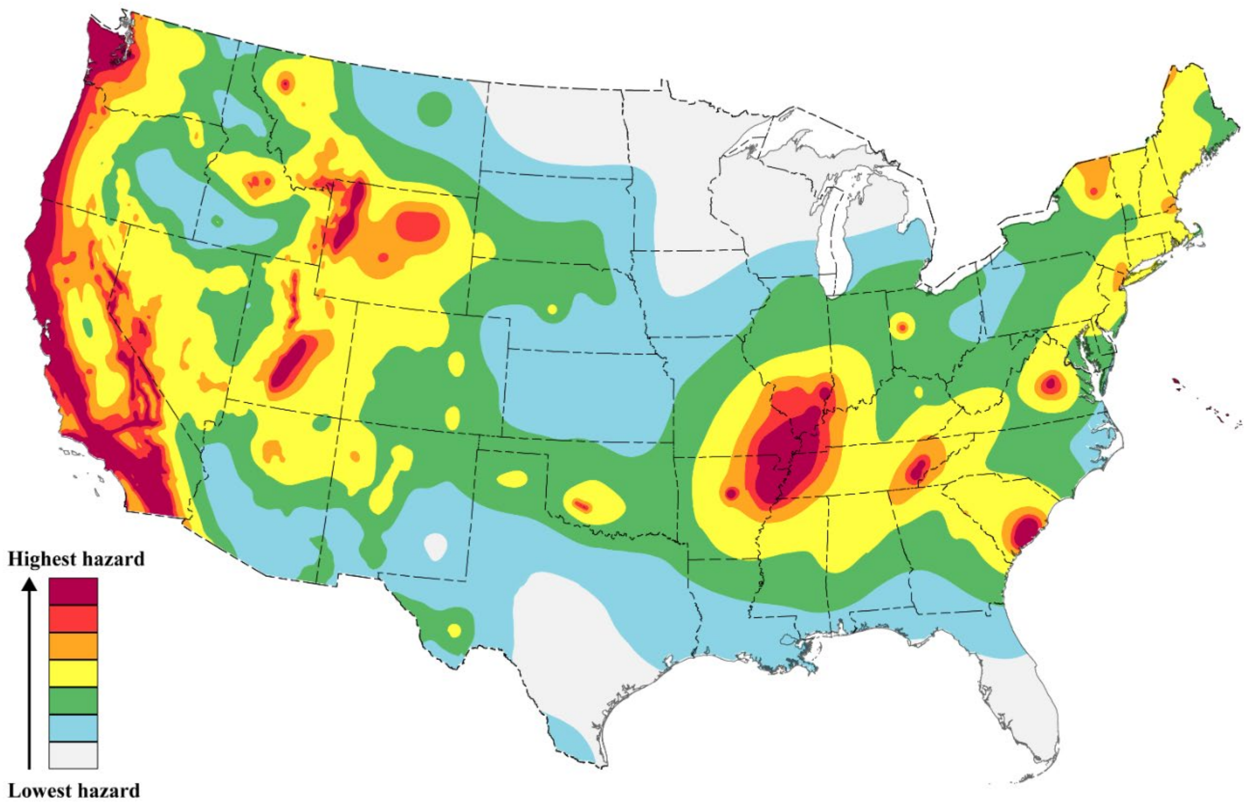
Figure 6.3.3-1: Seismic Hazard Model (2023) – Chance of Damaging Earthquake Shaking.

Source: USGS



Overall, the mid-Atlantic and central Appalachian regions of Maryland are characterized by a moderate amount of low-level earthquake activity, but their causes are largely a matter of speculation. In Maryland, for example, there are numerous faults, but none is known or suspected to be active. As shown in Figure 3.3.6-2, the region and the County are within a low earthquake hazard zone, which means the probability of any severe earthquake in the area is minimal. However, there are moderate earthquake hazard areas (yellow) adjacent to the County, which could create impacts in Anne Arundel County. The severity of earthquakes is influenced by several factors, including the depth of the quake, the geology in the area, and the soils.

Figure 3.3.6-2: Seismic Hazard Model (2023)
Source: USGS



The standard for magnitude measures is the Richter Scale, an open-ended scale expressed in whole numbers and decimal fractions. The Richter Scale is logarithmic, meaning that an earthquake of magnitude 5.0 has 10 times the wave amplitude of a magnitude 4.0 and 100 times the ground vibration amplitude of a magnitude 3.0 event. Table 3.3.6-1 shows the relationship Richter magnitude and earthquake effects.

Table 3.3.6-1 Richter Scale Magnitudes and Associated Earthquake Size Effects

Richter Magnitudes	Earthquake Effects
Less than 3.5	Generally, not felt but recorded.
3.5-5.4	Often felt but rarely causes damage.
5.4- 6.0	At most, slight damage to well-designed buildings; can cause major damage to poorly constructed buildings over small regions.

Table 3.3.6-1 Richter Scale Magnitudes and Associated Earthquake Size Effects

Richter Magnitudes	Earthquake Effects
6.1-6.9	Can be destructive up to about 100 kilometers from epicenter.
7.0-7.9	Major earthquake; can cause serious damage over large areas.
8.0 or greater	Great earthquake; can cause serious damage in areas several hundred kilometers across.

Measurement of the severity of an earthquake can be expressed in several ways, the two most common being intensity and magnitude. The intensity, reported on the Modified Mercalli Intensity (MMI) Scale, is a subjective measure in terms of eyewitness accounts (see Table 3.3.6-2). Intensities are ranked on a 12-level scale and range from barely perceptible (I) to catastrophic destruction (XII). The lower intensities are described in terms of people's reactions and sensations, whereas the higher intensities relate chiefly to observable structural damage. Magnitude is an objective measure of earthquake severity and is closely related to the amount of seismic energy released at the focus of an earthquake. It is based on the amplitude of seismic waves as recorded on standardized seismographs.

Table 3.3.6-2 Mercalli Intensity Scale Value Descriptions

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

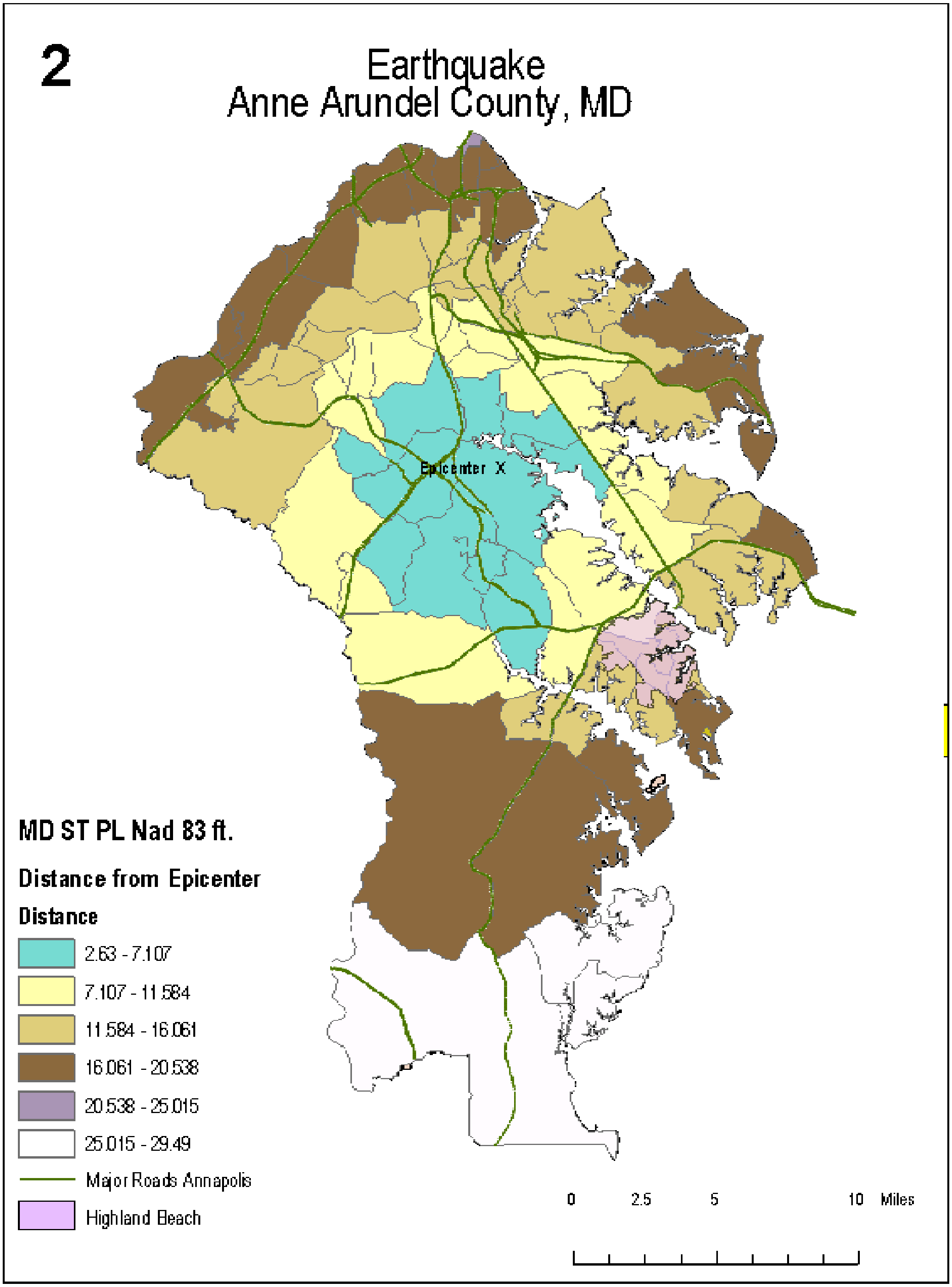
Table 3.3.6-2 Mercalli Intensity Scale Value Descriptions

Intensity	Richter Magnitude	Shaking	Description/Damage	Average Estimated Annual Frequency
			ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.	
IX		Violent	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.	100 to 150 per year
X	<7.3	Disastrous	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.	18 per year
XI	<8.1	Very Disastrous	Most buildings and bridges collapse, roads, railways, pipes and cables destroyed. Historic structures very likely to be damaged or destroyed.	One per year
XII	>8.1	Catastrophic	Destruction: trees fall; lines of sight and level are distorted; ground rises and falls in waves; objects are thrown upward into the air.	One per year

Source: U.S. Geological Survey (USGS).

However, an earthquake of magnitude 5.0 located in the center of the County, as illustrated in Figure 3.3.6-3, could have substantial effects on the County. An earthquake of this magnitude would potentially create a loss of $10,550,753,073 (2024 inflation adjusted dollars) to buildings and their contents. Note that the HAZUS database that was originally used to estimate total building and contents values is no longer available, so the aforementioned building content loss value is extrapolated from the 2018 HMP using the U.S. Bureau of Labor Statistics on-line inflation calculator. A significant earthquake could potentially put the entire population of the County at risk, although potential losses would vary greatly depending on specific conditions at the time, and by site.

Figure 3.3.6-3 Earthquake Scenario – Anne Arundel County
Source: Anne Arundel County Office of Emergency Management



3.3.6.3 Past Occurrences

For the 2025 plan update, the USGS historical earthquake data was used to identify past earthquakes in Anne Arundel County. The earliest recorded earthquake in Maryland occurred in Annapolis, on April 24, 1758. The shock lasted 30 seconds and was preceded by subterranean noises. In recent years, moderate-sized earthquakes in nearby States have been felt in Maryland with only negligible effects. Anne Arundel County has experienced few minor earthquakes of low magnitude and intensity over the past 40-plus years. The USGS earthquake history for Maryland indicates there have been 17 earthquakes within Maryland (or close enough to feel) since 2000. These events are detailed in Table 3.3.6-3.

Table 3.3.6-3 Earthquake Events, 2000 to 2024

Date	General Location	Intensity	Magnitude
December 18, 2001	Columbia near US29-MD32	II	1.5-2.0 (est.)
March 22, 2002	Columbia near US29-MD32	I	1-2 (est.)
December 9, 2003	28 miles west of the Richmond in rural Powhatan County, VA	VI	4.5
February 23, 2005	Southeastern Baltimore near Fort McHenry, Dundalk, Glen Burnie, Pasadena, Gambrills	I-II	2.0-2.1
December 17, 2008	6 miles west of Lancaster, PA	IV	3.4
July 1, 2009	Southwestern New Jersey	III	2.8
September 29, 2009	4 miles NNE (15°) from Bel Air North, MD	II	1.6
July 16, 2010	Potomac-Shenandoah Region, MD	V	3.4
August 23, 2011	5 miles SSW (195°) from Mineral, VA	V-VI	5.8
August 9, 2015	Near Crownsville in Anne Arundel, MD	I-II	2.2
October 30, 2017	Glenelg, Maryland	I	1.52
November 11, 2017	0.5 miles ESE of Roxbury, MD	I	1.5
November 30, 2017	Near Dover, Delaware	V	4.1
June 25, 2021	Southeast of Woodlawn	I-II	2.6
October 11, 2022	3 miles east-southeast of Sykesville	I-II	2.0
February 8, 2023	18 miles east off the coast of the Maryland/Virginia	I-II	2.6
January 2, 2024	2 miles west of Rockville	I-II	2.3

Source: Maryland Geological Survey, January 2000 to 2024

Table 3.3.6-4 describes recent significant earthquake events to have impacted Anne Arundel County in more detail.

Table 3.3.6-4 Description of Significant Earthquake Events in Anne Arundel County as of 2024

Event Date	Earthquake Description
July 16, 2010	A 3.6 magnitude earthquake centered in Rockville, MD and was the largest earthquake ever recorded near Washington, D.C. The earthquake was felt in the D.C.-area, Maryland, Virginia, West Virginia, and Pennsylvania. There were no reports of damage or injuries.
August 23, 2011	A 5.6 magnitude earthquake occurred near Mineral, Virginia and was widely felt from Maine to Georgia, west to Cincinnati, Cleveland, and Chicago, and southeastern Canada. The total economic losses from the earthquake were about 200-300 million. There was extensive damage to the National Cathedral and the Washington Monument. There were no injuries reported in Anne Arundel County. There was substantial damage to the chimneys of the Historic Annapolis Museum. In all, there were many buildings in the area that suffered some damage from the earthquake.
August 9, 2015	A 2.2 magnitude earthquake occurred near Crownsville in Anne Arundel County. There were reports of people hearing loud booms and walls shaking. There were

Table 3.3.6-4 Description of Significant Earthquake Events in Anne Arundel County as of 2024

Event Date	Earthquake Description
	no injuries reported. There were no reports of any structural damage, apart from sporadic power outages.

Sources: www.nbcnews.com and Eye on Annapolis.

Finally, going further back, three earthquakes of note include:

- November 19, 1969 – an earthquake (magnitude 4.3) occurred near Elgood, West Virginia. The event was felt as far away as West Hyattsville.
- February 10, 1972 – tremor (magnitude 3.8) at Wilmington, Delaware, was felt at Elkton, Maryland.
- February 28, 1973 – residents throughout a broad area of the middle-Atlantic region of the United States were jolted out of their sleep by shock waves from a minor earthquake (magnitude 3.8) near the Delaware - New Jersey - Pennsylvania border. Numerous points in northeastern Maryland reported this earthquake.

Based on historical records over the past 55 years, the probability of significant future earthquakes occurring in Anne Arundel County and the planning area is minimal.

3.3.6.4 Probability of Future Earthquake Events

Given Anne Arundel County's proximity to the Central Virginia Seismic Zone, it is expected that the County will occasionally experience earthquakes in the future. Probabilistic ground motion maps are typically used to assess the magnitude and frequency of seismic events. These maps measure the probability of exceeding a certain ground motion, expressed as percent peak ground acceleration (i.e., %PGA), over a specified period of years. The severity of earthquakes is site-specific and is influenced by soil type and proximity to the earthquake epicenter, among other factors. The 2,500-year return period, or 0.04%-annual chance of occurrence, is much more varied than the 100-year return period.

Figure 3.3.6-1 shows that Anne Arundel County has a 5-25% chance to experience a slight (or greater) earthquake event in the next 100 years. Anne Arundel County, along with most of Maryland is in a low to moderate earthquake hazard zone (see Figure 3.3.6-2). Since 2000, 16 earthquake events have occurred in or near Maryland. This equates to a potential future occurrence of about 0.67 minor earthquake events annually.

3.3.6.5 Earthquake Risk Assessment

Like other states on the eastern seaboard, Maryland is designated by the USGS as a low-moderate risk state for earthquake occurrence. Earthquake events can and occasionally do occur, though they are much less intense than those that occur along the west coast of the United States. The greatest seismic risk in Anne Arundel County is in the Eastern Tennessee Seismic Zone.

Earthquakes are low-probability, high-consequence events. While they may occur only once in the lifetime of an asset, they may have devastating impacts. A moderate earthquake can seriously damage unreinforced buildings, building contents, and non-structural systems and seriously disrupt building operations. Moderate and even very large earthquakes may occur, however infrequently, in areas of normally low seismic activity. Consequently, local construction is seldom designed to the standards required to mitigate potential earthquake impacts. As such, buildings and infrastructure in Anne Arundel County are particularly vulnerable to higher-magnitude earthquakes.

3.3.6.6 Earthquake Hazards in Highland Beach

Highland Beach has about the same level of exposure and vulnerability to earthquakes as the rest of the County, although it is possible that local soils may differ from other parts of the County due to the coastal location. However, as noted in text, the County generally has little risk from this hazard because of the very low seismicity in the region. Potential impacts are negligible.

3.3.6.7 Impacts to People, Structures, Systems, and Resources

The impacts from a nearby earthquake would be experienced County-wide upon occurrence and would likely be felt through much if not all the State. Earthquakes impact people, structures, systems, and other resources in many ways, and have been described in this chapter primarily through the historical event narratives throughout the County. Table 3.3.6-4 highlights the most likely impacts the County and its communities will face based on previously observed impacts combined with forecasting for future conditions.

Earthquake
The Public's Perspective

A survey conducted during the 2025 plan update asked County residents their level of concern for hazards identified in the plan.

55.84% of respondents indicated that they are "not concerned" with earthquake. Another 35.06% indicate they are "somewhat concerned."

84.03% of respondents indicated that they have seen "no change" in the frequency or intensity of the earthquake hazard over the last 10 years.

14.15% of respondents indicate that an earthquake event has caused damage to their residential or commercial property.

People

There are no known deaths, injuries, or property damage from earthquakes in Anne Arundel County. The very low probability of an event suggests that potential for these impacts is minimal. The HMPC and its consultant reviewed various open sources of earthquake probability data for this region of the country. As shown in Figures 6.3.3-1 and 6.3.3-2, the seismic hazard in Maryland is negligible, with a predicted 5-25% likelihood of a slight (or greater) earthquake occurring in 100 years. This means that even in low-probability (higher severity) events, the potential risk to the built environment is minimal because of the low predicted levels of shaking.

Structures & Systems

Ground shaking is the primary cause of earthquake damage to man-made structures. Many factors influence the strength of earthquake shaking at a site including the earthquake's magnitude, the site's proximity to the fault, the local geology, and the soil type.

Earthquakes give little to no warning. They are capable of having a large impact on an area. The impacts of an earthquake can be similar to that of a tornado. After-effects from an earthquake can include impacted roadways, downed power and communication lines, and damages to structures (especially poorly built, or those already in disrepair). Earthquakes are not a seasonal hazard and thus can be experienced year-round. This can present its own set of issues.

As stated previously, the probability of a seismic event in Anne Arundel County is low. However, if for some reason an event was to occur with the County near the epicenter, there is no way to comprehend the amount of damage that could be sustained by the County.

Considering that there is no history of damage in the region due to earthquakes, damages are estimated to be limited to the more dilapidated structures and structures with unreinforced masonry. Therefore, structures identified as potentially at risk of damage due to an earthquake are older structures. In consideration of new structures, modern building codes and the low expected magnitude of earthquakes in the County, limited property damage is anticipated.

An earthquake can sever wires and fibers and destroy network equipment within the earthquake's reach. Earthquakes can cause a loss of power that keeps communication systems running. Typically, during earthquake events, many people are attempting to communicate at the same time. This causes the communications system infrastructure to become oversaturated and cannot support additional users.

Natural, Historic, and Cultural Resources

An earthquake can impact water quality. Stronger earthquakes can cause damage to sewer lines, gas lines, or any infrastructure containing hazardous materials, releasing contaminants into the water.

Historic buildings, due to their age, are especially vulnerable considering the structures were not designed and constructed to absorb the swaying ground motions caused by earthquakes. Therefore, major structural damage, or outright collapse, can result. However, given the extremely low-risk factor and associated impacts for Anne Arundel County, the likelihood of damages resulting from an earthquake are very low.

Earthquakes can cause damage at cultural heritage sites; stronger earthquakes are able to cause irreparable damage. Earthquakes can destroy valuable cultural artifacts, damaging both directly and indirectly to property and cultural heritage.

Community Activities

Earthquakes can impact community activities in Anne Arundel County, specifically indoor activities as earthquakes can cause significant structural damage. People can be harmed, and structures can be significantly damaged. However, based on past occurrences it is likely that only a slight disruption to events may occur as a result of an earthquake in the region, long-term disruptions or event cancelations are not anticipated from this hazard.

3.3.6.8 Future Land Use and Development Trends

Emergency managers and seismologists agree there is no more important factor in reducing a community's risk from an earthquake than the adoption and enforcement of up-to-date building codes. Evaluating older buildings and retrofitting structural and nonstructural components are also critical steps. To survive and remain resilient, communities could also strengthen core infrastructure and critical facilities so that they can withstand an earthquake or other disaster and continue to provide essential services.

Professionals in the disaster response and recovery field have been known to say, “Earthquakes don't kill people, buildings do.” (FEMA, 2021). They are referring to the fact that while it is not possible to control seismic occurrences, communities have the ability to adopt and enforce the latest building codes maintained by the International Code Council (ICC), whose codes include the following:

- **International Building Code (IBC), which** applies to almost all types of new buildings.
- **International Residential Code (IRC), which** applies to new one- and two-family dwellings and townhouses of not more than three stories in height.
- **International Existing Building Code (IEBC), which** applies to the alteration, repair, addition, or change in occupancy of existing structures.

The ICC publishes new editions of the International Codes every three years, and many states and localities have adopted them since the first editions were issued in 2000.

Some provisions within the IBC, IRC, and IEBC are intended to ensure that structures can resist seismic forces during earthquakes. These seismic provisions represent the best available guidance on how structures should be designed and constructed to limit seismic risk. Changes or additions to seismic provisions come from an array of sources, including new research results and documentation of performance in the past.

Stronger building codes may also lessen the impact of other hazards, such as severe storms, tornadoes, and floods.

With all that said, it is unlikely new developments in Anne Arundel County will change the County’s risk for an earthquake event. However, new development means that property damages are likely to be higher in the event of a large enough earthquake. Therefore, it can be stated that future development will create a scenario where losses from an earthquake event are higher in Anne Arundel County. The Town of Highland Beach has very little to no development pressure, meaning future development within the town is unlikely to change the earthquake hazard.

National Earthquake Hazards Reduction Program

The National Earthquake Hazards Reduction Program (NEHRP) spearheads federal efforts to reduce the fatalities, injuries, and property losses caused by earthquakes. It was established by Congress in 1977 and directs four federal agencies to coordinate their complementary activities to implement and maintain the program: FEMA, the National Institute of Standards and Technology (NIST); the National Science Foundation (NSF); and the USGS. NEHRP also partners with state and local governments, universities, research centers, professional societies, trade associations, and businesses to mitigate earthquake risks. (National Earthquake Hazards Reduction Program, 2021).

NEHRP funding is available to support the seismic mitigation planning components of the local hazard mitigation process. Funding may also be used to promote education and community awareness about seismic hazards, including education about earthquake insurance for high-risk areas.

3.3.6.9 Future Conditions

Scientific and governmental organizations continue to research climate change to learn how it can potentially affect the frequency and intensity of natural hazards. To date, USGS has identified only one correlation between the weather and earthquake induction:

> *Large changes in atmospheric pressure caused by major storms like hurricanes have been shown to occasionally trigger what are known as "slow earthquakes," which release energy over comparatively long periods of time and do not result in ground shaking like traditional earthquakes do. While such large low-pressure changes could potentially be a contributor to triggering a damaging earthquake, the numbers are small and are not statistically significant.* (Buis, A., 2019, October 29).

Data compiled by the National Oceanic and Atmospheric Administration (NOAA) shows that the number of earthquakes per year has seen significant variation, but the overall trend shows an increasing frequency. However, it should be noted that a century-based timeframe is minuscule compared with geological timescales that run into millions of years. Therefore, the increased frequency of earthquakes does not necessarily point towards a geological change.

One likely explanation for this is that earthquake detection centers have become more advanced and span the globe and so are more likely to pick up on seismic activity. Along with an increase in the number of earthquakes, the NOAA data shows a decline in the frequency of high-intensity earthquakes (i.e., above six in magnitude). This suggests that there has been an increase in the frequency of low-intensity tremors around the world – which further reinforces the idea that better equipment allows us to record more earthquake events.

For low-risk earthquake areas such as Maryland and Anne Arundel County, it is highly unlikely that the annual frequency of earthquake events (0.67 per year on average) will change to any appreciable degree.

3.3.6.10 Considerations for Next Planning Cycle

Future monitoring, evaluating, and updating of this Plan should consider the following factors related to earthquakes:

- Since the adoption of the 2025 HMP update, has the region experienced an earthquake or small tremors?
- Has any new scientific research or methodology changed the ability to predict earthquake events or assess risk and vulnerability?
- Has there been any significant change in the population, built environment, natural environment, or economy that could affect the risk or vulnerability to earthquakes?

3.3.7 Extreme Temperatures

The Extreme Temperatures section includes the following sub-topics:

1. Description of Extreme Heat
2. Location, Extent, Magnitude
3. Past Occurrences
4. Probability of Future Extreme Heat Events
5. Extreme Heat Risk Assessment
6. Extreme Heat Hazards in Highland Beach
7. Impacts to People, Structures, Systems, and Resources
8. Future Land Use and Development Trends
9. Future Conditions
10. Considerations for Next Planning Cycle

3.3.7.1 Description of Extreme Heat & Cold

Temperature extremes can result from heat waves, unseasonably cold weather, and winter storms. Other natural hazards such as floods and severe storms occur more frequently in Anne Arundel County and serve to overshadow extreme temperature when considering hazard mitigation planning; however, the effects of extreme temperatures, especially on vulnerable populations, can be devastating.

Extreme Heat

Atmospheric variables can affect the impacts of extreme heat. Humid conditions exacerbate human discomfort with high temperatures and can increase the adverse effects of prolonged exposure to extreme heat. Heat-related illnesses like heat exhaustion or heat stroke happen when the body is not able to cool itself. While the body normally cools itself by sweating, during extreme heat, this might be insufficient. In these cases, a person’s body temperature rises faster than it can cool itself, which can cause damage to the brain and other vital organs.

The relationship between heat and humidity is best explained through the Heat Index chart, developed by the National Weather Service (NWS) as a means of portraying how the combined threat of heat and humidity impacts people. Humid conditions can make it seem hotter than it actually is (National Weather Service).

Heat is one of the leading weather-related killers in the United States, despite the ability to prevent or reduce the risk of heat exhaustion and heat stroke through outreach and intervention. (United States Environmental Protection Agency, March 2016).

Extreme heat can lead to death by pushing the human body beyond its limits. Under normal conditions, the body's internal thermostat produces perspiration that evaporates and cools the body. However, in extreme heat and high humidity, evaporation is slowed, and the body must work extra hard to maintain a normal temperature. The human body dissipates heat by varying the rate and depth of blood circulation, by losing water through the skin and sweat glands, and as a last resort, by panting, when blood is heated above 98.6°F. Sweating cools the body through evaporation. However, high relative humidity retards evaporation, robbing the body of its ability to cool itself. When heat gain exceeds the level the body can remove, body temperature begins to rise, and heat related illnesses and disorders may develop.

Temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks are defined as extreme heat. Humid or muggy conditions, which add to the discomfort of high temperatures, occur when a "dome" of high atmospheric pressure traps hazy, damp air near the ground. Excessively dry and hot conditions can provoke dust storms.

There are seasonal patterns to excessive heat waves, with an event most likely to occur in the summer months. Excessive heat can also cause utility outages due to an increased demand for electricity. Utility outages could severely hamper the County’s ability to provide services as facilities become inoperable and must be closed due to a lack of power or water.

Extreme Cold

What is considered an excessively cold temperature varies according to the normal climate for the region. Whenever temperatures drop decidedly below normal and wind speed increases, heat leaves the human body more rapidly, increasing the possibility of negative effects of these extreme cold temperatures.

Wind chill can multiply the impacts of extremely cold temperatures, especially to people. Wind chill describes the rate of heat loss on the human body resulting from the combined effect of low temperature and wind. As winds increase, heat is carried away from the body at a faster rate, driving down the skin temperature and eventually the internal body temperature.

Every winter, extremely cold arctic air joining together with brisk winds leads to dangerously cold windchill values. People exposed to extreme cold are susceptible to frostbite in a matter of minutes. Areas most prone to frostbite are uncovered skin and the extremities, such as hands and feet. Hypothermia is another threat during extreme cold, occurring when the body loses heat faster than it can generate heat. Cold weather can also affect crops, especially in late spring or early fall, when cold air outbreaks can damage or kill produce, as well as residential plants and flowers. A freeze occurs when the temperature drops below 32°F. Freezes and their effects are significant during the growing season, as plant species have different tolerances to cold temperatures.

Extreme cold affects people by potentially exposing them to frostbite or hypothermia which can become life threatening. What constitutes extreme cold varies throughout the country. According to the Maryland Department of Health Extreme Cold Emergency Plan (2022 Version 1.0), an extreme cold event is defined as a weather condition with excessively low temperatures or a combination of cold temperatures and wind that has the potential to case cold-related illnesses or injuries. An extreme cold event is defined in hours, a day, or series of days when:

- The expected temperature or wind chill is forecasted to be approximately minus 5 degrees Fahrenheit or lower.
- Weather or environmental conditions are such that a high incidence of cold-related illnesses or injuries can reasonably be expected (Maryland Department of Health, 2023).

There are seasonal patterns to extreme cold temperatures, with events most likely to occur in the winter months. Extreme cold can cause utility outages, frozen pipes to burst and other structural damage.

3.3.7.2 Location, Extent, & Range of Magnitude of Extreme Temperatures

Extreme temperature is not a hazard with a defined geographic boundary. All areas of Anne Arundel County are susceptible to the effects of extreme heat and extreme cold. Higher elevations away from coastal areas tend to be a few degrees cooler, on average, than lower elevations.

Extreme heat can be measured with the Heat Index (HI) chart (Figure 3.3.7-1), developed by the NWS. The HI is sometimes referred to as the "apparent temperature." The HI, given in degrees Fahrenheit, is a measure of how hot it truly feels when relative humidity (RH) is added to the actual air temperature.

To find the HI, the NWS calculates the apparent temperature. For example, if the air temperature is 96°F and the RH is 65%, the HI— or how hot it actually feels — is 121°F. Since HI values were devised for shady, light wind conditions, exposure to full sunshine can increase HI values by up to 15°F. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous. This corresponds to a level of HI that may cause increasingly severe heat disorders with continued exposure and/or physical activity.

Figure 3.3.7-1 Heat Index and Relative Humidity, Effects on People
Source: National Weather Service

Relative Humidity (%)

Air Temperature

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

With Prolonged Exposure and/or Physical Activity

With Prolonged Exposure and/or Physical Activity
Extreme Danger
Heat stroke or sunstroke highly likely
Danger
Sunstroke, muscle cramps, and/or heat exhaustion likely
Extreme Caution
Sunstroke, muscle cramps, and/or heat exhaustion possible
Caution
Fatigue possible

The NWS issues a range of watches and warnings associated with **extreme heat**:

- **Excessive Heat Outlook – Be Aware!** The potential exists for an excessive heat event in the next three to seven days. An outlook is used to provide information to those who need considerable lead time to prepare for the event, such as public utilities, emergency management, and public health officials.
- **Excessive Heat Watch – Be Prepared!** 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. It is intended to provide enough lead time so those who need to set preparation plans in motion can do so, such as established local excessive heat event plans.
- **Excessive Heat Warning – Take Action!** Issued within 12 hours of the onset of extremely dangerous heat conditions. The warning is used when the maximum heat index temperature is expected to be 105°F or higher for at least two days and nighttime air temperatures will not drop below 75°F; however, the criteria vary across the country, especially for areas not used to extreme heat conditions that could lead to serious illness or death.
- **Heat Advisory – Take Action!** Issued within 12 hours of the onset of extremely dangerous heat conditions when the maximum heat index temperature is expected to be 100°F or higher for at least two days and nighttime air temperatures will not drop below 75°F; however, the criteria vary across the country, especially for areas that are not used to dangerous heat conditions that could lead to serious illness or death.

Most areas of the U.S. are at some risk of extreme heat events, but these are much more common in the west and southwest. Nevertheless, the mid-Atlantic in general, and Anne Arundel County in particular are at some risk from extreme heat, particularly during the June through September months, when temperatures exceeding 100 degrees Fahrenheit are always a possibility. High temperatures may be exacerbated by humidity and poor air quality, presenting additional risks to vulnerable populations. The potential for extreme heat events is uniform for all of Anne Arundel County. All people and assets are considered to have the same degree of exposure.

The urban heat island effect refers to the phenomenon where urban areas are significantly warmer than surrounding rural areas, primarily due to the presence of large amounts of paved surfaces like roads and buildings which absorb and radiate heat more readily than vegetation, leading to a noticeable temperature difference; a dense tree canopy can significantly mitigate this effect by providing shade, releasing moisture through evapotranspiration, and cooling surrounding air, thus lowering the overall temperature in an urban area compared to areas with less tree cover.

The NWS issues a range of watches and warnings associated with **extreme cold**, including notices about wind chill, freezes, and frost:

- **Wind Chill Warning –Take Action!** Issued when dangerously cold wind chill values are expected or occurring. Those in an area with a wind chill warning should avoid going outside during the coldest parts of the day. If those in the area do have to go outside, they should dress in layers, cover exposed skin, and make sure at least one other person knows their whereabouts.
- **Wind Chill Watch – Be Prepared!** Issued when dangerously cold wind chill values are possible. As with a wind chill warning, those in the area should adjust their plans to avoid

being outside during the coldest parts of the day. Those travelling in the watch area should make sure their cars have at least a half a tank of gas and an updated winter survival kit.

- **Wind Chill Advisory – Be Aware!** Issued when seasonably cold wind chill values, but not extremely cold values, are expected or occurring. Those in an area under this type of advisory should dress appropriately and cover exposed skin when venturing outdoors.
- **Hard Freeze Warning –Take Action!** Issued when temperatures are expected to drop below 28°F for an extended period, killing most types of commercial crops and residential plants.
- **Freeze Warning –Take Action!** Issued when temperatures are expected to go below 32°F for a long period of time. This temperature threshold kills some types of commercial crops and residential plants.
- **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.
- **Frost Advisory – Be Aware!** Issued when areas of frost are expected or occurring, posing a threat to sensitive vegetation.

Extreme cold can be measured using the Wind Chill Temperature (WCT) index chart, developed by the NWS. The WCT calculates the dangers from winter winds and freezing temperatures. Based on the WCT, at a temperature of 0°F, even a light wind of 5 MPH can create a wind chill of -11°F and cause frostbite within 30 minutes.

Figure 3.3.7-2 Wind Chill Chart
Source: National Weather Service

Temperature (°F)

Wind (mph) / Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes | 10 minutes | 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T=Air Temperature (°F) V=Wind Speed (mph)

Effective 11/01/01

Most areas of the U.S. are at some risk of extreme cold events, but these are much more common in the north. Nevertheless, the mid-Atlantic region in general, and Anne Arundel

County in particular are at some risk from extreme cold. Anne Arundel is especially susceptible to extreme cold during the December-February months.

Extreme cold affects people by potentially exposing them to frostbite and/or hypothermia which can both become life-threatening if not addressed in a timely manner. Frostbite can cause damage to body tissue which is a direct result of extreme cold. Frostbite can occur in a human within 30 minutes with a wind chill of -20 Fahrenheit (F). Frostbite affects various areas of the body, specifically extremities like fingers, toes, ear lobes and the tip of the nose. Hypothermia is also a direct result of extreme cold. Hypothermia is brought on when the body temperature drops below 95 F. Hypothermia has the ability to kill, however those who survive hypothermia are likely to have chronic kidney, liver and pancreas issues. (National Weather Service, Stay Safe in the Extreme Cold (weather.gov)

3.3.7.3 Past Occurrences

A query of the National Centers for Environmental Information (NCEI) Storm Events database for the 2025 plan update shows 14 "excessive heat" events between 2000 and 2024. A query of the database for "extreme cold/wind chill" shows 5 "extreme cold/wind chill" events and 7 "cold/wind chill" events between 2000 and 2024.

Based on the reported previous occurrences listed above, it is reasonable to assume that extreme heat and extreme cold events will continue in the County, but the impacts to the planning area will most likely be minimal.

Extreme Heat

The NCEI database indicates that between 2000 and 2024, Anne Arundel County experienced 14 "excessive heat" events. No events have caused property or crop damage in the County. There are two recorded deaths associated with this hazard. Based on this data, Anne Arundel County experiences 0.6 "excessive heat" events annually.

Table 3.3.7-1 Excessive Heat Events in Anne Arundel County, 2000-2024

Date	Deaths	Injuries	Property Damage	Crop Damage
01/02/2000	0	0	0.00K	0.00K
06/09/2008	1	0	0.00K	0.00K
07/22/2011	0	0	0.00K	0.00K
07/25/2016	0	0	0.00K	0.00K
08/13/2016	0	0	0.00K	0.00K
07/03/2018	1	0	0.00K	0.00K
2025 Plan Update				
07/19/2019	0	0	0.00K	0.00K
07/20/2019	0	0	0.00K	0.00K
07/21/2019	0	0	0.00K	0.00K
07/28/2023	0	0	0.00K	0.00K
07/05/2024	0	0	0.00K	0.00K
07/09/2024	0	0	0.00K	0.00K
07/10/2024	0	0	0.00K	0.00K
07/16/2024	0	0	0.00K	0.00K
Total	2	0	0.00K	0.00K

Source: Storm Events Database, NOAA database

Cold/Wind Chill

The NCEI database indicates that between 2000 and 2024, Anne Arundel County experienced 7 "cold/wind chill" events. No events have caused property or crop damage in the County. There are no recorded deaths or injuries associated with this hazard. Based on this data, Anne Arundel County experiences 0.29 "cold/wind chill" events annually.

Table 3.3.7-2 Cold/Wind Chill Events in Anne Arundel County, 2000-2024

Date	Deaths	Injuries	Property Damage	Crop Damage
12/07/2002	0	0	0.00K	0.00K
01/10/2004	0	0	0.00K	0.00K
01/15/2004	0	0	0.00K	0.00K
01/05/2018	0	0	0.00K	0.00K
01/21/2019	0	0	0.00K	0.00K
01/30/2019	0	0	0.00K	0.00K
12/23/2022	0	0	0.00K	0.00K
Total	**0**	**0**	**0.00K**	**0.00K**

Source: NCEI Storm Events Database, NOAA

Extreme Cold/Wind Chill

The NCEI database indicates that between 2000 and 2024, Anne Arundel County experienced 5 "extreme cold/wind chill" events. No events have caused property or crop damage in the County. There are no recorded deaths or injuries associated with this hazard. Based on this data, Anne Arundel County experiences 0.21 "extreme cold/wind chill" events annually.

Table 3.3.7-3 Extreme Cold/Wind Chill Events in Anne Arundel County, 2000-2024

Date	Deaths	Injuries	Property Damage	Crop Damage
01/21/2000	0	0	0.00K	0.00K
01/22/2000	0	0	0.00K	0.00K
01/27/2000	0	0	0.00K	0.00K
12/22/2000	0	0	0.00K	0.00K
04/192001	0	0	0.00K	0.00K
Total	**0**	**0**	**0.00K**	**0.00K**

Tables 3.3.7-4 and 3.3.7-5 include descriptions for significant extreme heat and extreme cold/wind chill events, respectively.

Table 3.3.7-4 Significant Extreme Heat Events in Anne Arundel County from 2000 – 2024

Event & Date	Extreme Heat Description
January 2, 2000	Normal "high" temperatures for the first week of January in this region are typically in the low 40's. Due to high pressure off the Southeast coast turning winds southerly over the Mid-Atlantic region, temperatures reached the mid 60's to low 70's which is highly uncharacteristic for this area during January.
June 9, 2008	High temperatures in this area reached the mid to upper 90s across the Anne Arundel area of Maryland. Coupled with dew points in the lower 70s, heat index values reached near 105F.
July 22, 2011	The combination of heat and high humidity caused heat indices to reach as high as 120F degrees. Numerous reports of heat-related illnesses were received by State Health Authorities on July 22.
July 25, 2016	A heat index of approximately 110F degrees was reported in Annapolis, Maryland.
August 13, 2016	A heat index of approximately 110F degrees was reported in various locations.

Table 3.3.7-4 Significant Extreme Heat Events in Anne Arundel County from 2000 – 2024

Event & Date	Extreme Heat Description
July 3, 2018	A heat index of approximately 110 was reported in various locations. The Maryland Department of Health reported 1 fatality due to the excessive heat in Anne Arundel County.
July 19-21, 2019	Temperatures from the mid-90s to the lower 100s combined with dew points near 70 degrees to create dangerously high heat index values. Heat index values exceeded 110 degrees.
July 28, 2023	A heat index of approximately 110F was reported in various locations across Anne Arundel County.

Source: NCEI Storm Events Database, NOAA

In addition to the NCEI database, the State of Maryland Department of Health, Office of Preparedness and Response, provides weekly reports during the warm months of the year (May through September) with data on the numbers of heat-related illnesses and deaths by jurisdiction and age group. These reports indicated heat-related deaths in Anne Arundel County in 2016 and 2017, but none in 2014 or 2015. The data does not extend further back in time.

3.3.7.4 Probability of Future Extreme Temperature Events

Based on historical data from the NCEI Storm Events Database, the County is likely to experience 0.6 extreme heat events annually in the future. Anne Arundel County is likely to experience 0.5 extreme cold/wind chill events annually in the future. Overall, 1.1 extreme temperature events will occur annually, which means extreme temperatures are likely to occur in Anne Arundel County.

3.3.7.5 Extreme Temperatures Risk Assessment

The greatest danger from extreme temperatures is to people, as prolonged exposure can impact both healthy individuals and those with pre-existing medical conditions. Health-related illnesses include heat stroke, heat exhaustion, heat cramps, sunburn, and heat rash. Although all these illnesses can cause problems, the two most deadly are heat stroke and heat exhaustion.

Older adults, the very young, and people with mental illness and chronic diseases are at highest risk from extreme heat. High heat indexes can exacerbate pre-existing health and medical conditions, and some medications may make the body more susceptible to impacts from extreme heat. However, even young, healthy people can be affected if they participate in strenuous physical activities during hot weather. Summertime activity, whether on the playing field or the construction site, must be balanced with actions that help the body cool itself to prevent heat-related illness such as heat exhaustion and heat stroke.

Extreme heat conditions can increase the incidence of mortality and morbidity in affected populations. People can suffer heat-related illnesses when the body is unable to compensate for the extreme heat and properly cool itself. Very high body temperatures can cause damage to the brain and other vital organs.

Extreme cold can cause frostbite or hypothermia and quickly become life threatening. People who have poor blood circulation, drink alcohol, or use illicit drugs, remain outdoors for long periods of time, or are not properly dressed for extreme cold temperatures may have a greater chance of developing frostbite or hypothermia. Body temperatures that are too low affect the brain, making it difficult to think clearly or move well. This makes hypothermia particularly dangerous to those with the condition, as they may not understand what is happening or know what to do about it. Additionally, when extreme cold occurs simultaneously with precipitation events such as a snow or ice storms, accidents that can cause injury or death may occur, such as slip and fall accidents, overexertion accidents related to shoveling snow or clearing ice, and motor vehicle accidents.

Several County facilities are made available to community members in response to prolonged high/low temperatures and excessive humidity. The following facilities are available to provide temporary relief when the County Executive makes a declaration:

- Anne Arundel County Police Department District Station Lobbies and Community Rooms available 24/7
- Anne Arundel County Senior Activity Center Community Rooms available during normal business hours 8:30AM-4PM, Mon- Fri
- Anne Arundel County Public Library Community Rooms available during normal business hours 10AM to 9PM Mon-Thurs and 10AM to 5PM Fri and Sat

Visit https://www.aaCounty.org/cool for locations and hours.

3.3.7.6 Extreme Temperature Hazards in Highland Beach

Highland Beach has about the same level of exposure and vulnerability to extreme temperatures as the rest of the County. However, as noted in text, the County generally has little risk from this hazard because the climate of the area does not suggest extreme heat or cold events are particularly common. Potential impacts are negligible.

3.3.7.7 Impacts to People, Structures, Systems, and Resources

Extreme temperatures impact people, structures, and critical resources in many ways, and has been described in this chapter primarily through the historical event narratives. The following sections highlight the most likely impacts the County and its communities will face based on previously observed impacts combined with forecasting for future conditions.

Extreme Heat
The Public's Perspective

A survey conducted during the 2025 plan update asked County residents their level of concern for hazards identified in the plan.

34.62% of respondents indicated that they are "concerned" with extreme heat and 28.21% of respondents are "very concerned" with extreme heat.

78.67% of respondents indicated that they have seen an "increase" in the frequency or intensity of the extreme heat hazard over the last 10 years.

Nearly a quarter (24.53%) of respondents indicate that an extreme heat event has caused damage to their residential or commercial property.

People

Extreme heat and cold primarily impact people rather than buildings or critical facilities. Those hardest hit by both heat and cold waves are adults 65 years of age or older, many who are already physically vulnerable. Excessive heat exposure also affects people with certain pre-existing medical conditions, including cardiovascular disease, respiratory illnesses, and obesity. Small children are also more susceptible to temperature extremes.

Home and landowners across the State are also at risk of the impacts from an extreme temperature event. Impacts to the public include potential for injury or loss of life, and destruction and/or loss of land and property due to extreme temperatures.

For an extreme temperature event, as with all disaster events, responders face the risk of personal injury while performing necessary job functions.

Structures

Buildings or infrastructure of significant age may be more susceptible to temperature extremes. For example, burst pipes could damage buildings and necessitate repairs during extreme cold events, and HVAC or air-conditions systems could overheat or be damaged during an extreme heat event. Additionally, power outages during extreme heat or cold events could have significant consequences to people that occupy buildings. However, the primary impacts of extreme temperatures are on people rather than buildings. Nonetheless, facilities need to be maintained to ensure that they operate in appropriate conditions for people.

Infrastructure may also experience impacts in the form of damage to roads and bridges and temporary closure of mass transit in the event of cascading impacts, such as power outages.

Systems

An extreme temperature event could be costly for state and local governments, depending on the length and geographic extent of the temperatures because of the potential for crop loss and business disruption from the direct and cascading temperature impacts. Some of the costs could be recouped through federal grant reimbursements, but local governments would still feel the fiscal impact of a major event.

Natural, Historic and Cultural Resources

Loss of crops, impacts to wildlife, and increased propensity towards drought (for high temperatures) would have a major impact to the environment during extreme temperature events.

Community Activities

Outdoor activities in Anne Arundel County which may be canceled or moved inside due to extreme temperatures include:

- Anne Arundel County Fair Week
- Annapolis Juneteenth Parade and Festival
- May Day
- Fourth of July Weekend
- Annapolis Rotary Crab Feast

If an excessive heat event occurs at the same time as these events or others, participants and visitors are at risk of experiencing the negative effects of high temperature exposure.

3.3.7.8 Future Land Use and Development Trends

Current forecasts indicate moderate growth in the County's population will continue over the 30-year forecast period, but that the rate of growth will slowly begin to decline. The total County population is forecast to increase to 632,200 by the year 2040, representing a 12.3% increase from 2015 to 2040. This population growth will be accompanied by development in the form of mixed-use development, redevelopment, and in-fill development.

Increasing populations and development typically do not directly worsen or change extreme temperatures. However, a growing population does rely on a greater number of public services, including utilities. During an extreme heat or cold event, extra strain can be placed on heating and cooling systems that are trying to compensate for the extreme temperatures. This can lead to blackouts and additional wear or damage to systems, which can be costly to repair.

Extreme heat conditions are expected to become more frequent and intense due to changing climate conditions. The need for more cooling centers is one major consideration in terms of future development to meet the needs of vulnerable populations. Populations vulnerable to extreme temperatures include children, older adults, pregnant women, those with medical conditions, and individuals working outdoors.

According to Plan 2040, the County has identified areas where the tree canopy is lacking – particularly in North County. Poor tree canopy contributes to poor air quality, poor water quality, and heat islands in the summer. Sub watersheds in North County and around Parole have been identified for restoration, including to increase the tree canopy. Many of these areas were developed prior to modern environmental regulations that require measures to protect trees and water quality. Redevelopment and restoration projects both have the potential to improve environmental conditions for residents in these areas. Areas with the most degraded environmental conditions have lower median incomes and disproportionately higher concentrations of minorities than the rest of the County.

3.3.7.9 Future Conditions

Future development and the resulting population increase has a minimal potential to elevate vulnerabilities to extreme temperature; however, depending on climate change variables, an increase in vulnerability related to public health and safety is possible. Regarding extreme heat, the Center for Climate and Energy Solutions reported the following information:

> *During the past decade, daily record high temperatures have occurred twice as often as record lows across the continental United States, up from a near 1:1 ratio in 1950. By midcentury, if greenhouse gas emissions are not significantly curtailed, scientists expect 20 record highs for every low. The ratio could be 50:1 by the end of the century. By the 2050's, many of the Mid-Atlantic States including urban parts of Maryland and Delaware could see a doubling of days per year above 95 degrees F.*
>
> *Extreme heat can also increase the risk of other types of disasters. When heat occurs in conjunction with a lack of rain, drought can occur. This, in turn, can encourage more extreme heat, as the sun's energy acts to heat the air and land surface, rather than to evaporate water. Hot dry conditions also increase the risk of wildfires, like the ones in 2013 in Colorado that were fueled by record high heat and an ongoing drought.*

Highlights from the April 2016 *Maryland Climate and Health Profile* produced by the Maryland Department of Health and Mental Hygiene indicate that the occurrence of summertime extreme heat events more than doubled during the 1980's, 1990's, and 2000 in Maryland compared to the 1960's and 1970's. Modeling indicates that extreme heat events are projected to rise across all counties in Maryland into 2040. Additional highlighted data includes:

- Extreme heat events increased the risk of heart attacks in Maryland by 11%.
- The increase in heart attack related extreme heat events was much higher among non-Hispanic blacks compared to non-Hispanic whites (27% vs. 9%).
- Compared to 2010, increases in the frequency of extreme heat events during summer months in 2040 are projected to result in a higher rate of hospitalization for heart attack in Maryland.
- Compared to 2010, increases in the frequency of extreme heat events during summer months in 2040 are projected to result in a higher rate of hospitalization for asthma in Maryland.

3.3.7.10 Considerations for Next Planning Cycle

Future monitoring, evaluating, and updating of this Plan should consider the following factors related to extreme temperature:

- Have extreme temperature events occurred within the planning area since adoption of the 2025 HMP update?
- Did extreme temperature events take place in areas adjacent area that impacted the County by virtue of being in proximity?
- Has new scientific research or methodology, potentially related to climate change, improved the ability to predict extreme temperature events or assess risk and vulnerability?
- Has there been significant change in the population, built environment, natural environment, or economy that could affect the risk or vulnerability to extreme temperature, including land use for agricultural purposes?

3.3.8 Thunderstorm (Lightning, Hail, & Straight-line Winds

The Thunderstorm section includes the following sub-topics:

1. Description of Thunderstorm
2. Location, Extent, Magnitude
3. Past Occurrences
4. Probability of Future Severe Thunderstorm Events
5. Thunderstorm Hazards in Highland Beach
6. Thunderstorm Risk Assessment
7. Impacts to People, Structures, Systems, and Resources
8. Future Land Use and Development Trends
9. Future Conditions
10. Considerations for Next Planning Cycle

3.3.8.1 Description of Thunderstorm

More than 100,000 thunderstorms occur each year in the United States, though only about 10% of these storms are classified as severe. A thunderstorm with wind gusts in excess of 58 mph (50 knots) and/or hail with a diameter of 1 inch or more is classified as a severe thunderstorm. Although thunderstorms affect a small area, they are dangerous because they can generate tornadoes, hail, strong winds, flash flooding, and lightning. According to the National Weather Service, while thunderstorms can occur in all regions of the United States, they are most common in the central and southern states, because atmospheric conditions in those areas are ideal for generating and feeding these powerful storms.

Thunderstorms occur when air masses of varying temperatures and moisture content collide. Rapidly rising warm, moist air is the driving force behind the creation of thunderstorms. These events may occur singularly, in lines, or in clusters. They can move through an area quickly or linger for hours. Straight-line winds, which in extreme cases may result in wind gusts that exceed 100 mph, are responsible for most thunderstorm-related wind damage. One type of straight-line wind, the downburst, can cause damage equivalent to that of a strong tornado and can be extremely dangerous to the aviation industry.

Lightning, which may accompany high winds, is a discharge of electrical energy resulting from the buildup of positive and negative charges within a thunderstorm, creating a bolt when the buildup of charges becomes strong enough. This flash of light usually occurs within the clouds or between the clouds and the ground. A bolt of lightning can reach temperatures approaching 50,000 degrees Fahrenheit. As it flashes, lightning rapidly heats the surrounding air, which cools following the bolt. This rapid heating and cooling of the air causes thunder. On average, 89 people are killed each year by lightning strikes in the United States.

Some storms produce a particular type of high wind called a derecho. Derechos are widespread, long lived, straight-line windstorms associated with severe thunderstorms. They can cause hurricane-force winds, tornadoes, heavy rains, and flooding. Derechos travel quickly, with sustained winds that often exceed the threshold for hurricane-force winds. They typically occur in the summer months, though they can occur any time of year and at any time of the day or night.

Hailstorms are another potentially destructive outgrowth of severe thunderstorms. Early in the development of a hailstorm, ice crystals form within a low-pressure front due to the rapid rising of warm air into the upper atmosphere and the subsequent cooling of the air mass. Frozen droplets gradually accumulate on the ice crystals until having developed sufficient weight, they fall as precipitation—as balls or irregularly shaped masses of ice greater than 0.75 inches (1.91 cm) in diameter. The size of hailstones is a direct function of the size and severity of the storm. High-velocity updraft winds are required to keep hail in suspension in thunderclouds. The strength of the updraft is a function of the intensity of heating at the Earth's surface. Higher temperature gradients relative to elevation above the surface result in increased suspension time and hailstone size.

3.3.8.2 Location, Extent, & Range of Magnitude of Thunderstorms

Thunderstorms affect relatively small areas when compared with hurricanes and winter storms. The typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Of the estimated 100,000 thunderstorms that occur each year in the United States, about 10 percent are classified as severe.

Hailstorms occur more frequently during the late spring and early summer when the jet stream migrates northward across the Great Plains. This period has extreme temperature changes from the ground surface upward into the jet stream, which produces the strong updraft winds needed for hail formation.

Peak periods for hailstorms, late spring, and early summer coincided with the Midwest's peak agricultural seasons for crops such as wheat, corn, barley, oats, rye, tobacco, and fruit trees. Long-stemmed vegetation is particularly vulnerable to damage by hail impacts and winds. The land area affected by individual hail events is not much smaller than that of a parent thunderstorm, an average of 15 miles in diameter around the center of a storm.

The severity of hailstorms is measured by duration, size of the hail itself, and by geographic extent. All of these factors are directly related to the weather phenomena that create hail, and thunderstorms. There is wide potential variation in these severity components. Data on the probability and frequency of occurrence of hailstorms is limited, with little recent research. Outside of the coastal regions, most of the United States experiences hailstorms at least two days each year. The entire County is at risk from hailstorms. Hailstorms affect Anne Arundel County equally and uniformly. Hailstorms have affected the entire County at one time or another.

3.3.8.3 Thunderstorms Past Occurrences

Historical occurrences for thunderstorm wind, lightning, and hail events are included below. These events are gathered from the National Center for Environmental Information (NCEI) Storm Events Database, for the period of January 1, 1950, through August 31, 2024. Incidents with property damage, crop damage, and/or injuries or deaths are highlighted in data tables within this chapter (Tables 3.3.8-1 and 3.3.8-2).

The NCEI Storm Events Database indicates that 278 "thunderstorm wind" events have occurred in Anne Arundel County within the time frame queried. This means that annually, about 3.7 days will have a thunderstorm wind event in the County. Of the 278 event days, over half (i.e., 149) caused reported property damage. Property damage has totaled 4.63 million dollars and crop damage has totaled over 18.25 thousand dollars. These thunderstorm wind events have also caused 2 recorded deaths (March 17, 1990) and 33 reported injuries.
Note: the database cannot accurately report damages from thunderstorms, since presumably the large majority of such damages are either not reported, addressed via private insurance (the

data for which is highly proprietary), or simply repaired by utilities or public entities without any specific reporting requirements.

The NCEI Storm Events Database indicates that there have been 93 “hail” events in Anne Arundel County since 1950. These events produced hail ranging in size between 0.75 and 2.0 inches in diameter. Of the 93 hail events, 4 resulted in property damage and no events resulted in crop damage.

Based on historical records from the NCEI database the future probability of hailstorms in Anne Arundel County is reasonably high – about 1.3 hail events occur annually in the County. However, property damage and impact on life in the County is minimal compared to the potential damage from other hazards.

The NCEI Storm Events Database indicates that 38 “lightning” events have occurred in Anne Arundel County since 1950. This means that about 0.5 lightning events occur annually in the County. These events have caused 2 recorded deaths (June 17, 2000, and July 25, 2010) and 21 recorded injuries. Additionally, lightning events have caused 1.42 million dollars in reported property damage. There was no crop damage as a result of these events.

The NCEI Storm Events Database indicates that between 1950 and 2024 Anne Arundel County experienced 165 severe thunderstorms. Severe thunderstorms are those that either produce a tornado, have winds of at least 58 mph (50 knots or ~93 km/h), and/or hail at least 1" in diameter. Structural wind damage may imply the occurrence of a severe thunderstorm. Particularly severe lightning and hail events resulting in property damage, injuries, or deaths are included in more detail on Table 3.3.8-1.

Based on historical records from the NCEI database, the future probability of thunderstorms (including thunderstorm wind, hail, and lightning events) in Anne Arundel County is very high – thunderstorms occur very often in the County, particularly during the spring and summer months. However, generally speaking, property damage and impact on life in the County are minor compared to the potential damage from other hazards.

Table 3.3.8-1 Severe Lightning & Hail Events, 1950-2024

Date	Event Type	Direct Deaths	Direct Injuries	Property Damage ($)
6/24/1996	Lightning	0	0	20,000
6/24/1996	Lightning	0	0	40,000
11/8/1996	Hail	0	0	1,000
6/22/1997	Lightning	0	0	3,000
8/17/1997	Lightning	0	2	25,000
4/1/1998	Lightning	0	1	20,000
4/17/1998	Hail	0	0	5,000
6/2/1998	Hail	0	0	10,000
6/26/1998	Lightning	0	0	20,000
8/10/1998	Lightning	0	1	-
6/14/1999	Lightning	0	0	5,000
7/22/1999	Lightning	0	0	15,000
8/14/1999	Lightning	0	1	-
8/20/1999	Lightning	0	0	5,000
8/20/1999	Lightning	0	0	500
5/10/2000	Lightning	0	0	110,000
6/17/2000	Lightning	1	8	-
6/18/2000	Lightning	0	0	5,000

Table 3.3.8-1 Severe Lightning & Hail Events, 1950-2024

Date	Event Type	Direct Deaths	Direct Injuries	Property Damage ($)
7/15/2000	Lightning	0	0	30,000
7/15/2000	Lightning	0	0	10,000
8/30/2001	Lightning	0	0	80,000
4/18/2002	Lightning	0	0	40,000
4/18/2002	Lightning	0	0	70,000
6/13/2003	Lightning	0	0	40,000
8/3/2003	Lightning	0	1	-
6/17/2004	Lightning	0	0	350,000
8/10/2004	Lightning	0	0	10,000
8/10/2004	Lightning	0	0	50,000
7/27/2005	Lightning	0	0	450,000
4/20/2008	Lightning	0	0	20,000
8/7/2018	Lightning	0	7	-
Total	**-**	**1**	**21**	**1,434,500**

Table 3.3.8-2 includes descriptions of especially severe thunderstorm events that have occurred since the previous plan update (2018 to 2024).

Table 3.3.8-2. Description of Recent Significant Severe Thunderstorm and Hail Events, 2018-2024

Event & Date	Thunderstorm Description
August 7, 2018	An upper level low near the region combined with high instability and increasing winds aloft to produce thunderstorms, some of which became severe. Six people from the set-up crew of Anne Arundel County National Night Out event were struck by lightning in a field. All were released from the hospital.
July 5, 2020	An upper-level disturbance interacting with a stalled surface front draped over Maryland produced widely scattered severe thunderstorms during the afternoon of Sunday, July 5th, 2020. Numerous trees were blown down in Lake Ridge, including one large tree which fell on a detached garage causing it to collapse injuring 19 people (1 critically).
September 1, 2021	A severe thunderstorm from remnants of Hurricane Ida produced a tornado in Anne Arundel County near Londowntowne, Annapolis, Gingerville, Weems Creek and Parole. This storm resulted in downed trees and power lines as well as caused significant damage to buildings.
July 6, 2022	A severe thunderstorm that produced an EF-1 tornado occurred in the Edgewater area of Anne Arundel County. The weather service indicated that a supercell thunderstorm tracked across central Maryland. It was estimated that maximum wind speed reached 90 mph, and the maximum path width was 100 yards. The path length was 6.1 miles. The tornado tore down power lines, tore roofing off of structures and upended a 12,000-pound sailboat. There were no serious injuries from the storm. There were extensive power outages.

Sources: NCEI storm Events Database and Tornados touch down in Charles County, Anne Arundel County | wusa9.com.

3.3.8.4 Probability of Future Thunderstorms

Reported extreme weather events since 1950 provide an acceptable framework for determining the future occurrence in terms of frequency for such events. Each extreme weather hazard is also often accompanied by other risks. For example, thunderstorms are often accompanied by windstorms, flooding, hail, and lightning. Based on historical records, the interrelated nature of these events, and other indicators of weather systems, it can reasonably be assumed that this type of event is highly likely to occur (3.4 out of 4) as defined by the Risk Factor Methodology probability criteria. Additionally, the potential for these events to cause future damages to life and property is also relatively high.

3.3.8.5 Thunderstorms in Highland Beach

Highland Beach has about the same level of exposure and vulnerability to thunderstorms as the rest of the County. The County has a moderate exposure to this hazard, but the impacts are generally insignificant.

3.3.8.6 Thunderstorms Risk Assessment

The frequency of extreme weather events is expected to increase, which increases the County's vulnerability to this hazard. Additionally, vulnerability is higher in more densely developed areas. However, all assets located in Anne Arundel County can be considered at risk for extreme weather events, including the County's population, buildings, and infrastructure. Damages primarily occur as a result of thunderstorm wind, lightning strikes, and hail.

Thunderstorm has the potential to impact people, structures, systems, natural, historic & cultural resources, and community activities in Anne Arundel County. The following sections examine the vulnerability of, and likely impacts to, these systems based on previously observed impacts combined with forecasting for future conditions.

3.3.8.7 Impacts to People, Structures, Systems, and Resources

The frequency of thunderstorm events is expected to increase, which increases the County's vulnerability to this hazard. Additionally, vulnerability is higher in more densely developed areas. However, all assets located in Anne Arundel County can be considered at risk to extreme weather events. This includes all of the County's population, buildings, and infrastructure. Damages primarily occur as a result of high winds, lightning strikes, and hail, as well as flood impacts associated with these events.

People

Thunderstorms pose significant risks to health and safety, as they can lead to injuries, fatalities, and exacerbate pre-existing health conditions, while also causing psychological stress and potential flash flooding that threatens life and property.

Thunderstorms wind and lightning can cause injuries and fatalities. Since 1950, there have been a recorded 4 deaths and 55 injuries caused by thunderstorm wind and lightning, respectively. Thunderstorms can exacerbate certain health conditions such as asthma and arthritis. Stress and anxiety caused by thunderstorms can have psychological effects on individuals. Heavy rainfall from thunderstorms can lead to flash flooding, which is the leading cause of death associated with thunderstorms. Floodwaters can quickly inundate homes, roads, and other infrastructure, posing a serious risk to life and property.

Thunderstorm
The Public's Perspective

A survey conducted during the 2025 plan update asked County residents their level of concern for hazards identified in the plan.

34.19% of respondents indicated that they are "concerned" with thunderstorm. Only 8.39% of respondents were "not concerned".

54.05% of respondents indicated that they have seen an "increase" in the frequency or intensity of the thunderstorm hazard over the last 10 years.

Nearly half (48.57%) of respondents indicate that a thunderstorm event has caused damage to their residential or commercial property.

Structures

Severe hailstorms and thunderstorms pose a serious threat to property and essential services, leading to extensive damage to vehicles and buildings, as well as potential disruptions in electricity and healthcare. The impact of these weather events underscores the importance of preparedness and resilience in affected areas.

Severe hailstorms have the potential to cause significant property damage, particularly to automobiles and some building types in the form of broken windows, roof damage, and structural failure. Thunderstorms can typically cause power outages by knocking down power lines and transformers. Thunderstorms can disrupt critical services such as electricity, water, and healthcare.

Systems

A great concern for the County is damage to electric power lines; power outages for residents and businesses across the area can disrupt the availability of emergency services, including 911. During past events, severe thunderstorms have downed trees across power lines, snapped utility poles, and even blown down transformers, resulting in widespread outages. Downed power lines create a dangerous threat to public safety; although difficult to quantify, long-term power outages can result in significant hardship for residents and major economic impacts for local businesses.

Severe thunderstorms can cause road closures, flight delays, and railway disruptions. Flooding and debris from high winds and rain may make roads impassable. Heavy rainfall can overwhelm drainage systems, leading to flooding and contamination of water supplies. High winds, lightning, and heavy rain can damage power lines and transformers leading to widespread power outages. This can disrupt electricity supply to homes, businesses, and other critical facilities. Severe thunderstorms can impact emergency services. Communication disruptions, road blockages, and power outages can slow down response times and coordination efforts.

Natural, Historic and Cultural Resources

Severe weather events, including hail, heavy rain, and high winds, pose significant threats to both the agricultural sector and historic buildings, with the latter being particularly susceptible to damage due to their vulnerable materials. The consequences of such weather can lead to structural deterioration, mold growth, and even fires, underscoring the need for protective measures.

Hail and heavy rain typically have the greatest impact on the agricultural community. High winds, hail, and lightning can cause significant damage to historic buildings. The materials used in historic buildings are often more vulnerable to weather-related damage. Lightning strikes can cause fires, which can be particularly devastating for historic wooden structures.

Community Activities

Severe thunderstorms and hailstorms in Anne Arundel County pose significant risks, leading to the postponement or cancellation of outdoor events and making water-related activities hazardous. It is essential for residents and event organizers to remain vigilant and prioritize safety during such weather conditions.

Severe thunderstorm and hailstorms can postpone or cancel outdoor events in Anne Arundel County, including festivals, sports games, and community gatherings. Boating, fishing, and other water-related activities can become dangerous during severe thunderstorms.

3.3.8.8 Future Land Use and Development Trends

All future structures and infrastructure built in Anne Arundel County will likely be exposed to extreme weather events and may experience damage. Since the previous statement is assumed to be uniform Countywide, the location of development does not increase or reduce the risk necessarily. By adhering to building codes, Anne Arundel County and its jurisdictions can ensure that new development is built to current standards for wind resistance.

3.3.8.9 Future Conditions

It is not well known how climate change might impact the strength and frequency of thunderstorms, as is the case with tornadoes. However, the frequency and severity of severe weather events is projected to increase.

Climate modeling predicts that conditions conducive to severe thunderstorms will arise more often as the Earth warms up. Modeling suggests that weather conditions which lead to severe storms will arise 5% to 20% more often per one degree Celsius of global temperature change, primarily due to increased atmospheric instability. However, because severe storms do not always arise even in the most favorable conditions, any associated increase in severe thunderstorms is expected to be smaller. Compared with other regions, the Northern Hemisphere is predicted to experience the largest increase in convective environments (i.e., environments favorable to creating severe storms).

Given this information, the future annual average rate of thunderstorms can be estimated for Anne Arundel County given two possible scenarios considering a current incidence of 5.5 thunderstorm events annually (including annual rates of thunderstorm wind, hail, and lighting events). The most conservative scenario – a 5% increase in severe weather conditions – would mean the County would average approximately 5.78 thunderstorm events per year in the future. In the most extreme scenario – a 20% increase in severe weather conditions – the County would average approximately 6.6 thunderstorm events per year in the future.

3.3.8.10 Considerations for Next Planning Cycle

Future monitoring, evaluating, and updating of this Plan should consider the following questions related to thunderstorms and hailstorms:

- Is more recent data about these hazards expected to be updated in the 2030 plan update?
- Has new scientific research or methodology changed the ability to predict such hazard events?
- Has there been a significant change in the population, built environment, natural environment or economy that could affect the risk or vulnerability to these hazard types?
- Is there new evidence related to the impacts of climate change that could affect the level of risk or vulnerability to these hazard types?

3.3.9 Severe Winter Storms

The Severe Winter Storms section includes the following sub-topics:

1. Description of Severe Winter Storms
2. Location, Extent, Magnitude
3. Past Occurrences
4. Probability of Future Severe Winter Storm Events
5. Severe Winter Storm Risk Assessment
6. Severe Winter Storm Hazards in Highland Beach
7. Impacts to People, Structures, Systems, and Resources
8. Future Land Use and Development Trends
9. Future Conditions
10. Considerations for the Next Planning Cycle

3.3.9.1 Description of Severe Winter Storms

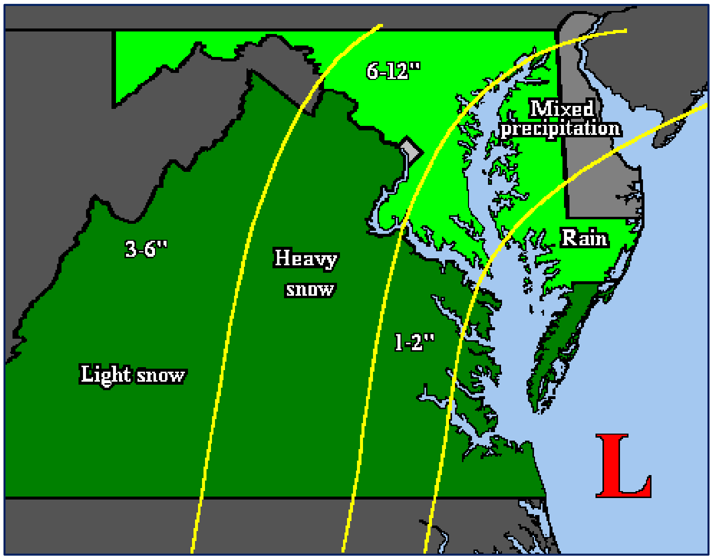
Winter storms typically form along a front generally following the meandering path of the jet stream. These storms, called mid-latitude cyclones or extra-tropical cyclones, differ from hurricanes in that they move from west to east as opposed to east to west. These weather patterns carry cold air from Canada and the Rockies into the southern U.S. A severe winter storm event includes a storm with heavy snow, ice, or freezing rain – all of which can cause significant problems for residents.

Heavy snowfall and extreme cold can immobilize an entire region. Even areas that normally experience mild winters can be hit with a major snowstorm or extreme cold. Winter storms can result in flooding, storm surge, closed highways, blocked roads, downed power lines, and hypothermia.

The County’s greatest winter storms are "Nor'easters." It takes a specific combination of conditions to get heavy snow and wind from a Nor’easter. First, an arctic air mass should be in place. As high pressure builds over New England, cold, arctic air flows south. This dense cold air is unable to move west over the Appalachian Mountains and thus is funneled south down the valleys and along the Coastal Plain. This is called "cold air damming." To the east of the cold air is the warm water of the Gulf Stream. The contrast of the cold air sliding south into the Carolinas and the warm air sitting over the Gulf Stream creates a breeding ground for storms. With the correct position of the jet stream, storm development off the Carolinas may become "explosive" (sudden, rapid intensification with a dramatic drop in the central pressure of the storm). Nor’easters can produce blizzard conditions. The National Weather Service (NWS) definition of a blizzard is a winter storm that produces the following conditions for three hours or longer: sustained winds or frequent gusts 35 mph or greater and falling and/or blowing snow reducing visibility frequently to less than one-quarter mile on a widespread or local basis.

The ideal position of the jet stream has it crossing the west coast of the United States and then splitting. The northern branch crosses the northern Rockies and Canada and the southern branch dips down to the Gulf Coast states. The latter branch then turns northeast across Virginia and rejoins the northern branch near Newfoundland. The northern branch of the jet supports the southward sinking cold air. The southern branch carries a disturbance from the Gulf Coast northeast to the Carolina coast where it intensifies into a Nor’easter. Winds around the storm center carry warm, moist air from over the Gulf Stream up and over the cold inland air. As the air rises, it cools and causes snow to begin falling.

Figure 3.3.9-1 DC Winters: How a Nor'easter Forms
Source: NOAA NWS
https://www.weather.gov/lwx/winter_DC-Winters



During winter storm events, it is quite common for a rain-snow line to develop over the Richmond-Washington-Baltimore-Philadelphia metropolitan areas. The heaviest snow band generally occurs in a 50-mile-wide swath about 150 miles northwest of the low-pressure center (represented as an "L" on Figure 3.3.9-1). Closer to the low, the warm ocean air changes the precipitation over to sleet, freezing rain, and eventually rain. The track of the storm can mean the difference between heavy rain, freezing rain, or sleet (marked as mixed precipitation in the diagram), and a foot or more of snow.

Winter weather may range from a moderate snow over a period of a few hours to blizzard conditions with blinding wind-driven snow that lasts for several days. Some winter storms impact multi-state regions. Winter storms may be accompanied by low temperatures, ice, and heavy and/or blowing snow, which can severely impair visibility. Winter weather may include snow, sleet, freezing rain, or a mix of these wintry forms of precipitation.

- **Sleet:** Raindrops that freeze into ice pellets before reaching the ground, usually bounce when hitting a surface, and do not stick to objects; however, sleet can accumulate like snow and cause a hazard to motorists.
- **Freezing rain:** Rain that falls onto a surface with a temperature below freezing, forming a glaze of ice. Even small accumulations of ice can cause a significant hazard, especially on power lines and trees.
- **Ice storm:** Occurs when freezing rain falls and freezes immediately upon impact. Communications and power can be disrupted for days, and even small accumulations of ice may cause extreme hazards to motorists and pedestrians.
- **Freeze:** Characterized by low temperatures, especially when they fall below the freezing point (zero degrees Celsius or 32 degrees Fahrenheit). House fires and carbon monoxide poisoning may occur when households use supplemental heating devices (wood, kerosene, etc.) and fuel-burning lanterns or candles for emergency heating or lighting.

Table 3.3.9-1. National Weather Service Winter Weather Warnings, Watches, and Advisories

Event & Date	Severe Winter Storm Description
Blizzard Warning	Issued for frequent gusts greater than or equal to 35 mph and accompanied by falling and/or blowing snow, frequently reducing visibility to less than ¼ mile for three hours or more.
Winter Storm Warning	Significant winter weather event including snow, ice, sleet, blowing snow, or a combination of these.
Wind Chill Warning	Chill values of -35°F or colder that can cause frostbite within as short a period as 10–15 minutes of exposure.

Table 3.3.9-1. National Weather Service Winter Weather Warnings, Watches, and Advisories

Event & Date	Severe Winter Storm Description
Freeze Warning	Temperatures of 32°F or colder for a significant period that could kill outdoor plants at the beginning or end of the growing season.
Winter Storm Watch	Issued when conditions are favorable for a significant winter storm event (heavy sleet, heavy snow, ice storm, heavy snow, blowing snow, or a combination of events).
Wind Chill Watch	Issued when there is the potential for a combination of extremely cold air and strong winds to create dangerously low wind chill values.
Winter Weather Advisory	A combination of winter weather conditions, such as 3 to 6 inches of snow expected within a 24-hour period; 5 to 8 inches of snow within a 24-hour period; light freezing precipitation; and/or blowing snow.
Wind Chill Advisory	Wind chill values between -25°F and -35°F that can cause frostbite within as short a period as 20–25 minutes of exposure.
Freeze Advisory	Temperatures in the mid-30s (°F) accompanied by clear skies, light winds, and high humidity near the ground that could kill outdoor plants at the beginning or end of the growing season.

Source: National Weather Service, Winter Weather Warnings, Watches, and Advisories. Retrieved at: https://www.weather.gov/safety/winter-ww

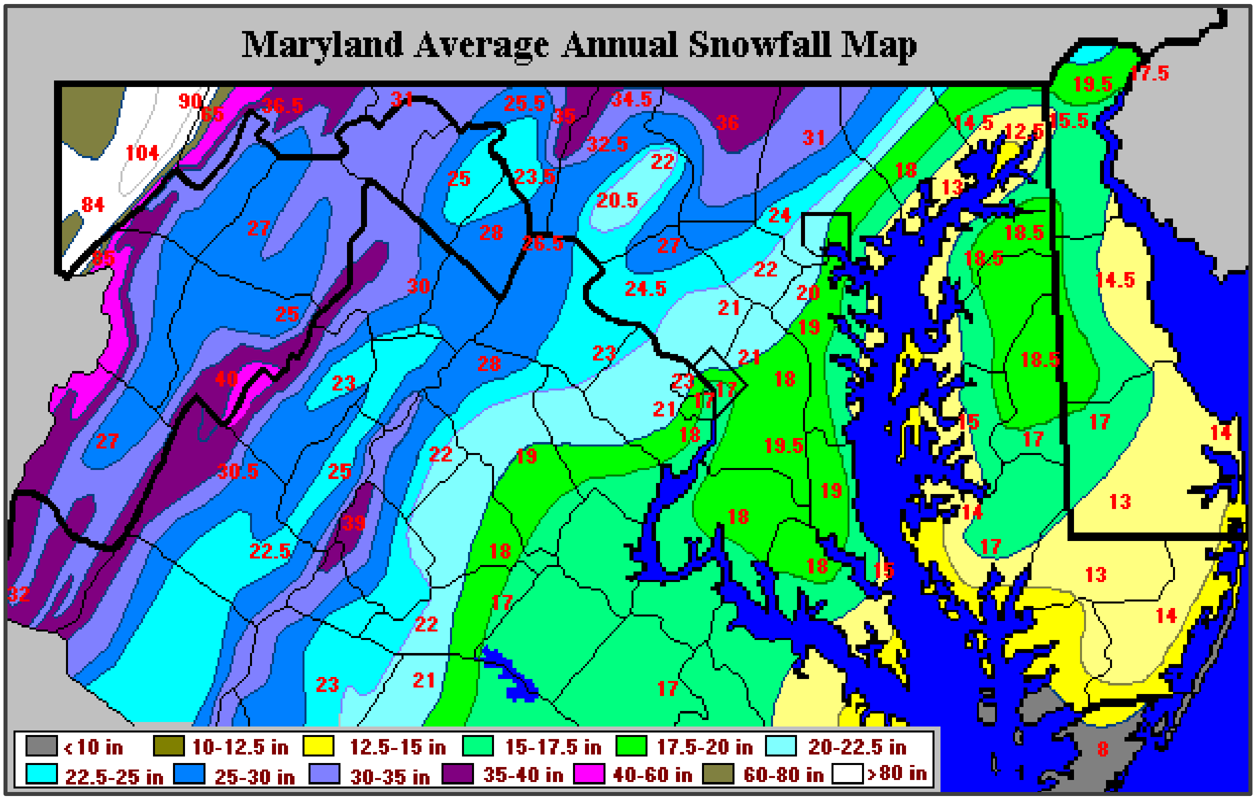
3.3.9.2 Location, Extent, & Range of Magnitude of Severe Winter Storms

Nearly the entire United States is considered at risk for severe winter storms. Heavily populated areas are particularly impacted when severe winter storms disrupt communication and power due to downed lines from high winds and icing. Debris associated with heavy icing may impact utility systems and transportation routes. The potential for winter storms is uniform for all of Anne Arundel County. All people and assets are considered to have the same degree of exposure.

The Regional Snowfall Index (RSI), an evolution of the Northeast Snowfall Impact Scale (NESIS) seeks to rank snowstorms regionally throughout the United States based on the impacts these systems have on society. The scale is broken into five event categories ranging from 1, (“Notable”) to 5 (“Extreme”). The amount of snowfall for a particular storm and the population impacted are the factors used in assigning NESIS values. This scale differs from other meteorological indices in that it uses population information in addition to meteorological measurements. Researchers have calculated the scores for high-impact storms dating back to the 1900s.

Seasonal snowfall in Maryland is approximately 20.6 inches. Average seasonal snowfall ranges from 10 inches on the lower Eastern Shore to 110 inches in Garrett County. The most snowfall ever recorded in a single winter in Maryland was during the winter of 2009-10. When 262.5 inches of snow fell at Keyser’s Ridge in Garrett County. There is, however, significant variation from year to year. February is the month when maximum accumulations on the ground are usually reached. Figure 3.3.9-2 shows the average annual snowfall for Maryland. The figure shows the average yearly snowfall in Anne Arundel County ranges from 17.5 to 22 inches depending upon the location in the County.

Figure 3.3.9-2 Maryland Average Snowfall Map
Source: National Weather Service



Blizzards are the most severe type of winter storms characterized by low temperatures, strong winds, and heavy blowing snow. Many winter depressions give rise to exceptionally heavy rain and widespread flooding. Conditions worsen as the temperature drops, rain turns to ice, and accumulation of ice begins to occur. Winter storms are known to spawn other natural hazards, such as coastal flooding and erosion, severe thunderstorms, tornadoes, high winds, and severe ice.

Ice storms can often be as disruptive as blizzards. Trees, cars, roads, and other surfaces develop a coating or glaze of ice making even small accumulations of ice an extreme hazard to motorists and pedestrians. The most prevalent impacts of heavy accumulations of ice are slippery roads and walkways, collapsed roofs from fallen trees, telephone poles and lines, electrical wires, and communication towers. As a result of severe winter storms, telecommunications and power can be disrupted for days.

3.3.9.3 Past Occurrences

Anne Arundel County and Maryland have experienced several new winter storms of varying magnitudes since the 2018 HMP.

For purposes of these past occurrences, winter storm events include heavy snow, winter weather, winter storms, ice storms, and blizzard events as identified by the National Centers for Environmental Information (NCEI) Storm Events Database. Note: Cold/Wind Chill events are included in the Extreme Temperatures section of this plan.

Note: the NCEI data extends back only to 1996 for the winter storm hazards, so not all historic winter storms are included in the data set.

Heavy Snow

The NCEI database indicates that between 1996 and 2024, Anne Arundel County experienced 7 “heavy snow” events. One of these events resulted in property damage in the amount of $150,000 (February 12, 2006). No reported deaths or injuries occurred from these events. Based on this data, Anne Arundel County experiences 0.25 “heavy snow” events annually.

Table 3.3.9-2 summarizes the “heavy snow” events that resulted in death, injury and/or property damage.

Table 3.3.9-2 Heavy Snow Events Resulting in Death, Injuries, and/or Property Damage, 1996-2024

Date	Event Type	Deaths	Injuries	Property Damage ($)	Crop Damage ($)
2/12/2006	Heavy Snow	0	0	150,000	0
Total	**-**	**0**	**0**	**150,000**	**0**

During the February 12, 2006, heavy snow event total snowfall across much of Maryland ranged generally between 8-14 inches. A period of thundersnow occurred overnight and early in the morning of the 12th across portions of the northern Washington DC suburbs and the Baltimore suburbs of Maryland, where localized snowfall ranged between 14 to 22 inches. The highest snowfall total occurred at Columbia Hills, MD, in Howard County, where snowfall was 22.5 inches.

Winter Weather

The NCEI database indicates that between 1996 and 2024, Anne Arundel County experienced 97 “winter weather” events. None of these events have resulted in reported property damage. No reported deaths or injuries occurred from these events. Based on this data, Anne Arundel County experiences 3.46 “winter weather” events annually.

The most significant of these occurred January 22-24, 2016. Dubbed “Snowzilla”, the storm dumped nearly 30 inches of snow on BWI Marshall Airport and resulted in widespread traffic interruptions and downed trees. There is no reliable way to estimate damages from the event. The Obama administration declared a major disaster (DR-4261) for Maryland to assist with the recovery.

Maryland – Severe Winter Storm and Snowstorm

FEMA-4261-DR
Declared March 4, 2016

On March 4, 2016, President Obama declared that a major disaster in the State of Maryland. This declaration made Public Assistance requested by the Governor available for eligible local governments on a cost-sharing basis for emergency work and the repair or replacement of facilities damaged by the severe winter storm and snowstorm. This declaration also authorized snow assistance for a period of 48 hours for the counties.

Source: FEMA (www.fema.gov/locations/maryland#declared-disasters)

Winter Storms

The NCEI database indicates that between 1996 and 2024, Anne Arundel County experienced 36 “winter storm” events. Of these, three events resulted in property damage totaling $2.005M. These events have contributed to 1 death (January 25, 2000) and 1 injury (January 20, 2000). Based on this data, Anne Arundel County experiences 1.29 “winter storm” events annually.

Table 3.3.9-3 summarizes the “winter storm” events that resulted in death, injury and/or property damage.

Table 3.3.9-3 Winter Storm Events Resulting in Death, Injuries, and/or Property Damage, 1996-2024

Date	Event Type	Deaths	Injuries	Property Damage ($)	Crop Damage ($)
1/20/2000	Winter Storm	0	1	0	0
1/25/2000	Winter Storm	1	0	0	0
2/14/2003	Winter Storm	0	0	2,000,000	0
2/5/2010	Winter Storm	0	0	5,000	0
Total	**-**	**1**	**1**	**2,005,000**	**0**

The February 14, 2003, winter storm event brought record-breaking snow and sleet accumulations reported across north-central Maryland. A total of 28.2 inches of snow was recorded at Baltimore-Washington International Airport. Across southern Maryland, accumulations of mainly sleet ranged from 7 to 12 inches. As a general rule of thumb, 1 inch of sleet accumulation is equivalent to 3 inches of snow. The storm took a toll on residents, structures, transportation systems, emergency responders, businesses, livestock, and travelers.

More recently, the Mid-Atlantic was impacted with blizzard conditions and record-breaking snow on February 6-7, 2010. On February 5th, 2010, a strong storm moved across the Gulf of Mexico and up the East Coast of the United States. This storm produced heavy snowfall from Virginia to New Jersey. Many sites in Pennsylvania, Virginia, Maryland, Delaware, and New Jersey received record snowfall. Snowfall totals at some sites exceeded 30 inches in Maryland and Pennsylvania. Reports of snowfall in excess of 20 inches were common in the Pittsburgh, Harrisburg, Philadelphia, Washington, and Baltimore metropolitan areas. The NWS indicated that blizzard conditions were recorded at Baltimore/Washington International Thurgood Marshall Airport on February 7th from approximately 12 midnight to 5 a.m. Saturday. During this time period wind gusts were reported at 37 mph, with visibility at or below one-quarter mile with heavy snow.

The storm caused major disruption to the area and left hundreds of thousands without power from Virginia to Pennsylvania. The storm caused massive power outages in the Washington and Baltimore areas, where temperatures were close to freezing at the height of the storm. Across Maryland, approximately 100,000 residents were without power. Heavy snow and blowing snow closed roads, rails, and major airports throughout the Mid-Atlantic region Friday into Saturday.

Ice Storm

The NCEI database indicates that between 1996 and 2024, Anne Arundel County experienced 4 “ice storm” events. Of these, one event resulted in property damage totaling $10,000 (January 14, 1999). There are no recorded deaths or injuries associated with this hazard. Based on this data, Anne Arundel County experiences 0.14 “ice storm” events annually.

Table 3.3.9-4 summarizes the “ice storm” events that resulted in death, injury and/or property damage.

Table 3.3.9-4 Ice Storm Events Resulting in Death, Injuries, and/or Property Damage, 1996-2024

Date	Event Type	Deaths	Injuries	Property Damage ($)	Crop Damage ($)
1/14/1999	Ice Storm	0	0	10,000	0
Total	**-**	**0**	**0**	**10,000**	**0**

Blizzard

The NCEI database indicates that between 1996 and 2024, Anne Arundel County experienced 3 “blizzard” events. Of these, one event resulted in property damage totaling $7,500 (January 7, 1996). There are no recorded deaths or injuries associated with this hazard. Based on this data, Anne Arundel County experiences 0.11 “blizzard” events annually.

Table 3.3.9-5 summarizes the “ice storm” events that resulted in death, injury, and/or property damage.

Table 3.3.9-5 Blizzard Events Resulting in Death, Injuries, and/or Property Damage, 1996-2024

Date	Event Type	Deaths	Injuries	Property Damage ($)	Crop Damage ($)
1/7/1996	Blizzard	0	0	7,500	0
Total	**-**	**0**	**0**	**7,500**	**0**

The Blizzard of ‘96 event listed in the table above caused millions of dollars in damage throughout the Maryland region. The historic event led to snow totals in central Maryland between 20-26 inches. Wind gusts of over 35 mph, produced 4-7 feet snow drifts. The storm closed all major highways, and the Washington Metro system suffered several above-ground mishaps in Maryland. All federal, state, and local governments were closed Monday (the 8th) and Tuesday (the 9th). Most school districts remained closed throughout the week.

3.3.9.4 Probability of Future Severe Winter Storm Events

As with all climate- and weather-based hazards, there is no completely reliable way to estimate probabilities of future occurrences, except over a fairly long period of time. However, given the long history of winter storms on the Atlantic seaboard, it is reasonable to expect an average of one or more significant events every year. These can include ice storms and snowstorms, and the definition can also include extreme cold.

Based on past and recent history, certain parts of Anne Arundel County have a high probability of severe winter storms occurring in the future. Based on the annual average events for each winter storm sub-hazard (included in the NCEI) included in the previous section, the County has experienced a total of 152 winter storm events between 1996 and 2024. Therefore, it can be estimated that Anne Arundel County will experience 5.25 winter storm events annually.

3.3.9.5 Severe Winter Storm Risk Assessment

All assets located in Anne Arundel County can be considered at risk from severe winter storms. This includes 100 percent of the County’s population, structures, critical facilities, and infrastructure. Damage can primarily occur because of cold temperatures, heavy snow or ice, and sometimes strong winds. Due to their regular occurrence, these storms are considered hazards only when they result in damage to specific structures or cause disruption to traffic, communications, electric power, or other utilities.

Since winter storms have become a regular occurrence in Anne Arundel County, as well as other counties throughout Maryland, strategies have been developed to respond to these events. Snow removal and utility repair equipment are present to respond to typical events. The use of auxiliary heat and electricity supplies such as wood-burning stoves, kerosene heaters, and gasoline power generators reduces the vulnerability of specific structures. Locations lacking adequate equipment to protect against cold temperatures or significant snow and ice are more vulnerable to winter storm events. Even for communities that are prepared to respond to winter storms, severe events involving snow accumulations that exceed six or more inches in a twelve-hour period can cause a large number of traffic accidents, interrupt power supply and communications, and cause the failure of inadequately designed and/or maintained roof systems.

Losses associated with winter storms are typically related to snow removal and business interruption, although power failure is also a significant secondary hazard commonly associated with winter storms, and particularly ice events. In addition to the impacts on transportation, power transmission, and communications, severe winter storms in Anne Arundel County have at times caused severe property damage due to roof collapses. According to FEMA, most injuries and fatalities related to winter storms are caused by vehicle accidents and hypothermia.

3.3.9.6 Severe Winter Storm Hazards in Highland Beach

Highland Beach has about the same level of exposure and vulnerability to severe winter storms as the rest of the County. The County has a moderate risk from this hazard overall; however, Anne Arundel and Highland Beach experience winter weather often enough that the jurisdictions are well prepared for it. While potential impacts are serious, there is nothing to suggest that these would be catastrophic or long-lasting.

3.3.9.7 Impacts to People, Structures, Systems, and Resources

Severe winter weather impacts people, structures, systems, and other resources in many ways, and has been described in this chapter primarily through the historical event narratives throughout the County. The following sections highlight the most likely impacts the County and its communities will face based on previously observed impacts combined with forecasting for future conditions.

Severe Winter Storm
The Public's Perspective

A survey conducted during the 2025 plan update asked County residents their level of concern for hazards identified in the plan.

Majority (34.42%) of respondents indicated that they are only "somewhat concerned" with severe winter storm. Another 29.87% indicate they are "concerned".

48.30% of respondents indicated that they have seen a "decrease" in the frequency or intensity of the severe winter storm hazard over the last 10 years.

18.87% of respondents indicate that a severe winter storm event has caused damage to their residential or commercial property.

People

Severe winter storms do not have impacts in any one geographical section of the County. The most vulnerable populations to this hazard are the very old and the young, as well as those individuals whose socioeconomic status prevents them from having access to adequate shelter and heat. The economic impacts of this hazard cannot be evaluated geographically.

Extreme cold associated with winter storms can cause older pipes to freeze and burst, leaving residents without access to water. Large amounts of snow or ice can damage power lines, leading to power outages. Power outages, if lengthy, can lead to dropping temperatures within homes and businesses, and are especially dangerous to those who rely on at-home medical equipment for support needs. Back-up heat and generators can mitigate these issues, but residents should take the proper precautions when using these.

The NCEI database shows one death, one injury, and 152 winter weather related events between 1996 and 2024 in Anne Arundel County.

Other impacts to people from winter weather:

- People can die in traffic accidents on icy roads.
- People can die of heart attacks while shoveling snow.
- People can die of hypothermia from prolonged exposure to cold.
- People can die of injuries related to exposure to cold:
    - 50% are people over the age of 60 years old.
    - Over 75% are males.
    - About 20% occur in the home.
- Of injuries related to ice and snow:
    - About 70% occur in automobiles
    - About 25% are people caught out in the storm.
    - The majority are males over 40 years old.

Structures

A winter storm can adversely affect roadways, utilities, business activities, and cause freezing conditions. They can result in the closing of secondary roads, particularly in rural locations, loss of utility services, and depletion of oil heating supplies. Most structures, including the County's critical facilities, should be able to provide adequate protection. However, if there is a heavy snowfall or a significant accumulation over time, the weight of the snow may cause building damage or even collapse. Those facilities with backup generators are better equipped to handle a severe weather situation should the power go out.

Other potential impacts to structures include:

- Strong winds can put pressure on buildings and their foundations leading to roof uplift, siding detachment, and window breakage.
- Other hazards include carbon monoxide poisoning, house fires, loss of electricity, frozen plumbing, and roof collapse.
- Severe winter storms pose a threat to energy infrastructure, transportation, and any exposed critical infrastructure.
- Healthcare and public health facilities may experience delays due to transportation and electrical power impacts.

Systems

Some rural areas of the County may be more susceptible to isolation due to the potential loss of telephone communications and road closings. Power failures and interruption of water supplies are not uncommon from ice storms as well as heavy snow or blizzard conditions. Areas of vulnerability include low-income and elderly populations, mobile homes, and infrastructure such as roadways and utilities that can be damaged by such storms. Additionally, low-lying areas of the County can be impacted by flooding related to rapid snow melt.

A major winter weather event would be costly for state and local governments because of the potential for damage associated with property (during severe storms), storm cleanup, and loss of power. Some of the costs could be recouped through federal grant reimbursements, but local governments would still feel the fiscal impact of a major event.

- Roads, rail systems, ports, waterways, and airports can all be affected by severe winter storms.
- Roadways can be disrupted due to snow and ice accumulations.
- Emergency services may be impacted by severe winter storms if communications networks fail.

Natural, Historic, and Cultural Resources

Environmental impacts of winter storms often include damage to shrubbery and trees due to heavy snow loading, ice buildup, and/or high winds which can break limbs or even bring down large trees. An indirect effect of winter storms is the treatment of roadway surfaces with salt, chemicals, and other de-icing materials which can impair adjacent surface and ground waters. This is particularly a concern in highly urban areas. Additionally, rapid snowmelt may also lead to flash flood events, which causes further environmental impacts.

Additional natural, historic, and/or cultural impacts may include:

- Severe winter storms can cause physical damage to historical buildings/areas.
- Severe winter storms can cause environmental stress in historical buildings.
    - Freeze-thaw cycles can cause cracks and structural weakness.
- Severe winter weather events can disrupt the transmission of traditional knowledge and practices associated with cultural sites, especially in Indigenous communities.
- Snow and ice can cause accessibility issues to cultural sites.
    - This can hinder preservation efforts.
    - Reduce tourism.

Community Activities

Activities that take place in the winter months (December through March) are most likely to be impacted by winter weather, particularly those occurring during holiday season (e.g., December). Activities and events that are outside and/or multi-day are most vulnerable to postponement or cancellation if a severe winter storm affects the area. Other impacts to community activities due to severe winter weather include:

- Severe winter storms can cause schools to close down temporarily as well as workplaces.
- Events and gatherings may be postponed or canceled.
- Businesses may be impacted by severe winter storms, forcing them to close temporarily.

3.3.9.8 Future Land Use and Development Trends

Because severe winter storms are not limited to geographic boundaries or population groups, it is difficult to identify development and population trends that will impact this hazard in the future. Current land use and building codes incorporate standards that address and mitigate snow accumulation.

As the population of Anne Arundel County continues to grow, new development can increase vulnerability by increasing the number of assets exposed to the potential impacts of winter storm events. As discussed, all buildings are vulnerable to widespread utility disruptions, including loss of heat and electricity, as well as structure collapse or damage from downed trees. Generally, property owners and land developers should mitigate the impacts of winter storms by avoiding flat roofs and constructing to the most recent building code requirements for snow loading and insulation.

The potential for impacts of future growth and development on severe winter storms will be monitored and evaluated in the next planning cycle to consider whether the level of risk has changed and whether there are mitigation opportunities related to development that may reduce hazard impacts in the future.

3.3.9.9 Future Conditions

According to Climate Communication Science and Outreach, climate change is fueling an increase in the intensity and snowfall of winter storms. The atmosphere now holds more moisture, and that in turn drives heavier than normal precipitation, including heavier snowfall in the appropriate conditions.

The following list includes known U.S. winter storm trends as they relate to climate change:

- National Oceanic and Atmospheric Administration (NOAA) scientists, examining 120 years of data, found that there were twice as many extreme regional snowstorms in the U.S. between 1961 and 2010 compared to 1900 to 1960.
- According to the U.S. Fourth National Climate Assessment, "Heavy precipitation events [defined as the heaviest 1 percent of all daily events] in most parts of the United States have increased in both intensity and frequency since 1901."
- From 1958 to 2016, the amount of precipitation falling in very heavy events (the top 1 percent of all daily precipitation events) increased by 55 percent in the Northeast.
- The 5th Assessment Report of the Intergovernmental Panel on Climate Change states: It is likely that since about 1950 the number of heavy precipitation events over land has increased in more regions than it has decreased. Confidence is highest for North America and Europe where there have been likely increases in either the frequency or intensity of heavy precipitation with some seasonal and regional variations. It is very likely that there have been trends towards heavier precipitation events in central North America.

Given the above information, it makes sense to plan for more frequent and extreme winter storm conditions in Anne Arundel County. Undertaking preparedness campaigns, as well as infrastructure and utilities upgrades, and preparedness initiatives will strengthen resilience.

3.3.9.10 Considerations for the Next Planning Cycle

Future monitoring, evaluation, and updating of this Plan should consider the following factors related to severe winter storms:

- Have any severe winter storm events occurred since this Plan was adopted?
- Has any new scientific research or methodology changed the ability to predict severe winter storm events or assess risk and vulnerability?
- Has there been any significant change in the population, built environment, natural environment, or economy that could affect the risk or vulnerability to severe winter storm events?
- Is there any new evidence related to the impacts of climate change that could affect the level of risk or vulnerability to severe winter storm events?

3.3.10 Tornado

The Tornado section includes the following sub-topics:

1. Description of Tornado
2. Location, Extent, Magnitude
3. Past Occurrences
4. Probability of Future Tornado Events
5. Tornado Risk Assessment
6. Tornado Hazards in Highland Beach
7. Impacts to People, Structures, Systems, and Resources
8. Future Land Use and Development Trends
9. Future Conditions
10. Consideration for the Next Planning Cycle

3.3.10.1 Description of the Tornado

A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud extending to the ground. Tornadoes are most often generated by thunderstorm activity (but sometimes result from hurricanes and other tropical storms) when cool, dry air intersects and overrides a layer of warm, moist air, forcing the warm air to rise rapidly. The damage caused by a tornado is a result of the high wind velocity and wind-blown debris, also accompanied by lightning or large hail. According to the National Weather Service (NWS), tornado wind speeds normally range from 40 to more than 300 miles per hour.

On average, more than 800 tornadoes are reported each year in the U.S., according to the National Oceanic and Atmospheric Agency (NOAA), resulting in an average of 80 deaths and 1,500 injuries annually. Tornadoes are more likely to occur during the spring and early summer months of March through June, but they can also develop in other months. They are also more likely to form in the late afternoon and early evening but can occur at any time of day. Most tornadoes are a few dozen yards wide and touch down only briefly; however, small, short-lived tornadoes can inflict tremendous damage. Highly destructive tornadoes can carve out a path of devastation more than a mile wide and several miles long.

Waterspouts are weak tornadoes that form over warm water; they are most common along the Gulf Coast and southeastern states where the water is warmer. Waterspouts occasionally move inland, becoming tornadoes that cause damage and injury. However, most waterspouts dissipate over the open water, causing threats only to marine and boating interests. Typically, a waterspout is weak and short-lived, and because they are so common, most go unreported unless they cause damage.

The destruction caused by tornadoes ranges from light to devastating, depending on the intensity, size, and duration of the storm. Typically, tornadoes cause the greatest damage to structures of light construction such as residential homes (particularly mobile homes) and tend to remain localized in impact.

Tornado Warning vs. Watch

Per the National Weather Service, a Tornado Watch is issued when severe thunderstorms and tornadoes are possible in and near the watch area. It does not mean that they will occur. It only means they are possible.

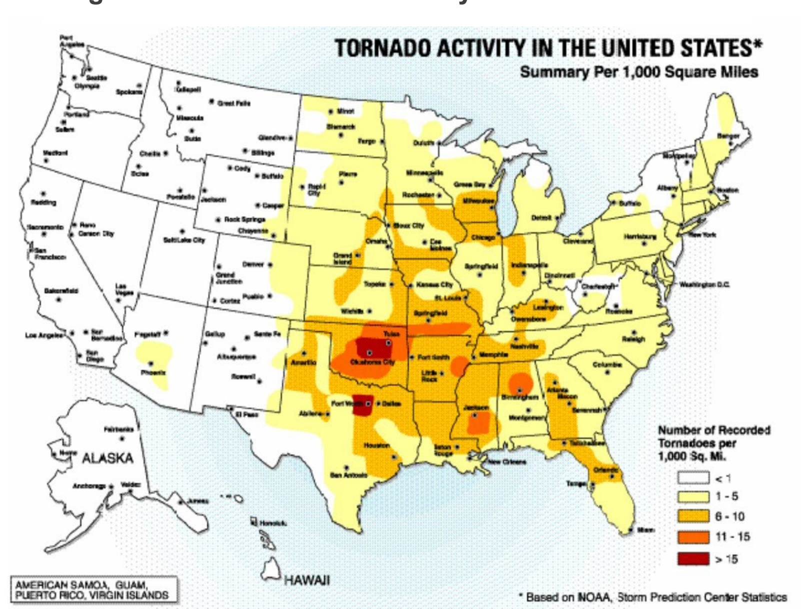
A Tornado Warning is issued when a tornado is imminent. When a tornado warning is issued, seek safe shelter immediately by moving to the lowest level of the building. If there is no basement, move to an interior room or hallway on the lowest floor, stay away from windows, and cover your head if possible. If you are in a car, do not try to outrun a tornado; leave the vehicle immediately and lie flat in a ditch or depression. Mobile homes offer little protection from tornadoes and should be abandoned. If you cannot reach an appropriate building in time, lie flat in a ditch or depression.

3.3.10.2 Location, Extent, & Range of Magnitude of Tornado

Tornadoes can range from just several yards to over two miles in width and have the potential to destroy nearly everything in their path. Although tornadoes normally travel on the ground for short distances, tornado tracks of 200 miles or more have been reported. Tornado paths average 4 miles in length but may reach up to 300 miles. Widths average 300 to 400 yards, but severe tornadoes have cut swaths a mile or more in width or have formed groups of two or three funnels traveling together. On average, tornadoes move between 25 and 45 miles per hour, but speeds over land of up to 70 mph have been reported. Tornadoes rarely last more than a couple of minutes over a spot or more than 15 to 20 minutes in a 10-mile area, but their short periods of existence do not limit their potential devastation to an area. The destructive power of a tornado results primarily from its high wind velocities and sudden changes in pressure. Damages from tornadoes result from extreme wind pressure and windborne debris. Since tornadoes are generally associated with severe storm systems, they are often accompanied by hail, torrential rain, and intense lightning. Depending on their intensity, tornadoes can uproot trees, bring down power lines, and destroy buildings. Flying debris is the main cause of serious injury and death.

Tornado movement is characterized in two ways: direction and speed of spinning winds, and forward movement of the tornado, also known as the storm track. The forward motion of the tornado path can be a few hundred yards or several hundred miles in length. The width of tornadoes can vary greatly but generally range in size from less than 100 feet to over a mile in width. Some tornadoes never touch the ground and are short-lived, while others may touch the ground several times. Downbursts are characterized by straight-line winds. Downburst damage is often highly localized and resembles that of tornadoes. There are significant interactions between tornadoes and downbursts; a tornado path can also be affected by downbursts. Because of this, the path of a tornado can be very unpredictable, including veering right, left or even taking a U-turn.

Figure 3.3.10-1. Tornado Activity in the United States



As shown in Figure 3.3.10-1, an area covering portions of Texas, Oklahoma, Arkansas, Missouri, and Kansas is known as Tornado Alley, where the average annual number of tornadoes is the highest in the United States. Cold air from the north collides with warm air from the Gulf of Mexico, creating a temperature differential on the order of 20 – 30 degrees C. Most tornadoes in this area occur in the spring. People living in manufactured or mobile homes are most exposed to damage from tornadoes. Even if anchored, mobile homes do not withstand high wind speeds as well as permanent, site-built structures.

The magnitude of tornadoes was first measured by intensity on the Fujita-Pearson Tornado Scale, or simply the Fujita Scale, or F-Scale. The Fujita Scale, however, did not measure tornadoes by their size or width, but rather by the amount of damage to human-built structures and trees. The scale ranged from F0 for the weakest, to F6 for the most powerful, although an F6 has never been recorded. The Fujita Scale was updated in 2007 to the Enhanced F-Scale. The enhanced scale classifies EF0-EF5 damage as developed by engineers and meteorologists across 28 different types of Damage Indicators (DI) and Degrees of Damage (DoD). To establish a rating, the National Weather Service will examine the damage to different structures and use their formulated chart to assign an EF-number to the tornado. Both the Fujita Scale and the EF Scales are included in Table 3.3.10-1.

Table 3.3.10-1 Fujita and Enhanced Fujita Tornado Measurement Scale

Fujita Scale			Enhanced Fujita Scale	
F Number	**Fastest ¼ mile (mph)**	**3 Second Gust (mph)**	**EF Number**	**3 Second Gust (mph)**
0	40-72	45-78	0	65-85
Level of Damage: Light damage. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.				
1	73-112	79-117	1	86-110
Level of Damage: Moderate damage. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows/other glass broken.				
2	113-157	118-161	2	111-135
Level of Damage: Considerable damage. Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off				
3	158-206	162-209	3	136-165
Level of Damage: Severe damage. Entire stories of well-constructed homes destroyed; severe damage to large buildings, (e.g., shopping malls); trains overturned; trees debarked; heavy cars lifted off the ground and thrown.				
4	207-260	210-261	4	166-200
Level of Damage: Severe damage. Entire stories of well-constructed homes destroyed; severe damage to large buildings, (e.g., shopping malls); trains overturned; trees debarked; heavy cars lifted off the ground and thrown				
5	261-318	262-317	5	Over 200
Level of Damage: Devastating damage. Well-constructed houses and whole-frame houses completely leveled; cars thrown, and small missiles generated.				

Source: National Oceanic and Atmospheric Administration. http://www.spc.noaa.gov/faq/tornado/ef-scale.html

3.3.10.3 Past Occurrences

As of 2024, one tornado in Anne Arundel County has been a presidentially declared disaster.

Table 3.3.10-2 Tornado Events in Anne Arundel County from 1950 – 2024

Date	Magnitude	Deaths	Injuries	Property Damage ($)	Crop Damage ($)
07/02/1953	F1	0	0	250	$0
04/26/1960	F1	0	0	2,500	0
06/09/1961	F3	0	0	250,00	0
07/13/1961	F1	0	0	25,000	0

Table 3.3.10-2 Tornado Events in Anne Arundel County from 1950 – 2024

Date	Magnitude	Deaths	Injuries	Property Damage ($)	Crop Damage ($)
05/12/1974	F1	0	0	2,500	0
07/14/1975	F1	0	0	25,000	0
08/14/1976	F1	0	0	250,000	0
09/05/1979	F1	0	1	25,000	0
08/28/1992	F0	0	0	0	0
08/28/1992	F0	0	0	0	0
05/12/1993	F0	0	0	5,000	0
10/05/1995	F1	0	0	60,000	0
10/05/1995	F1	0	0	250,000	0
10/05/1995	F0	0	0	1,000	0
06/24/1996	F1	0	0	100,000	0
07/10/2000	F1	0	0	5,000	0
09/28/2006	F1	0	0	6,000,000	0
09/30/2010	EF0	0	0	15,000	0
04/05/2011	EF0	0	0	2,000	0
06/01/2012	EF0	0	0	3,000	0
06/01/2012	EF0	0	0	100,000	0
2025 PLAN UPDATE					
09/03/2020	EF0	0	0	1,250,000	0
09/01/2021	EF2	0	0	0	0
07/05/2022	EF-Unknown	0	0	0	0
Total:	**N/A**	**0**	**1**	**$8,371,000**	**$0**

A total of 24 tornadoes were identified in the NCEI Storm Events database for Anne Arundel County between 1953 and 2024. Of these 24 tornadoes, nine were F/EF 0, 12 were F/EF 1, one was F/EF2, one was EFU, and one was F/EF 3. These tornado events have caused a total of $8,371,000 in property damage and have resulted in one injury. Based on the historical event data, Anne Arundel County experiences about 0.34 tornado events annually. In the last 5 year planning period, this average increased to 0.6 tornado events annually.

Significant tornado events for Anne Arundel County are summarized below in Table 3.3.10-3.

Table 3.3.10-2. Significant Tornado Events in Anne Arundel County from 1953 – 2024

Event & Date	Tornado Description
July 2, 1953	This tornado was rated an F1 on the original Fujita Scale causing roughly $250 in damage. No injuries or deaths were reported.
April 26, 1960	The tornado on April 26 was spotted near Powhatan Beach and was described as a small tornado. No deaths and no injuries were reported. Property and crop damage estimates are not available for reference, although reports describe the tornado damaging two houses, a car, and two trees.
June 9, 1961	The tornado on June 9, 1961, occurred near the Anne Arundel County-Baltimore City border on the Anne Arundel side. It caused $250,000 in property damages, although no deaths or injuries were reported.
July 13, 1961	This F1 tornado was approximately 500 yards wide and spanned a half a mile. It caused $25,000 in property damages and no deaths or injuries were recorded.
July 14, 1975	This F1 tornado was approximately 100 yards wide and measured half a mile in length. It resulted in $25,000 of property damages, zero deaths, zero injuries, and no recorded crop damages.

Table 3.3.10-2. Significant Tornado Events in Anne Arundel County from 1953 – 2024

Event & Date	Tornado Description
August 14, 1976	This event was classified as an F1 tornado, 33 yards wide moving southwest. According to a local publication, the tornado decimated 11 townhouses mid-construction and severely damaged many large trees. An eyewitness observed the damage happen in just a few minutes.
September 5, 1979	On September 5th, 1979, an F1 tornado measuring 2.5 miles in length and 50 years in width was recorded in Anne Arundel, resulting in one injury and $25,000 in property damage. Witnesses observed the tornado blowing off a house's roof.
August 28, 1992	An F0 tornado 0.1 miles long and 7 yards wide was recorded near Annapolis. No injuries, deaths, crop damage, or property damage were reported. A second F0 tornado was recorded approximately 17 minutes later, mearing .1 miles in length and 10 yards in width. This tornado did not cause any deaths, injuries, significant crop damage, or significant property damage.
May 12, 1993	The F0 tornado on May 12, 1993, measured half a mile in length and 30 yards in width. No injuries, deaths, or crop damage were reported. The event resulted in $5,000 of property damage.
October 5, 1995	Three tornadoes occurred on October 5, 1995, in Anne Arundel County. The first event, an F1 tornado 3.8 miles long and 75 yards wide. This event resulted in $60,000 worth of property damage, including several uprooted trees, and damage to windows, roofs, cars, telephone wires, sailboats, and fences. Anne Arundel Community College and private homes sustained most of the damage. The second event began around 3 and a half hours later, as an F0 tornado half a mile long and 50 yards wide caused $1,000 in property damage. Minimal damage to trees and structures were recorded. The final tornado on this day began at F0 and became an F1, causing $250,000 in property damage. This tornado was 6 miles long and 100 yards wide. Over 200 trees and 11 homes were damaged while 2,600 people lost power in the County. Despite considerable losses, no injuries, deaths, or crop damage were reported on this day.
June 24, 1996	A mile-long, 100-yard-wide, F1 tornado damaged around $100,000 worth of property. A mobile home, a few trees, a roof, and several residences suffered damage. No injuries, deaths, or crop damage were reported.
July 10, 2000	This tornado began in Howard County and moved into Anne Arundel County. It was rated F1 and measured 0.7 miles in length and 100 yards in width. It caused around $5,000 in property damage. Trees, power lines, windows, doors, trailers, and homes endured damage. No injuries, deaths, or crop damage were reported.
September 28, 2006	At its peak, this tornado reached 250 yards in width and was rated an F1. Stores, trees, and several homes suffered extensive damage. Some trees were between 60 and 80 feet tall, while 13 of the 34 damaged homes were completely decimated. $6,000,000 in property damages were recorded. No injuries, deaths, or crop damage were reported.
September 30, 2010	This is the first recorded tornado in Anne Arundel County under the Enhanced Fujita Scale. It was rated an EF0, measuring 0.93 miles and 200 yards. It resulted in $15,000 of property damage and no crop damage. No injuries or deaths were reported.
April 5, 2011	This tornado was rated on EF0 and measured 0.61 miles in length and 50 yards in width. It damaged several pine trees, resulting in $2,000 of property losses. No people were injured or killed. No crop damages were recorded.
June 1, 2012	Two incidents were reported on June 1, 2012. The first event occurred at around 4:46 pm and caused $3,000 in property damage. It was 0.15 miles long and 75 yards wide. The second event happened at 6:06 pm and measured 6.62 miles in length and 100 yards in width. It caused $100,000 in property damage.
2025 PLAN UPDATE	

Table 3.3.10-2. Significant Tornado Events in Anne Arundel County from 1953 – 2024

Event & Date	Tornado Description
September 3, 2020	An EF0 tornado, 6.05 miles long and 100 yards wide, caused $1.25 million in damages. Although fences and roofs were damaged by the tornado, trees were primarily affected. Other jurisdictions in the tornado path include Montgomery County, Prince George's County, and Baltimore County.
September 1, 2021	This EF2-rated tornado brought 125 mph winds to the County and through Annapolis. It caused severe damage to residential, public, and commercial properties. Some of the affected areas include the Center of Technology South, Woodland Beach, Londontowne, and the Edgewater, Annapolis Harbor Center shopping area. At its peak, the tornado reached 200 yards in width and spanned 11.43 miles in length. Although it is one of the largest tornadoes in Maryland's recent history, estimates for property and crop damage are not available. No deaths or injuries were reported.
July 5, 2022	This tornado was caused by thunderstorms in Londontowne, Anne Arundel County and later traveled through the border of Howard County and Montgomery County. No injuries or deaths were recorded. No crop damage or property damage was recorded.

3.3.10.4 Probability of Future Tornado Events

The overall probability of a tornado in Anne Arundel County is unlikely, with a recurrence level of less than 1 event per year (historically the County experiences 0.34 tornado events annually). It is unlikely that very strong tornadoes (F4 or F5) will strike the area, although it remains a possibility. Climate change is projected to increase the frequency and intensity of extreme weather events, including severe thunderstorms. At this time, it remains uncertain whether this may also translate into an increased frequency of tornadoes.

All future structures and infrastructure built in Anne Arundel County will likely be exposed to tornados and may experience damage. Since the previous statement is assumed to be uniform Countywide, the location of development does not increase or reduce the risk necessarily. By adhering to building codes, Anne Arundel County can ensure that new development is built to current standards for wind resistance.

3.3.10.5 Tornado Risk Assessment

The frequency of tornados is expected to increase, which increases the County's vulnerability to this hazard. Additionally, vulnerability is higher in more densely developed areas. However, all assets located in Anne Arundel County can be considered at risk of tornados. This includes all the County's population, buildings, and infrastructure.

Aging and dilapidated structures or structures not built to applicable building codes are more susceptible to damage. Mobile homes and campgrounds are especially susceptible to damage due to tornado or high wind. Past experiences with tornadoes in the region show that, while rare, death and injury are indeed possibilities. Vulnerability to the effects of a tornado is dependent upon the age of a structure because as building codes become more stringent, buildings are capable of enduring greater wind forces.

All County structures and infrastructure might be exposed to the effects of a tornado. Depending upon the severity of a tornado, any existing structures might be damaged to some extent. Any future structures might be exposed to tornadoes or high winds as this hazard does not occur in specific locations. However, updated building codes including requirements for bracing and roof design, will mitigate damages to structures, from the effects of tornado and other extreme weather events.

3.3.10.6 Tornado Hazards in Highland Beach

Highland Beach has the same level of exposure and vulnerability to tornadoes as the rest of the County. The County has a very low risk from this hazard overall. The housing stock in the area is fairly vulnerable to the hazard; however, the very low probability of a tornado strike in such a small, specific area is so low that potential impacts must be considered negligible.

3.3.10.7 Impacts to People, Structures, Systems, and Resources

Tornados can cause considerable damage to people, structures, systems, and activities in Anne Arundel County. However, the overall impact to the planning area from tornadoes will most likely be low to moderate considering the frequency and magnitude of past occurrences. Impacts on people, structures, systems, resources, and community activities are considered in the following sections.

Tornado
The Public's Perspective

A survey conducted during the 2025 plan update asked County residents their level of concern for hazards identified in the plan.

The majority of respondents, 37.01%, indicated that they are only "somewhat concerned" with tornadoes. Just under half, 44.81%, indicate that they are "concerned" or "very concerned."

54.11% of respondents indicated that they have seen "no change" in the frequency or intensity of the tornado hazard over the last 10 years.

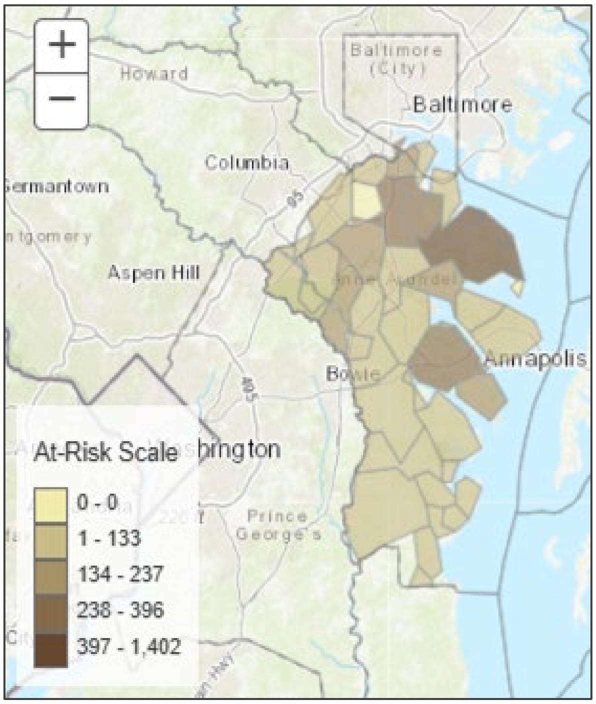
Just 8.49% of respondents indicate that a tornado event has caused damage to their residential or commercial property.

People

Populations most at risk to tornado and high wind-related hazards are aging populations and people with disabilities. These groups require more time and are more likely to seek emergency medical attention that might not be as readily available due to isolation and other various circumstances. These populations are sometimes electricity dependent, which means they may use durable medical and assistive equipment (DME) and devices, and certain essential health care services to live independently in their homes. Local incidents, such as prolonged power outages, can rapidly thrust these individuals into life-threatening situations within hours or days. Stress and anxiety caused by thunderstorms and associated power outages can have psychological effects on individuals, particularly those that are electricity dependent.

Over 3 million Medicare beneficiaries rely on electricity dependent DME and devices to live independently in their homes, and some of those individuals also have health care service dependencies. The HHS emPOWER Map is updated monthly and displays the total number of Medicare beneficiaries who have had an administrative claim for one or more types of electricity-dependent DME and devices, as well as at-risk combinations data for those who rely on a certain essential health care service(s) and any electricity-dependent DME and devices.

Figure 3.3.10-2 At-Risk Medicare Beneficiaries
Source: HHS emPOWER Map



These at-risk populations as of December 2024 are shown on Figure 3.3.10-2.

In total, Anne Arundel County has 102,393 beneficiaries, of which 3,393 (or 3.3% of the total) are considered at-risk because they rely on electricity due to their use of DME. The highest concentration of at-risk beneficiaries (492) is within the 21122 zip code (i.e., Pasadena and surrounding areas), followed by the 21061 zip code (i.e., Glen Burnie, Ferndale, Linthicum, and Severn, MD) which has 393 at-risk beneficiaries. While technology and warning system capabilities have improved significantly in recent years, tornadoes can still occur with little to no warning. In total, one person has been reported to have been injured by a tornado in Anne Arundel County.

Although tornadoes have caused zero casualties in the County, they still pose a significant threat to marginalized communities. As of 2021, the Maryland Department of Housing and Community Development Report on Homelessness indicated approximately 244 homeless individuals in Anne Arundel County. The homeless population is at a particular disadvantage during tornadoes because access to adequate shelter is likely extremely limited, especially if a tornado is unexpected. Dealing with the aftermath of the tornado could also disrupt access to essential resources.

Structures

Anne Arundel is the jurisdiction with the highest number of Maryland State assets within its boundaries. Alongside Baltimore County, Prince George's County, and Anne Arundel County are the top three counties in holding Maryland State assets based on building and content value. Alone, Maryland state owns over four billion dollars in building value and nearly half a billion dollars in content value in Anne Arundel County.

According to the County's Critical Facility database updated for the 2025 plan update, Anne Arundel County has 1,298 critical facilities/community lifelines. These facilities and lifelines have an estimated total building improvement value of $9,804,853,900.00.

Historically, tornadoes in Anne Arundel County have caused a recorded $8.371 million in property damage. Property owners often bear the burden of these costs and the disruption caused by damaged assets. According to the National Risk Index, the Expected Annual Loss caused by the tornado hazard for Anne Arundel County is $6.162 million. Of this amount, $1.699 million is building value, $4.462 million is population equivalence, and $394 is agricultural damage.

Systems

Traffic in essential roadways, like Interstate-97 and Route 50, could be blocked off by pollution, debris, or uprooted trees following a tornado event. Road repairs could lead to further disruptions or deter emergency responders from reaching people in need. Additionally, temporary loss of electricity, power, or communication networks is possible during tornadoes and the aftermath.

Natural, Historic and Cultural Resources

As documented by NOAA, tornadoes primarily uproot and destroy trees in their paths. This is particularly problematic because trees provide various ecosystem services to their habitats and communities. High winds can also scatter pollution that harm plants, animals, and the ecosystem.

The National Register of Historic Places was used to assess the vulnerability of natural, historic, and cultural resources to the tornado hazard. All historic properties throughout the County are deemed to be at risk during a tornado event. In terms of historical properties, there are 107 listings in the National Register of Historic Places in Anne Arundel County, including properties and special districts. High winds could decimate vulnerable properties and cause significant damage to these cultural resources.

National Risk Index Expected Annual Loss – Exposure Value

Building exposure is defined as the dollar value of the buildings determined to be exposed to a hazard according to a hazard-specific methodology (i.e., Hazus 6.0)

Population exposure is defined as the number of people determined to be exposed to a hazard according to a hazard-specific methodology (i.e., Hazus 6.0). Population exposure is also monetized using a value of statistical life (VSL) approach in which each fatality or ten injuries is treated as $11.6 million of economic loss.

Agriculture exposure is defined as the dollar value of the crops and livestock determined to be exposed to a hazard according to a hazard-specific methodology. This is derived from the United States Department of Agriculture 2017 Census of Agriculture County-level value of crop and pastureland.

Source: FEMA National Risk Index

Community Activities

Both outdoor and indoor activities can be impacted by tornadoes and can be subject to delays or cancelations. Tornadoes can block roads, which prevents people from reaching their destination, decimate buildings making activities impossible to occur, and create unstable environments for activities outdoors.

The Anne Arundel County Department of Recreation and Parks offers various programs throughout the year for people of all ages. During tornado season in the spring and summer, several recreation sports like track and field, archery, golf, and tennis could face disruption. Indoor activities, like ballet, open gym volleyball, yoga, and karate could also be affected in a tornado or during the aftermath.

Examples of community activities that could be disrupted or canceled if a tornado breaks out include Anne Arundel County Fair, Inc., the Flea Market and Craft Fair, the Tractor Pull, the State Jousting Championship, the Bunny in the Barnyard, the Rodeo, and the Halloween Happening events. In the fall, activities like National Take a Hike Day, Tater Tots Arts and Crafts, indoor dance classes, yoga, and self-defense courses are vulnerable to cancelation or delays.

3.3.10.8 Future Land Use and Development Trends

The entire Anne Arundel County planning area, including the Town of Highland Beach, can be subject to tornado events and their negative effects.

Areas of most concern during a tornado are those with high density development, such as the City of Annapolis. High density development is very common in North County. Tornado impacts in North County would be much more severe than in southern portions of the County due to development density.

Due to the lack of well-defined geographic extent for tornadoes and other high wind events, it is difficult to know how future development or changes in population patterns will change the tornado hazard. It is important that all future developments follow the building codes and design wind speed as set forth by Anne Arundel County in order to lessen potential damage from tornados to the greatest extent possible.

3.3.10.9 Future Conditions

National Geographic states that predicting whether climate change will have an effect on the frequency and power of tornadoes is challenging. Tornadoes are small compared to other extreme weather events, such as hurricanes, which can span hundreds of miles. The largest tornado on record measured "only" 2.6 miles wide. Tornadoes are also very short lived, lasting from a few seconds to a few hours as opposed to days or weeks at a time. These two factors make it very difficult to model in the climate simulations that are used to project the effects of climate change (National Geographic Society, 2022).

Instead, scientists must attempt to predict how climate change may impact the individual weather components that support the development of supercell thunderstorms (the type that produce tornadoes). These weather components include:

- warm, moist air
- an unstable atmosphere
- wind shear

As global temperatures rise, the warmer atmosphere is able to hold more moisture. This increases atmospheric instability, a vital supercell component. However, as the planet warms, wind shear is likely to decrease. These two forces work against each other, so it is difficult to anticipate which might have a greater impact on tornado formation.

The Fourth National Climate Assessment summarizes the complicated relationship between tornadoes and climate change: "Some types of extreme weather (e.g., rainfall and extreme heat) can be directly attributed to global warming. Other types of extreme weather, such as tornadoes, are also exhibiting changes which may be linked to climate change, but scientific understanding isn't detailed enough to project direction and magnitude of future change."

Due to the lack of well-defined geographic extent for tornado events, it is difficult to know how future development or changes in population patterns will impact the tornado hazard. It is very likely that the growing population in the County will place more people and properties at risk to a tornado. The County's population is projected to grow by 94,000 persons and 28,000 households by 2035, with much of the growth pressure happening in the north and in the Annapolis area. Therefore, new property owners and land developers should be educated in proper tie-down techniques and build to the most recent building code requirements for wind loading.

One thing known for certain is that we live in a warmer and wetter world due to climate change, and this is likely to have an effect on extreme weather events, including tornadoes. Unfortunately, in the case of tornadoes we cannot yet predict what that effect might be.

3.3.10.10 Consideration for the Next Planning Cycle

Future monitoring, evaluating, and updating of this Plan should consider the following factors related to tornadoes:

- Have any tornadic events occurred since this Plan was adopted, or did events occur in adjacent jurisdictions that impacted people or property in Anne Arundel County?
- Have any of the communities installed warning sirens or other systems that would enable the population to take cover in the event of an expected tornado?
- Have the results of new scientific research or methodology changed the ability to predict tornado events or assess risk and vulnerability?
- Has the County developed—or is it planning to develop—additional storm shelters?
- Have there been significant changes in the demographics, built environment, natural environment, or economy that could affect the risk or vulnerability to tornado events?
- Is there any new evidence related to the impacts of climate change that could affect the level of risk or vulnerability to tornado events?
- Has there been a significant increase in the number of persons who fall into one or more of the vulnerable population categories, thereby increasing the number and types of persons or groups at higher risk from tornado events?
- Closely examine critical facilities at risk by determining their construction type in all or some areas of the County.

3.3.11 Wildfire and Urban Interface Fire

The Wildfire and Urban Interface Fire section includes the following sub-topics:

1. Description of Wildfire and Urban Interface Fire
2. Location, Extent, Magnitude
3. Past Occurrences
4. Probability of Future Wildfire and Urban Interface Events
5. Wildfire and Urban Interface Fire Risk Assessment
6. Wildfire and Urban Interface Fire Hazards in Highland Beach
7. Impacts to People, Structures, Systems, and Resources
8. Future Land Use and Development Trends
9. Future Conditions
10. Considerations for Next Planning Cycle

3.3.11.1 Description of the Wildfire and Urban Interface Fire

Wildfires are uncontrolled fires often occurring in wildland areas, which can consume houses or agricultural resources if not contained. Wildland Urban Interface (WUI) is defined as the area where structures and other human development blend with undeveloped wildland.

Forest and grassland fires can occur any day throughout the year. Most of the fires occur during the spring season. The length and severity of burning periods largely depend on the weather conditions. Low humidity, high winds, below-normal precipitation, and high temperatures that are frequently present during the spring result in extremely high fire danger. Drought conditions can also hamper efforts to suppress wildfires as decreased water supplies may not prove adequate to quickly contain the fire. The second most critical period of the year is fall. Depending on the weather conditions, a sizeable number of fires may occur between mid-October and late November.

The relative humidity combined with a breeze creates the conditions for wildfires to spread rapidly. Fires can be rated based on their ability to ignite. The five fuel types which make up Maryland's land cover are listed below (Maryland Department of Natural Resources):

- **Deciduous Hardwood Forest:** Deciduous forests make up a large percentage of Anne Arundel County's vegetation. Fire intensity and rate of spread can be dependent on the amount of hardwood debris accumulated from dried leaves and plants. Fires fueled by hardwood debris will typically burn the surface leaves and plants, with flames ranging from 1-4 feet. In areas of dense dried shrubs, fire intensity is likely to increase substantially and smolder for long periods of time.
- **Tall Grass:** Tall grass makes up a small percentage of Anne Arundel County's land cover and typically grows in fields or plains. When cured and dried in abundance, tall grass burns hot and fast. Under the influence of a strong wind, and flames ranging 12-18 feet, fires can spread at a very fast rate.
- **Evergreen Litter:** The buildup of dried pine needles can easily ignite and spread. Flames from evergreen debris can range from 1 to 6 feet.
- **Evergreen Overstory:** In stands of densely packed evergreens and pines, surface fires can spread upwards toward the tree canopy. This could eventually result in crown fires, which spread from treetop to treetop, resulting in the torching of trees.
- **Marsh:** Although marshes are surrounded by water, they have a large quantity of fire fuels, which can burn rapidly. Flame lengths of marsh fires can reach 20 feet or more. Marshes are present along low-lying wetlands in Anne Arundel County

Wildfires are dependent upon the quantity and quality of available fuels.

- Fuel quantity is the mass per unit area.
- Fuel quality is determined by several factors, including fuel density, chemistry, and arrangement.

Arrangement influences the availability of oxygen. Another important aspect of fuel quality is the total surface exposed to heat and air. Fuels with large area-to-volume ratios, such as grasses, leaves, bark and twigs, are easily ignited when dry.

Climatic and meteorological conditions that influence wildfires include solar insulation, atmospheric humidity, and precipitation, all of which determine the moisture content of wood and leaf debris. Dry spells, heat, low humidity, and wind increase the susceptibility of vegetation to fire. Various natural and human agents can be responsible for igniting wildfires. Natural agents include lightning, sparks generated by rocks rolling down a slope, friction produced by branches rubbing together in the wind, and spontaneous combustion.

Wildfire events can range from small fires that can be managed by local firefighters to large fires impacting many acres of land. Large events may require evacuation from one or more communities and necessitate regional or national firefighting support. The impact of a severe wildfire can be devastating. While some fires are not human-caused and are part of natural succession processes, a wildfire can kill people, livestock, fish, and wildlife. They often destroy property, valuable timber, forage, and recreational and scenic values.

Vegetation loss is often an environmental concern with wildfires, but it typically is not a serious impact since natural re-growth occurs with time. The most significant environmental impact of vegetation loss is the potential for severe erosion, silting of stream beds and reservoirs, and flooding due to ground-cover loss following a fire event. Wildfires can also have a positive environmental impact in that they burn dead trees, leaves, and grasses to allow more open space for new and different types of vegetation to grow and receive sunlight. Another positive effect of a wildfire is that it stimulates the growth of new shoots on trees and shrubs, and a fire’s heat can open pinecones and other seed pods.

3.3.11.2 Location, Extent, & Range of Magnitude of Wildfire and Urban Interface Fire

The leading cause of wildfires in Maryland is due to human activity, which accounts for 96% of all wildfires. Improper debris and outdoor burning ignite an average of 35% of the fires each year. The second leading cause of wildfires in Maryland is arson, which accounts for 30% of ignitions. Other sources of wildfire ignitions include smoking, campfires, poorly discarded ashes, railroads, equipment use, downed power lines, and fireworks. Lightning is, however, the only natural cause of all wildfires, and accounts for 4% of wildfire ignitions in Maryland (Maryland Department of Natural Resources, 2023).

Most wildfires in Maryland are surface fires, which burn fallen debris along the “duff” layer. The duff layer is comprised of decomposed leaves, needles, twigs, and other organic material. During dry periods, fires can burn underground in this duff layer, for weeks, or even months, and cause severe issues (Maryland Department of Natural Resources, 2023). Fire intensity is typically higher in areas of dense vegetative fuels, such as grasses, evergreens, and shrubs. Maryland rarely experiences wildfires that burn in the tree canopy, known as crown fires.

However, crown fires can still occur during very dry and windy seasons, along dense stands of evergreen trees. Fuels, weather, and topography are the three factors that control wildfire behavior. Fire may be rated as low, moderate, high, very high, or extreme based on the type of fuels that help sustain them (Table 3.3.11-1).

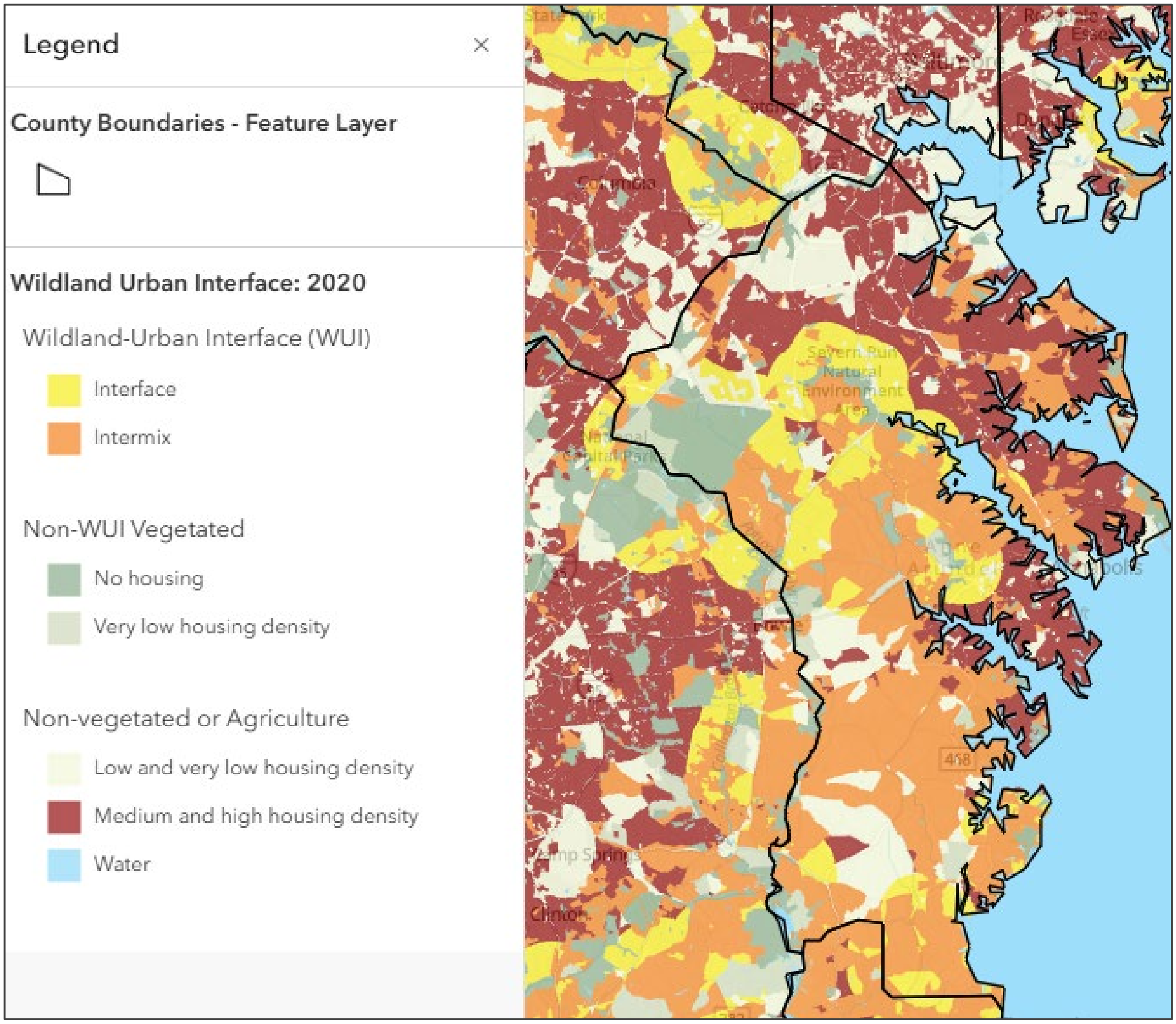
Table 3.3.11-1 National Fire Danger Rating System – Descriptions

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

Source: USDA – Wildland Fire Assessment System.

Areas at the greatest risk of wildfire events are those where structures and other human development meet undeveloped Wildland-Urban Interface (WUI). The WUI is characterized by an environment where fire can readily move between structural and vegetation fuels. Figure 3.3.11-1 depicts WUI areas (in yellow) and intermix areas (in orange) for Anne Arundel County. Intermix areas are defined as those where housing and vegetation intermingle, whereas WUI areas are characterized by development in the vicinity of continuous wildland vegetation.

Figure 3.3.11-1 Wildland Urban Interface, Anne Arundel County
Source: U.S. Forest Service, 2020



3.3.11.3 Past Occurrences

The Maryland Department of Natural Resources publishes the Annual Wildland Fire Report which documents various factors including the average number of monthly wildfires, prescribed burns, number of acres burned, and the total number of wildfires. These statistics are provided for each region of the state. Anne Arundel County, alongside Calvert County, Charles County, Prince George's County, and St. Mary's County make up Maryland's Southern Region. Over the last five years, 138 fires resulted in nearly 500 acres of land burned in the Southern Region.

Table 3.3.11-2 Central Region Wildfire Statistics from 2019 – 2023

Year	Number of Fires	Acres Burned
2019	20	26.9
2020	21	50.7
2021	29	22.0
2022	16	21.9

Table 3.3.11-2 Central Region Wildfire Statistics from 2019 – 2023

Year	Number of Fires	Acres Burned
2023	52	375.2
Total	**138**	**496.7**

Source: Maryland Department of Natural Resources publishes the Annual Wildland Fire Report, 2023.

Fire start incident data collected by the Maryland DNR Forest Service shows that fires in Maryland are a frequent and annual occurrence. Between 2000 and 2023 records indicate an average of 298 fire starts annually; these fires burned an average of 2,644 acres annually. In total, 2,644 fires burned a total of 63,844 acres of forest throughout Maryland between 2000 and 2023.

Table 3.3.11-3 summarizes the number of fires and acres burned in Anne Arundel County for this same time period.

Table 3.3.11-3 Fire Starts in Anne Arundel County, 2000 to 2023

Year	Number of Fire Starts	Acres Burned
2000	1	10.0
2001	1	12.2
2002	0	0.0
2003	0	0.0
2004	0	0.0
2005	4	27.7
2006	2	64.4
2007	5	7.0
2008	3	9.1
2009	2	15.5
2010	1	2.2
2011	1	500.0
2012	3	4.1
2013	5	22.4
2014	0	0.0
2015	0	0.0
2016	1	5.0
2017	3	3.0
2018	2	0.2
2019	1	10.5
2020	0	0.0
2021	3	0.6
2022	6	18.8
2023	4	3.9
Average	**2**	**29.9**
Total	**48**	**716.6**

Source: Maryland DNR Forest Service Fire Starts 2000 to 2023.

Between 2000 and 2024. Anne Arundel County experienced 48 fire starts which burned a total of 716.6 acres. On average, the County experiences 2 fire starts annually.

Note: The NCEI Storm Events database only includes one wildfire incident between 2000 and 2022 for Anne Arundel County. This incident is described in more detail below:

March 17, 2006 – 100 Acres were burned due to a wildfire in the Severn Run Natural Environment Area located near Millersville. Newspaper reports indicated that two firefighters were injured during the fire. Weather conditions were conducive to explosive fire growth, with very dry surface fuels, strong winds, and low relative humidity. Property damage was reported at $2,000.

3.3.11.4 Probability of Future Wildfire and Urban Interface Events

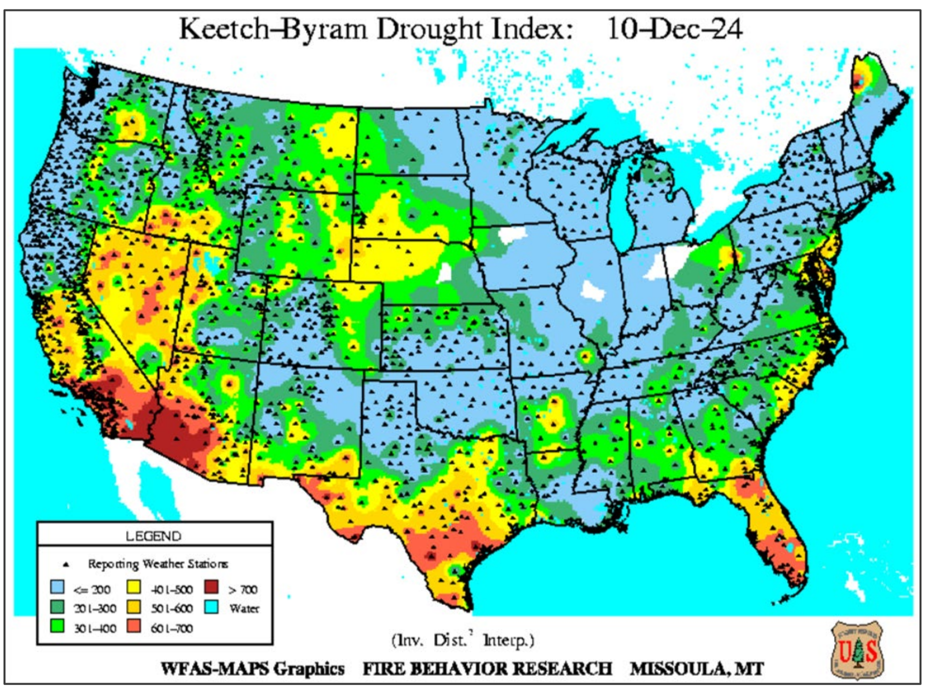
Although the entire County is vulnerable to wildfire and events have occurred regularly in the past, it is difficult to calculate the probability of future occurrences due to human interaction and the unpredictable and localized nature of the hazard. Based on historical data, the County experiences about 2 fire start events annually, which for planning purposes can be utilized as probability of future occurrence. In addition, the link between drought conditions and wildfire presents an additional challenge to calculating a specific return interval for probability.

One tool utilized for monitoring the development of conditions that may impact wildfire activity is the Keetch-Byram Drought Index (KBDI). The KBDI assesses the risk of fire by indicating the net effect of evapotranspiration and precipitation in producing cumulative moisture deficiency in deep duff (accumulated layers on the forest floor) and upper soil layers. The KBDI utilizes a scale from 0 to 800, with the higher number indicating a higher probability of fire activity and a higher likelihood of extreme fire behavior. The KBDI is most often used by fire response agencies as a guide to ensure that adequate resources, such as personnel, equipment, and water supplies, are on hand to respond to more frequent or severe wildfires.

The KBDI image presented in this section indicates that most of the Mid-Atlantic states are at low risk for wildfire on the date indicated. Anne Arundel County and central Maryland are closer to a moderate level of wildfire risk.

Based on historical records from the Maryland DNR Forest Service and the NCEI Storm Events Database, the future probability of wildfires in Anne Arundel County is fairly high. However, property damage and impact on life in the County is considered minimal compared to the potential damage from other hazards.

Figure 3.3.11-2 Keetch-Byram Drought Index – Nationwide
Source: U.S. Forest Service's Wildland Fire Assessment System



3.3.1.5 Wildfire and Urban Interface Fire Risk Assessment

Vulnerability to wildfire is influenced by many factors, such as land cover, weather, and the effectiveness of land management techniques. Although highly urbanized areas may be less vulnerable to wildfire, suburban neighborhoods located at the urban/wildland interface are vulnerable. The primary impacts of most wildfires are timber loss and environmental damage, although the threat to nearby buildings is always present. Secondary impacts may also include landslides and mudslides caused by the loss of groundcover which stabilizes the soil.

The Maryland State Hazard Mitigation Plan weighed risk factors to assign each County a risk rating from 1 (Low Risk) to 5 (High Risk). All of the counties in Maryland received a rating between 2 (Medium-Low Risk) and 4 (Medium-High Risk). Some of the risk factors considered include population vulnerability, population density, geographic extend, and property damage. Based on this analysis, Anne Arundel County was rated a 4 (Medium-High Risk) for wildfire.

Maryland's Strategic Forest Lands Assessment is conducted by the Maryland Department of Natural Resources with financial assistance from the United States Department of Agriculture Forest Service and is composed of many types of vulnerability studies applying to the forests of Maryland. Figure 3.3.11-3 shows one of the studies conducted on wildland/urban interface fire threat potential. Anne Arundel County ranges from "moderate" risk to "high" and "very high" risk. In some locations, the fire threat potential is "extreme" in the County.

Figure 3.3.11-3 Maryland's Strategic Forest Lands Assessment

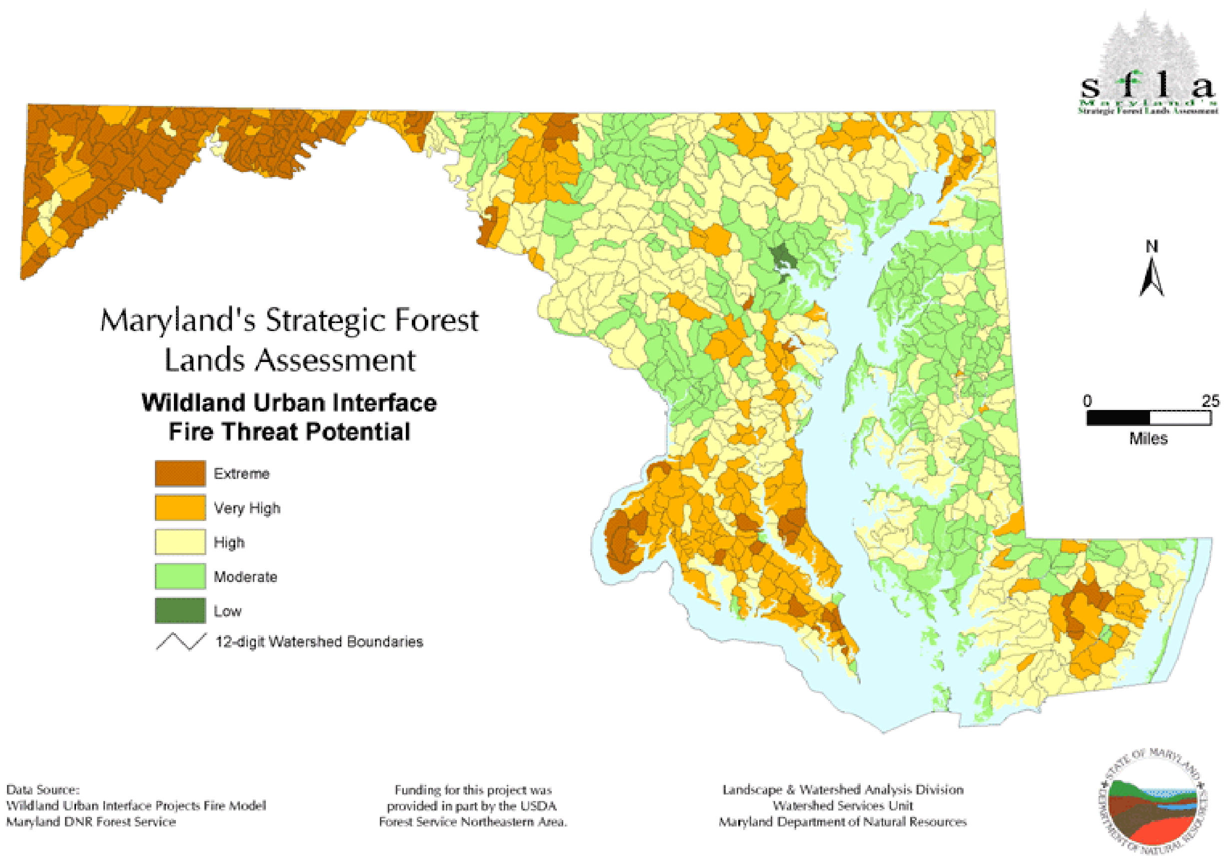
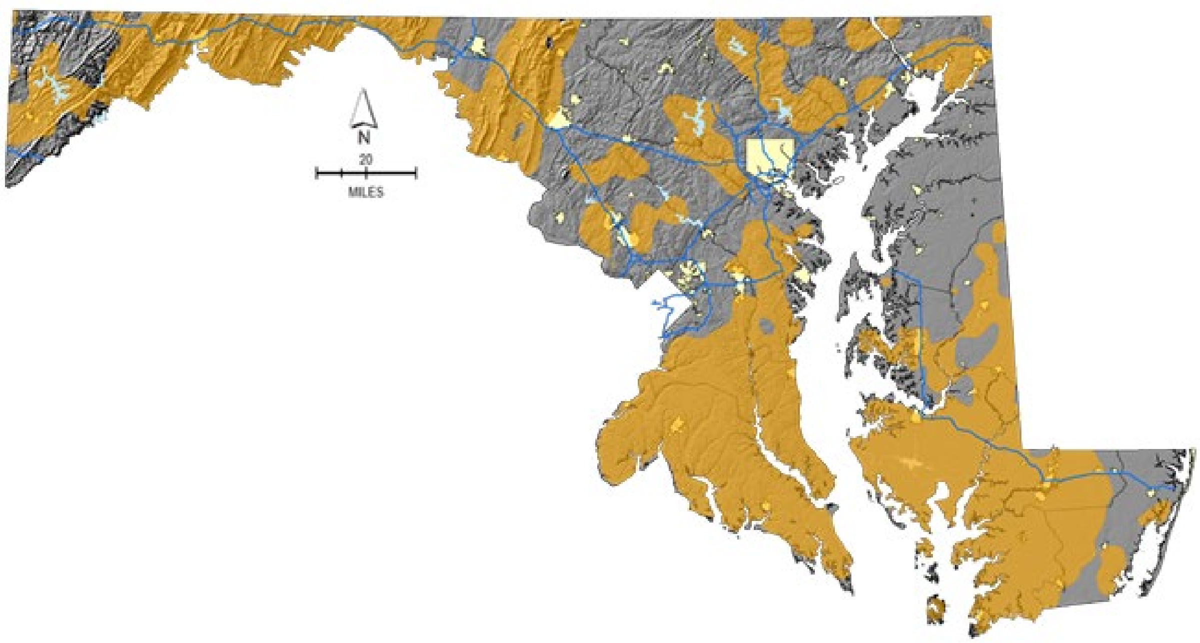


Figure 3.3.11-3 represents only a single component of the greater “Protect Forests From Harm (PFFH) Wildfire Priority Map.” Figure 3.3.11-4, which is part of the *2020 Forest Action Plan*, highlights areas within Maryland where the following three conditions are met:

1. Wildfire is historically prevalent
2. Wildfire has the potential to cause great harm to people and property
3. Where fuels and other conditions can increase the likelihood and intensity of wildfire

Anne Arundel County, excluding Annapolis and Highland Beach, are within the wildfire priority area as depicted in orange in Figure 3.3.11-4, meaning they meet the three aforementioned qualifications.

Figure 3.3.11-4 Protect Forests From Harm Wildfire Priority Map



3.3.11.6 Wildfire and Urban Interface Fire Hazards in Highland Beach

Highland Beach has about the same level of exposure and vulnerability to wildfire as the rest of the County, although open areas near water are clearly less likely to burn than areas that have more potential fuel. The Town has a minor risk from this hazard overall. Impacts can be considered negligible.

3.3.11.7 Impacts to People, Structures, Systems, and Resources

Wildfires can cause considerable damage to people, structures, systems, and activities in Anne Arundel County. However, the overall impact to the planning area from wildfires will most likely be low to moderate considering the frequency and magnitude of past occurrences. Impacts on people, structures, systems, resources, and community activities are considered in the following sections.

Wildfire
The Public's Perspective

A survey conducted during the 2025 plan update asked County residents their level of concern for hazards identified in the plan.

The majority of respondents, 42.21%, indicated that they are only "somewhat concerned" with wildfire. 36.36% of respondents indicated they are "not concerned" with this hazard.

77.62% of respondents indicated that they have seen "no change" in the frequency or intensity of the wildfire hazard over the last 10 years.

No (0%) respondents indicated that a wildfire event has caused damage to their residential or commercial property.

People

Wildfires pose serious threats to human safety and property in rural and suburban areas. Wildfire impacts in Maryland are most commonly associated with the natural environment due to the high number of forested areas in the state. Common impacts to the environment include destruction of forested areas, loss of wildlife habitat, destruction of crops, and temporary poor air quality due to smoke generated by wildfire. They can destroy crops, timber resources, recreation areas, and habitat for wildlife. Wildfires are commonly perceived as hazards in the western part of the country; however, wildfires are a growing problem in the wildland/urban interface of the eastern United States, including Maryland and Anne Arundel County.

Since 97% of wildfires are caused by people, wildfire ignitions are also more common in these Wildland-Urban Interface zones. Considering all factors, wildfires can be a significant threat in Maryland. Homes and other structures intermixed with wildland fuels are at risk, and WUI residents need to take actions to protect themselves and their property.

Fires can extensively impact the economy of an affected area, especially the logging, recreation, and tourism industries, upon which many counties depend. Major direct costs associated with forest fires or wildfires include the salvage and removal of downed timber and debris and the restoration of the burned area. If burned-out woodlands and grasslands are not replanted quickly to prevent widespread soil erosion, then landslides, mudflows, and floods could result, compounding the damage.

Considerations for social vulnerability populations aged 65 and older, children aged 5 and younger, pregnant women, and those with additional medical or mobility needs are most at-risk for breathing issues associated with poor air quality due to smoke generated from wildfires. The fire itself can cause property damage and physical injury or even death, while smoke and ash can greatly impact those with pre-existing respiratory diseases or heart diseases. In addition, aging populations, and those with medical or mobility needs are considered the most at risk during hazardous events because they require more time and are more likely to seek emergency medical attention that might not be as readily available due to isolation and other various circumstances.

Recently, beginning on June 7th, 2023, the air quality index in Anne Arundel County was at "moderate" levels and much of the northeastern United States was at "hazardous" levels, which triggered health warnings of emergency conditions. By the end of June, air quality alerts for Maryland were at hazardous levels. The drop in air quality was not due to a local, or even regional, wildfire but rather due to massive wildfires in Eastern Canada. The smoke from these fires generated an orange smog-like haze that lowered air quality for multiple days in Anne Arundel County.

Property owners in areas with high susceptibility to wildfire are at risk of property damage or property loss. Health risks include skin burns from the fire and lung damage from smoke inhalation, which can result in long-term health effects. While no people have died from wildfire, two people have been injured by a wildfire incident in Anne Arundel County.

Structures

Buildings are vulnerable to wildfires due to their proximity to vegetation, steep slopes, and dense neighborhoods. Wind-blown embers, direct flame contact, and radiant heat are the primary reasons homes burn during wildfires. To mitigate these risks, creating defensible space, replacing combustible materials, and covering openings with metal screens are essential strategies. All structures within the immediate area of a fire would be vulnerable, but older wooden structures would be more likely to suffer greater damage or be destroyed.

According to the County's 2025 Critical Facility and Community Lifeline database created for the plan update, Anne Arundel County has 1,298 critical facilities/community lifelines. These facilities and lifelines have an estimated total building improvement value of $9,804,853,900.00. Additionally, State of Maryland assets in Anne Arundel and the City of Annapolis are worth $4,117,145,038 in building value and $481,564,640 in content value spread over 761 properties. Critical facilities within the WUI are listed in Table 3.3.11-4 below.

Table 3.3.11-4 Community Lifelines Within the Wildland Urban Interface

FEMA Community Lifeline	Facility Type	Number of Facilities	Estimated Improvement Value ($)
Communications	Telecommunication Tower	65	$116,002,000
Energy	Solar Panel	6	$33,315,600
Food, Hydration, Shelter	Emergency Shelter	12	$479,840,700
	School	77	$1,006,936,400
	Warming & Cooling Center	4	$277,703,300
Hazardous Materials	Fixed HazMat Storage Site	91	$687,965,700
Health and Medical	Health Center	4	$14,071,600
Safety and Security	Fire & EMS	12	$181,338,600
	Government (County)	15	$73,252,400
	Police	1	$8,768,900
Transportation	MARC Station	1	$151,400
	Roads Operation	4	$1,108,700
Water Systems	Sewer Pump Station	80	$40,263,100
	Water Pump Station	5	$134,800
	Water Storage Tower	18	$7,289,000
	WTP	7	$10,087,800
	WWTP	10	24,854,600
Total:	**-**	**412**	**$2,960,839,400**

Note: Estimated Improvement Value based on MdPropertyView. Values are estimates for planning purposes only.
Source: Anne Arundel County Critical Facility and Community Lifelines Database, 2025.

According to FEMA's National Risk Index, the total Expected Annual Loss (EAL) due to wildfire is $63,835 in Anne Arundel County. Of this amount, $62,077 is building value, $1,757 is population equivalence, and $1 is agricultural damage. Total potential exposure (i.e. buildings, people, agriculture) as a dollar amount is $535,231,974,438.

Systems

Wildfires will likely cause minimal damage to networks and capabilities unless buildings, roadways, or systems are in wildfire affected areas. Deliveries may be delayed if operations are temporarily paused during repairs or while a wildfire occurs.

Transportation and utility systems are more likely to be negatively impacted by a wildfire event. Wildfires can block transportation routes and cause traffic delays, which would slow emergency responders and members of the public. Roadways connect the community – any blockages would disrupt how people move throughout the County and its communities. Additionally, emergency response workers such as firefighters are also greatly impacted by injuries, burns and smoke inhalation, particularly at high concentrations. These injuries can make the emergency response system less effective and slow overall response times.

Natural, Historic, and Cultural Resources

Poor air quality can negatively affect Anne Arundel's wildlife and plants, particularly if pollution, smoke, and ash linger. Inadequate air quality can lead to long-term ecosystem disruption. A deteriorated ecosystem can also exacerbate flooding if vegetation fails to provide a barrier.

Protecting historic buildings from wildfires poses unique challenges, as it involves replacing existing materials with non-combustible ones while maintaining historic integrity. Historic significance is determined by the original materials, which contribute to the building's visual character and authenticity. Use of substitute materials must adhere to guidelines like those outlined in the NPS Preservation Brief 16, which allows for historically accurate yet fire-resistant replacements.

Existing historic and cultural resources in the WUI areas are particularly at-risk of wildfires. Structures on the National Register of Historic Places were mapped in relation to the Wildland Urban Interface: 2020 data set from the U.S. Forest Service. Historic resources determined to be within the WUI include:

- 29 Historic Buildings
- 1 Historic Structure

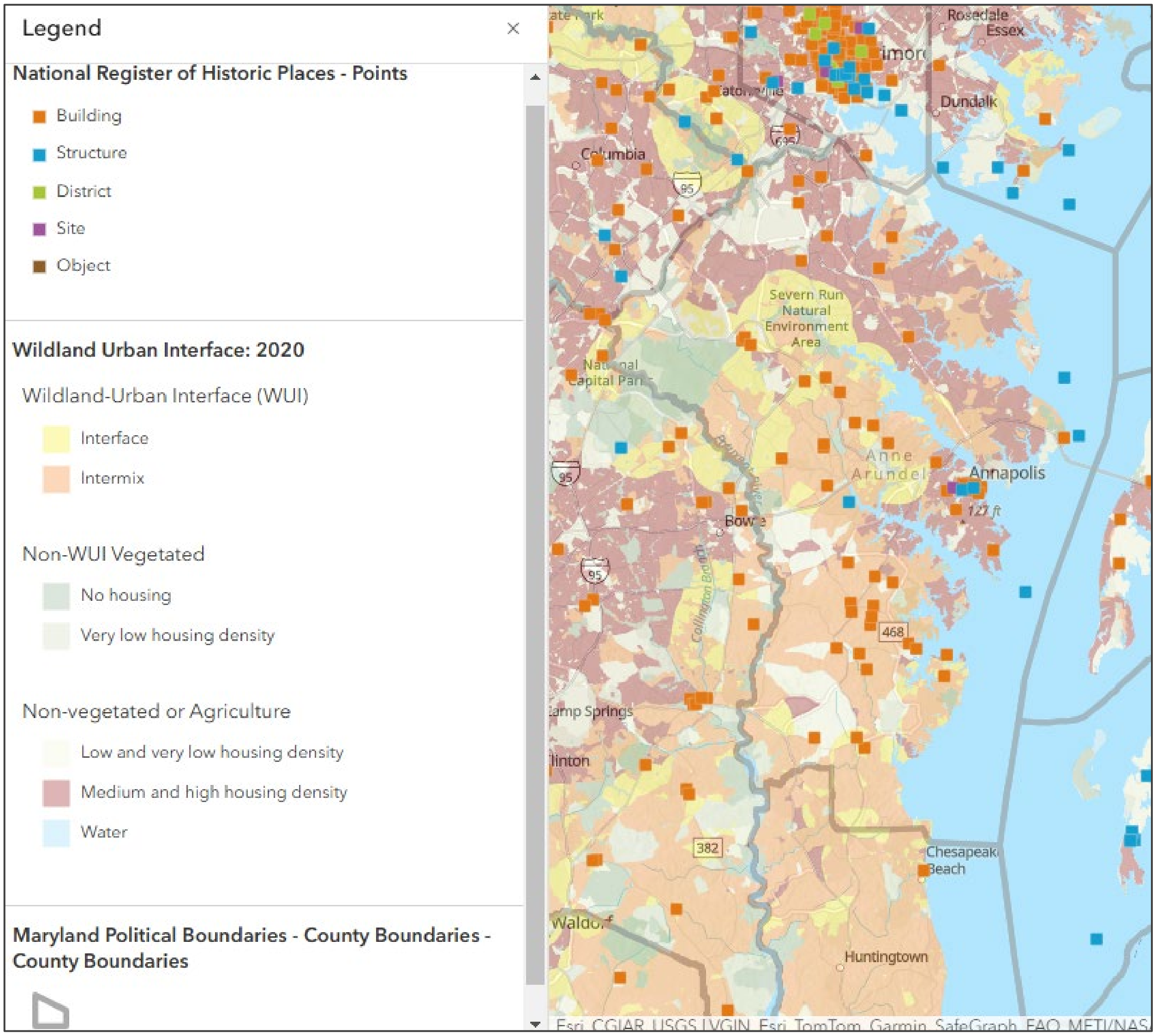
These 30 historic buildings and structure are shown on Figure 3.3.11-5.

Community Activities

Activities that have value to the community could potentially be impacted by wildfire events. When these activities are delayed or cancelled, the economy of the community is affected.

While wildfires occur every month in Maryland, community events most likely to be impacted by wildfire occur would be those that occur in peak wildfire seasons, spring and fall.

Figure 3.3.11-5 Historic & Cultural Resources within the WUI
Source: U.S. Forest Service 2020 & National Register of Historic Places



Wildfires mostly affect outdoor activities when air quality reaches levels too dangerous for people to be surrounded by. Some popular outdoor activities that could be disrupted by poor air quality are fishing, golf, and track and field.

The Flea Market, Craft Fair, and National Take a Hike Day could be canceled or delayed if the air quality makes outdoor activities unsafe to host.

3.3.11.8 Future Land Use and Development Trends

There are areas in Anne Arundel County that are at higher wildfire risk. These areas include heavily forested areas and developed land, such as towns and communities, that are within the Wildland Urban Interface. These areas are at higher risk due to the large tracts of forestland surrounding and encompassing them.

As human development continues to increase in Anne Arundel County, so will the number of WUIs and intermix areas. The potential for property damage and other wildfire impacts will increase each year as more properties are developed and more people move to these areas. However, encouraging principles of defensible space in new and existing development in these areas could help reduce the potential for wildfires to spread to structures.

New developments should be carefully placed near the WUI, if developed at all. In general, future development near or along large areas of contiguous forest should be avoided to reduce wildfire risk. Additionally, development in areas that lack public water and sewer service should be heavily considered as the lack of public water access may create difficulties in extinguishing large fires. These would include areas in Anne Arundel County that are in Growth Tiers II and IV, which are not planned for public sewer services. These growth areas are generally agriculture forest lands, or other natural lands. Therefore, the land adjacent to these growth areas, even should they have public sewer service, should be carefully considered for development.

3.3.11.9 Future Conditions

While wildfires occur every month in the State, they peak in the spring and fall seasons. During these seasons the leaves from deciduous trees have fallen to the ground, which allows sunlight and wind to reach the forest floor and dry out the fuel (i.e., leaves). Additionally, relative humidity tends to be drier during the spring and fall, which when combined with wind can create the conditions that allow a wildfire to spread quickly.

Climate change is expected to play a role in increasing the frequency and intensity of wildfires across the United States and in Maryland. An article written for the New York Times, in which the article references a United Nations Report, suggests the following:

> "In a moderate scenario for global warming, the likelihood of extreme, catastrophic fires could increase by up to a third by 2050 and up to 52 percent by 2100, the report estimates. If emissions are not curbed and the planet heats up more, wildfire risks could rise by up to 57 percent by the end of the century."

As climate warning progresses, precipitation is more likely to increase in the winter but decline during the summer, leading to increased drying of soils. This process, combined with less rain in the summer, could lead to more frequent, severe, and longer-lasting droughts that could result in more dry forest fuel. Increased heat waves may also increase the risk of wildfires.

3.3.11.10 Considerations for Next Planning Cycle

Future monitoring, evaluating, and updating of this Plan should consider the following factors related to wildfire:

- Have wildfire events occurred within the County since adoption of 2025 HMP update?
- Did wildfire events take place in adjacent jurisdictions that impacted the County?
- Has new scientific research or methodology changed the ability to predict wildfire events or assess risk and vulnerability?
- Has there been significant change in the population, built environment, natural environment, or economy that could affect the risk or vulnerability to wildfire, including changes in land use?
- Is there new evidence related to the impacts of wildfire that could affect the level of risk or vulnerability to wildfire?

3.3.12 Erosion

The Erosion section includes the following sub-topics:

1. Description of Erosion
2. Location, Extent, Magnitude
3. Past Occurrences
4. Probability of Future Erosion Events
5. Erosion Risk Assessment
6. Erosion Hazards in Highland Beach
7. Impacts to People, Structures, Systems, and Resources
8. Future Land Use and Development Trends
9. Future Conditions
10. Considerations for the Next Planning Cycle

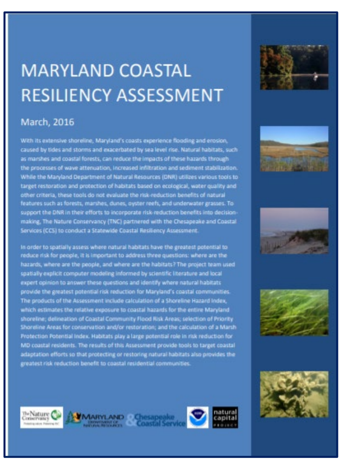
3.3.12.1 Description of the Erosion

Erosion is defined as the group of natural processes, including weathering, dissolution, abrasion, corrosion, and transportation, by which material is worn away from the earth's surface. One type of erosion is coastal erosion, which is a dynamic process that is constantly occurring at varying rates along the coasts and shorelines of the U.S. Numerous factors can influence the severity and rate of coastal erosion including human activities, tides, the possibility of rising sea levels, and the frequency and intensity of hurricanes. Strong storms and hurricanes can erode large sections of coastline with a single event. The process of coastal erosion results in permanent changes to the shape and structure of the coastline. Human activities such as land use practices and boating activities can also accelerate the process of coastal erosion.

According to the Maryland Department of Natural Resources (DNR), erosion is a significant problem currently facing Maryland's diverse coastal environment. Approximately 31% of Maryland's coastline is currently experiencing erosion. Sea level rise is a causal force, which influences the on-going processes that drive erosion, in turn making coastal areas ever more vulnerable to both chronic erosion and episodic storm events (Nor'easters, tropical storms, and hurricanes). According to the DNR, Maryland is currently losing approximately 580 acres of land per year to shoreline erosion.

3.3.12.2 Location, Extent, & Range of Magnitude of Erosion

Although possible to occur anywhere in the County, erosion is most likely to occur during Nor'easters or downgraded hurricanes that can significantly impact shoreline areas of the County. Anne Arundel County has hundreds of miles of shoreline, most of which is within close proximity to major metropolitan centers, such as Baltimore, Annapolis, and Washington D.C.



The 2016 Maryland Coastal Resiliency Assessment used spatially explicit computer modeling informed by scientific literature and local expert opinion to spatially assess where natural habitats have the greatest potential to reduce risk for people. According to the report, the products of the Assessment include calculation of a Shoreline Hazard Index, which estimates the relative exposure to coastal hazards for the entire Maryland shoreline, delineation of Coastal Community Flood Risk Areas, selection of Priority Shoreline Areas for conservation and/or restoration, and the calculation of a Marsh Protection Potential Index.

The Maryland Shoreline Hazard Index was calculated from six (6) physical variables: geomorphology, elevation, relative sea level rise, wave power, storm surge height and erosion rates, and five natural feature types (forest, marsh, dune, oyster reef and underwater grasses). Each variable is ranked from very low hazard (rank=1) to very high hazard (rank=5), based on criteria shown in Table 3.3.12-1 below, used within the InVEST coastal vulnerability model.

Table 3.3.12-1. Variables and Ranking System for InVEST Coastal Vulnerability Model

Variable	Very Low Hazard Rank (1)	Low Hazard Rank (2)	Moderate Hazard Rank (3)	High Hazard Rank (4)	Very High Hazard Rank (5)
Geomorphology	Bulkhead	Riprap	Groin, jetty, breakwater, unconventional structure, living shoreline	Coarse-grained sand to gravel beaches	Other natural shoreline, dilapidated bulkhead
Elevation (m)	14.7 - 81.	6 5.9 - 14.7	2.3 - 5.9	0.5 - 2.3	0 - 0.5
Natural Habitats	Forest	Marsh	Dune	Oyster reef, Underwater grass (dense = 4, less dense = 4.5)	No habitat
Sea Level Rise (meters)	None	1.32 -1.42	1.46 – 1.48	1.49 – 1.67	2.05 – 2.35
Wave Power (kW/m)	0 - 0.02	0.02 - 0.05	.05 - 0.16	00.16 - 0.78	Atlantic Shoreline
Storm Surge Height (feet)	0	0.1 - 2.2	2.3 - 3.5	3.6 - 4.6	4.7 - 8.9
Erosion Rate (feet/year)	Accretion or Protected	0 - 2, no change or unknown	2 - 4	4 - 8	>8

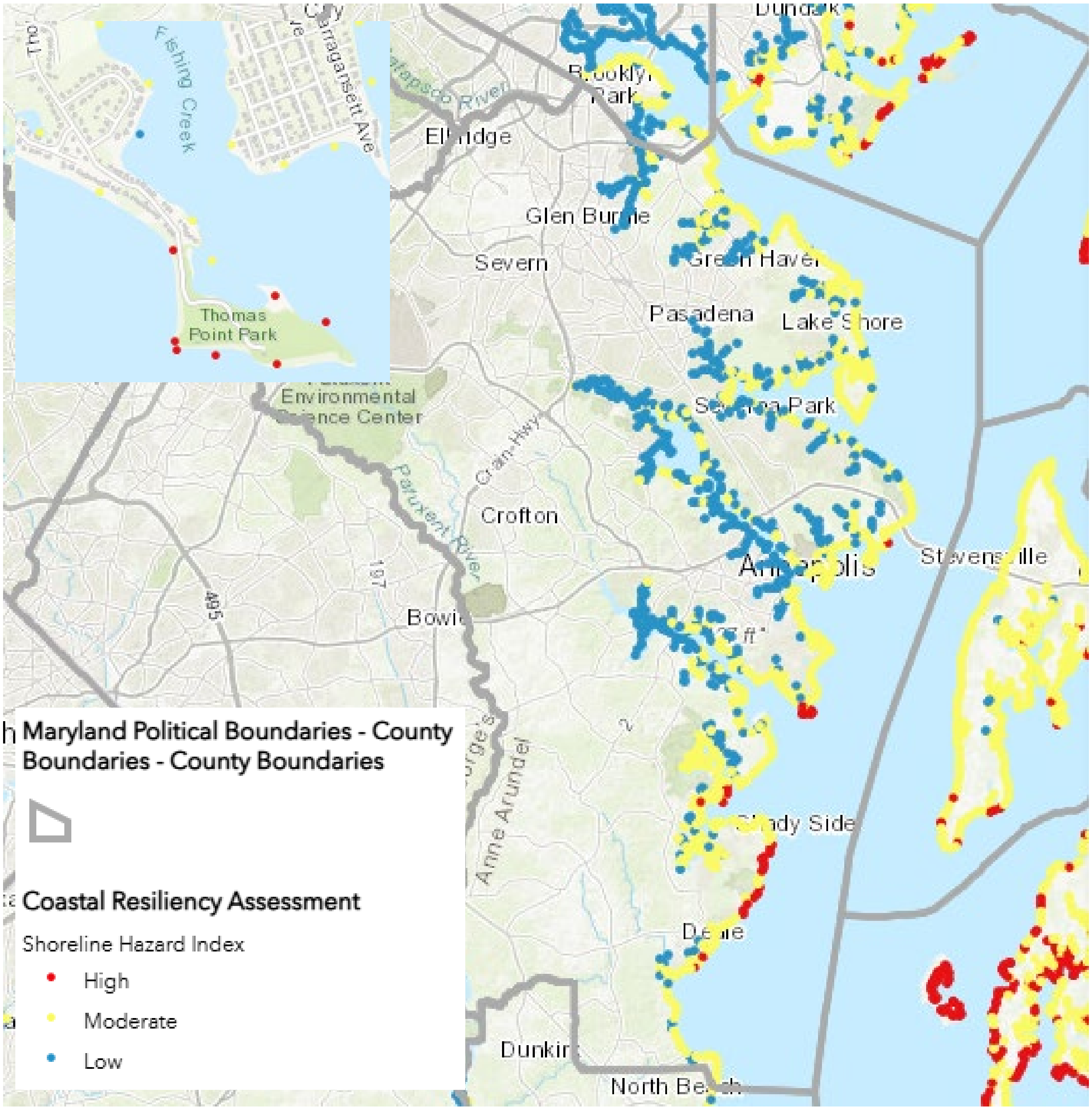
The analysis estimated the relative exposure of each 250-meter segment of the Maryland coastline to storm-induced erosion and flooding, and the relative effectiveness of existing natural habitats to buffer the shoreline from these hazards.

Protecting the Chesapeake Bay and its tributaries is considered one of the highest priorities for Anne Arundel County. To reduce water pollution and prevent erosion, the County places material such as topsoil, jute mats, grass seed, rip rap, etc. by hand or by machine on County-maintained property.

Figure 3.3.12-1 depicts the Shoreline Hazard Index for Anne Arundel County. As shown, the shoreline hazard index for the County's shorelines is predominately a mix of low (blue points) and moderate (yellow points) with some areas of high hazard (red points). Therefore, the relative exposure to storm-induced erosion is "moderate" for most of the County's shorelines. The areas with shoreline defined as "high" hazard (i.e., greatest exposure to coastal; hazards) are concentrated in Region 9 of the County, near the Deale and Shady Side Peninsula. These specific "high" hazard areas are depicted on Figure 3.3.12-3. Additionally, areas identified as "moderate" and "high" for shoreline erosion are predominantly located in designated Resource Conservation Areas in the Chesapeake Bay Critical Area.

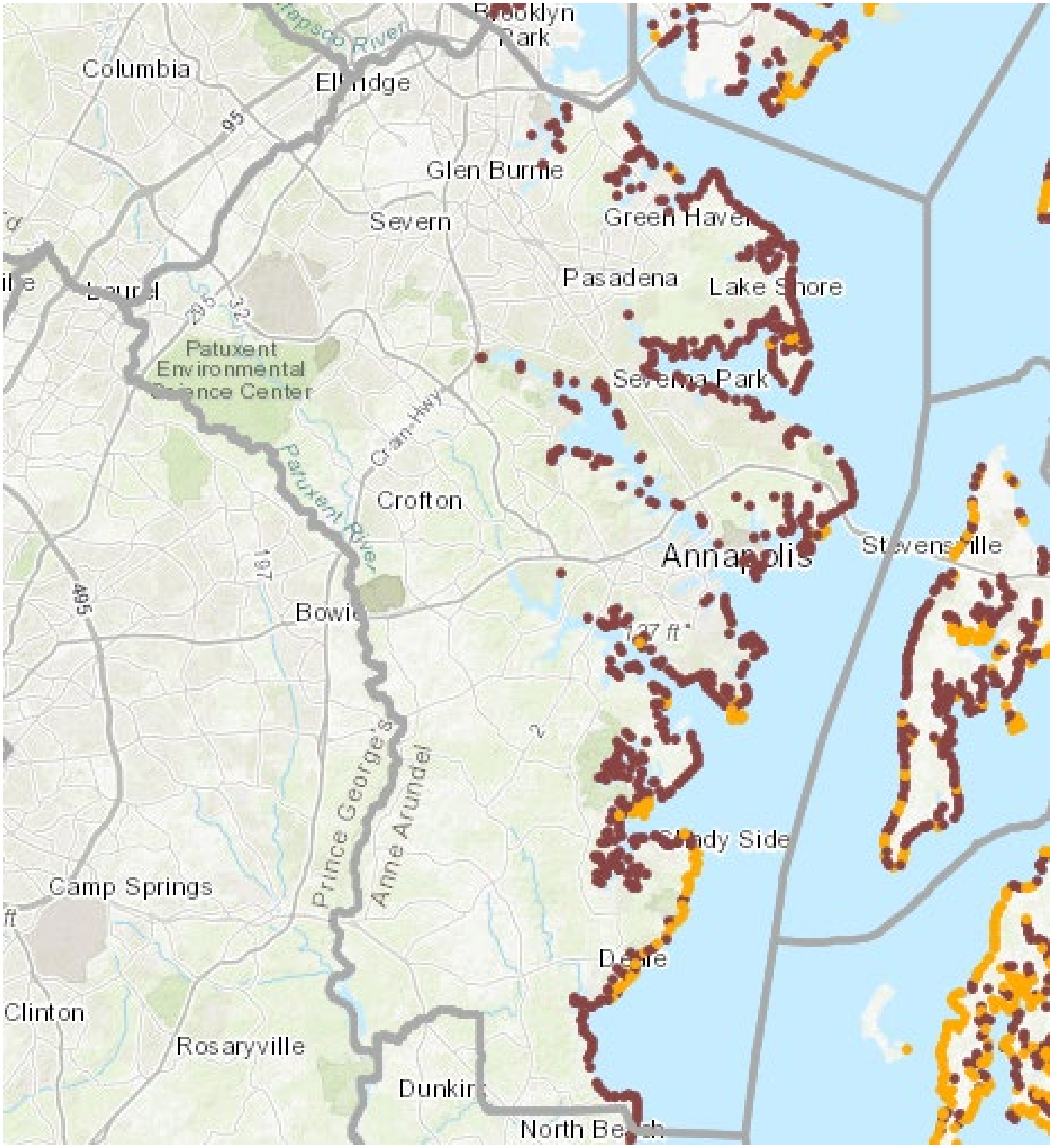
Additionally, another area of high hazard shoreline is the Thomas Point Park, the location of which has been highlighted on Figure 3.3.12-1.

Figure 3.3.12-1 Shoreline Hazard Index – Anne Arundel County
Source: Maryland Coastal Resiliency Assessment



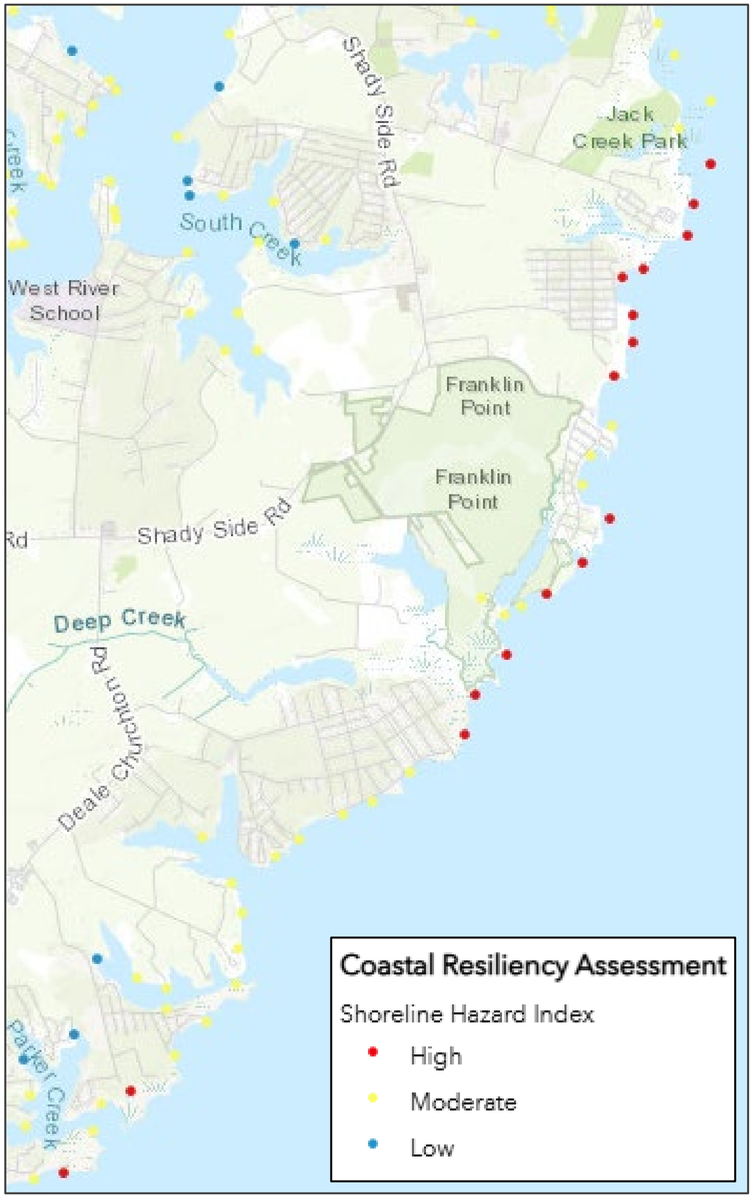
Additionally, some areas of shoreline in Anne Arundel County are considered “priority shoreline areas.” The Priority Shoreline Areas identify Tier 1 and Tier 2 priorities for conservation and restoration actions. Tier 1 and Tier 2 shorelines represent areas where habitats have the potential to play a high or moderate role in risk reduction, respectively, for adjacent coastal communities. These locations are useful for prioritizing mitigation action items and projects to help reduce risk from the erosion hazard. Priority Shoreline Areas have been mapped on Figure 3.3.12-2, following.

Figure 3.3.12-2 Priority Shoreline Areas, Tier 1 & Tier 2 – Anne Arundel County
Source: Maryland Coastal Resiliency Assessment



Tier 1 areas, which represent locations where habitats have the potential to play a high role in risk reduction, are mostly located in the Deale and Shady Side Peninsula area, which is mapped in more detail on Figure 3.3.12-4. Project prioritization in this area is important as several hazards with well-defined geographic extents (e.g., flood, erosion, sea level rise, and storm surge) are present in this area.

Figure 3.3.12-3 Shoreline Hazard Index – Deale/Shady Side
Source: Maryland Coastal Resiliency Assessment



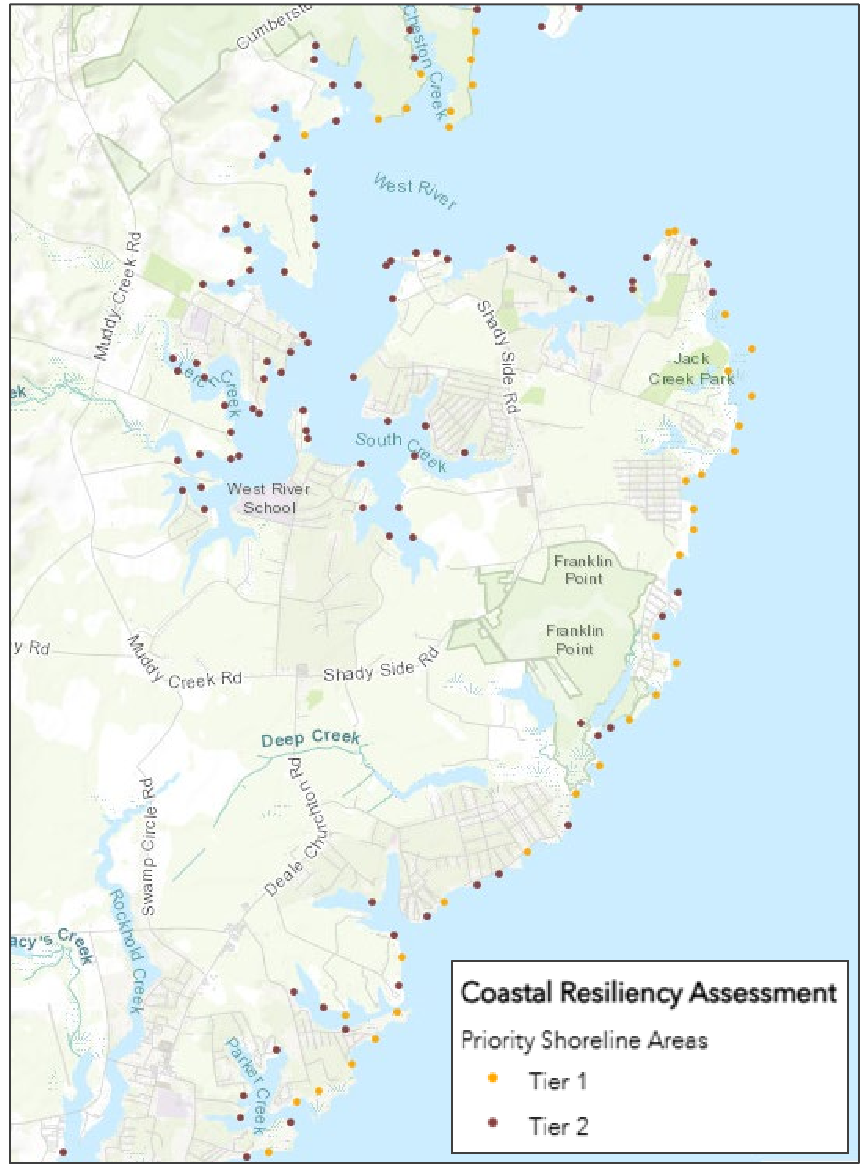
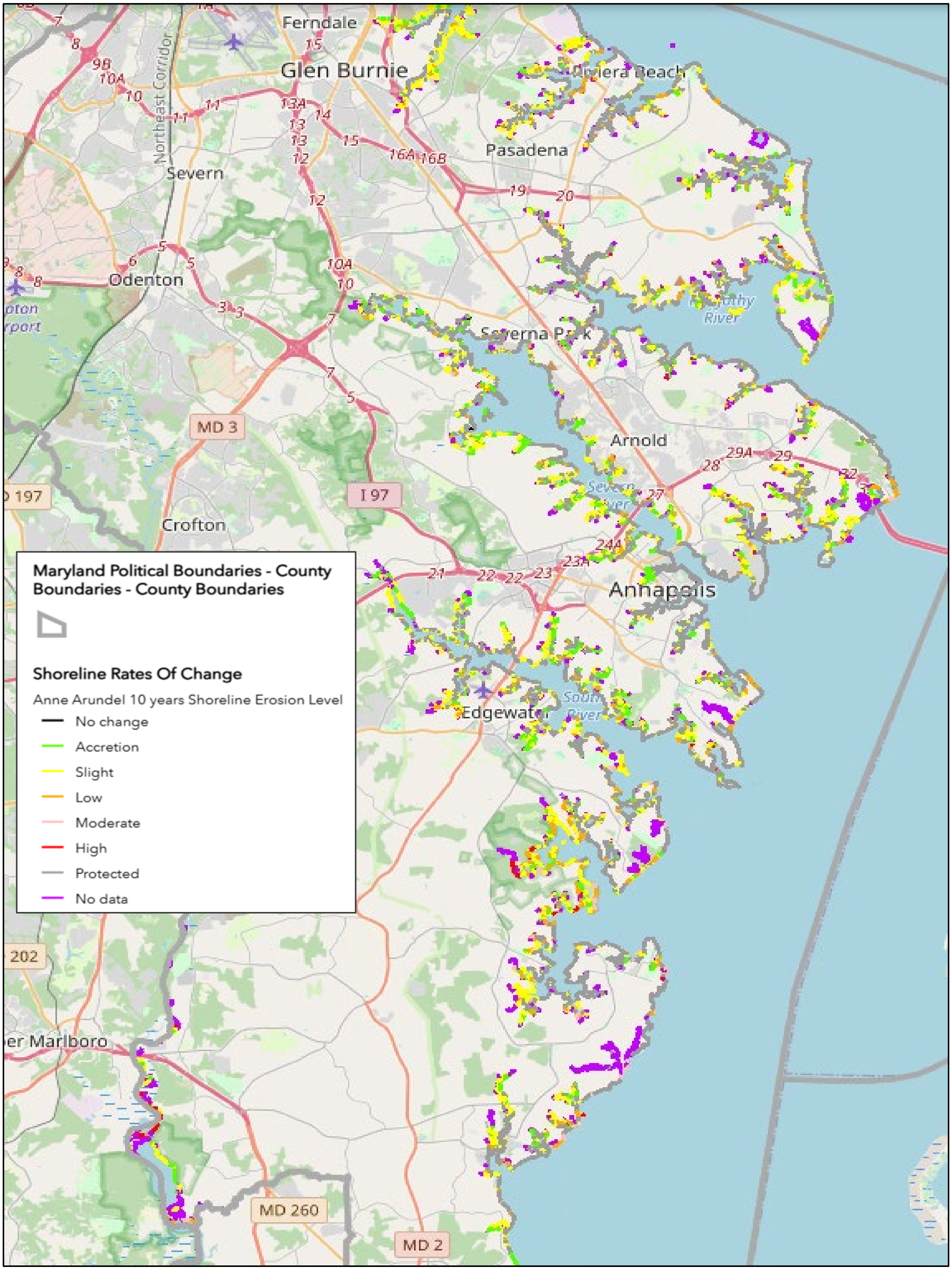


Figure 3.3.12-4 Deale-Shady Side Tier 1 & 2 Priority Areas
Source: Maryland Coastal Resiliency Assessment

Figure 3.3.12-5 Anne Arundel 10 Years Shoreline Erosion Level
Source: Maryland Coastal Atlas



3.3.12.3 Past Occurrences

Erosion is an ongoing problem along many areas of the Anne Arundel County shoreline, especially in Region 9. It is difficult, if not impossible, to assign a probability to the near constant small, ongoing erosion that may occur over a continuous period of time. However, a probability can be assigned to larger storm events such as Nor'easters, hurricanes, and other coastal storms that can result in significant storm induced coastal erosion.

Based on storm event data found in the NCEI Storm Events Database, there have been four major Nor'easters or downgraded hurricanes/tropical cyclone events that caused reported erosion in Anne Arundel County between 1990 and 2024. Most recently, Tropical Storm Isaias caused erosion damage in the County in August of 2020. This translates to about 0.12 storm events that contribute to erosion damage annually, or about 1 event every 10 years. In addition to the larger events described in more detail in Table 3.3.12-2, smaller Nor'easters and other coastal storms cause erosion along the County coastline on average one to two times per year. The period of time over which this data is provided suggests the probability of erosion will be about the same in the future, with year-to-year variations.

Table 3.3.12-2. Description of Significant Erosion Events in Anne Arundel County from 1990 – 2024

Date	Erosion Description
February 4, 1998	A powerful Nor'easter, carrying copious moisture from the Gulf of Mexico and Caribbean region, dumped between two and four inches of rain across much of Maryland between the foothills and the Chesapeake Bay. The highest totals, ranging from three to five inches, fell in lower southern Maryland, causing widespread flooding of low-lying and small streams and creeks. The degree of erosion was greater than that associated with the remnants of Hurricane Fran in 1996.
Septembe r 24, 1999	Hurricane Floyd made landfall just east of Cape Fear, North Caroline in the early morning hours of the 16th and moved north-northeast across extreme southeast Virginia to near Ocean City, Maryland by evening on the 16th. The event resulted in over 1,000 homes reporting flood damage, while over 100 roads closed. Between 8 and 12 inches of rain were reported. Strong southerly winds ahead of the hurricane pushed tides two to three feet above normal, flooding several low-lying areas in St. Mary's, Calvert, Harford, and Anne Arundel Counties. The NOAA database indicated that erosion was reported on the South River and Broad Creek.
Septembe r 18, 2003	On September 18, 2003, Hurricane Isabel made landfall on the North Carolina coast. By the time Isabel moved into central Virginia, it had weakened and was downgraded to a tropical storm. Isabel's eye tacked well werst of the Bay, but the storm's 40 to 50 mph sustained winds pushed a bulge of water northward up the bay and its tributaries producing a record storm surge. The Maryland western shore counties of the Chesapeake Bay and along the tidal tributaries of the Potomac, Patuxent, Patapsco, and other smaller rivers experienced a storm surge of five to nine feet above normal tides. The NOAA database indicated that in Baltimore County alone, $3 million in damage was estimated to have occurred from erosion of the shoreline. NOAA did not indicate the severity of erosion in Anne Arundel County, but based on the degree of flooding, it was most likely comparable to Baltimore County
October 27, 2012	There is no readily available evidence that Hurricane Sandy created significant erosion problems in Anne Arundel County. The event is listed in this table to recognize that it was reviewed and considered in the HMP update.
August 4, 2020	Tropical Storm Isaias moved up the east coast, passing through southern Maryland on the morning of Tuesday, August 4th, 2020, spawning several tornadoes as well as flooding rain and tropical storm force winds. Sustained winds of 39 mph reported at the

Table 3.3.12-2. Description of Significant Erosion Events in Anne Arundel County from 1990 – 2024

Date	Erosion Description
	U.S. Naval Academy ASOS (KNAK) at 7:56 AM EST, with a peak wind gust of 56 mph at 8:07 AM EST. Isolated reports of trees down across the County, but no significant damage reported.

Source: NCEI Storm Event Database.

3.3.12.4 Probability of Future Erosion Events

Erosion is an ongoing problem along many areas of the Anne Arundel County shoreline. It is difficult, if not impossible, to assign a probability to the near small, ongoing erosion that may occur over a continuous period of time. However, a probability can be assigned to larger storm events such as Nor'easters, hurricanes, and coastal storms that can result in significant storm induced erosion. The County experiences 0.12 storm events that cause erosion damage annually, or roughly 1 event every 10 years.

3.3.12.5 Erosion Risk Assessment

Episodic storms generate the most significant erosion along the Anne Arundel shoreline. Typically, these storms can impact the coast over periods of hours (tropical cyclones) to several days (Nor'easters). Although the storm events are short-lived, the resulting erosion can be equivalent to decades of long-term coastal change. The actual quantity of sediment eroded from the shore is a function of storm tide elevation relative to land elevation, the duration of the storm and the characteristics of the storm waves. During severe coastal storms, it is not uncommon for the entire berm and part of the dune to be removed from the beach. The amount of erosion is also dependent on the pre-storm width and elevation of the shoreline or beach. If the beach has been left vulnerable to erosion due to the effects of recent storms, increased erosion is likely. The time necessary for the beach to naturally recover from significant erosion can be years to decades.

3.3.12.6 Erosion Hazards in Highland Beach

Highland Beach has a higher exposure to the erosion hazard than many other parts of the County because of its coastal location. There are no reliable open-source records indicating the degree of damage to Highland Beach from past erosion events, which are usually related to storm surge. The potential impacts to Highland Beach may be considered moderate, but absent further study it is impossible to characterize them more precisely. Documented erosion from storm surge events and continued levels of sea rise in Highland Beach are presented in Appendix G.

3.3.12.7 Impacts to People, Structures, Systems, and Resources

Erosion primarily impacts waterfront communities along Anne Arundel County's coastline. Population increases along this area, particularly in Annapolis, amplifies erosion impacts on people, structures, systems, and resources. These impacts are described in detail in the following sections.

People

Erosion can lead to considerable structural deterioration and unstable foundations. Erosion from coastal storms has the potential to cause significant property damage particularly to properties located along the shoreline areas of Anne Arundel County. Potentially millions of dollars of shoreline development may be damaged or destroyed by the effects of erosion. Additionally, the loss of beach shoreline can also have a negative impact on a community due to the potential loss of tourism. Tropical cyclones and hurricanes can cause extensive damage to Anne Arundel's coastline. Erosion can also disrupt agriculture in the County by stripping away topsoil, resulting in crop and income loss for farmers. People living near or on the coastline can be vulnerable to property damage, land loss, displacement, and injury. Mitigating coastal erosion can be costly to the public and landowners.

Erosion
The Public's Perspective

A survey conducted during the 2025 plan update asked County residents their level of concern for hazards identified in the plan.

The majority of respondents, 32.26%, indicated that they are "very concerned" with erosion. Another 30.32% are "concerned" with erosion.

64.24% of respondents indicated that they have seen an "increase" in the frequency or intensity of the erosion hazard over the last 10 years.

19.63% of respondents indicate that an erosion event has caused damage to their residential or commercial property.

Structures

Essential infrastructure, like bridges and roads, can erode over time and require expensive repairs, disrupt activities, and pose danger to the population. Structures in Anne Arundel County's coastal areas and beaches are particularly vulnerable to this risk.

Critical facilities were assessed in relation to high erosion rate locations in the County. A buffer of 1,000 feet was placed around location points experiencing "high" erosion rates, based on the Coastal Resiliency Assessment. The analysis determined that only one critical facility is within the 1,000 foot buffer around high erosion rate locations. The name and location of this facility is:

- Bay Breeze Sewer Pump Station – 1575 Columbia Beach Road, Shady Side, Maryland 20764

While the facility is within the buffer, it is unlikely to be impacted by continued shoreline erosion at this location in the near future. The location does have shoreline armoring (bulkhead and rip rap) in place to mitigate further erosion. The facility is more at risk to the category 1 storm surge inundation area, as well as both 2050 and 2100 sea level rise scenarios.

Systems

The costs associated with shoreline erosion include the direct loss of land and its economic, cultural, and ecological values, as well as offsite impacts caused by increased sediment and nutrient loading to the Chesapeake Bay and its tributaries. Without appropriate mitigation measures, improvements such as houses, driveways, sewer pipes, or roads can be damaged or destroyed. This damage can lead to both public and private costs. Public costs may include lower tax revenue from reduced property values, capital budget expenses to repair or replace lost infrastructure, loss of historic properties or cultural sites, loss of recreational beaches, and the loss of productive farmland and forest that serve as the basis for a sustainable rural economy.

Natural, Historic, and Cultural Resources

Erosion can worsen water quality by spreading pollution, which can have negative consequences on plants and wildlife. According to the Maryland State Hazard Mitigation Plan, 70% of the state's shoreline is eroding. Wetlands, marshes, beaches, and coastal habitats are at risk of destruction or extensive damage to the ecosystem. Consequently, wildlife dependent on these habitats is vulnerable to population decline or forced migration. Eroded coastlines, as opposed to healthy coastlines, will likely not fulfill their function as a barrier against sea level rise and flooding.

Anne Arundel County has a rich cultural heritage, and settlement here has long focused on the shorelines. Historic and cultural resources at risk along shorelines in the County include: archaeological sites, historic sites and districts, and cemeteries. These resources can be damaged or completely washed away by coastal erosion.

Community Activities

Waterfront and beachfront activities are most vulnerable to erosion. Anne Arundel County features over 533 miles of shoreline, which residents and tourists enjoy. In the case of significant shoreline erosion, hiking, kayaking, fishing, and other outdoor shoreline or water activities are at risk of temporary or permanent disruptions.

3.3.12.8 Future Land Use and Development Trends

The areas where most erosion occurs in the County are part of the "Peninsula" and "Neighborhood Preservation" Development Policy Areas. These policy areas are defined by Plan2040 as follows:

Peninsula Policy Area: *Existing, primarily residential communities that are nearly surrounded by water; and served by a single primary road corridor for access and egress. These areas are located both within and outside of the PFA and the public sewer service area. Development is primarily limited to infill and redevelopment that must be compatible with the existing character of the neighborhood and where consideration of salt-water intrusion and vulnerability to sea level rise are given.*

Neighborhood Preservation Policy Area: *Existing residential communities and natural areas (may include local commercial and industrial uses) that are not intended for substantial growth or land use change but may have specific areas targeted for revitalization. Development is limited to infill, the addition of accessory dwelling units, and redevelopment that must be compatible with the existing neighborhood character. Public infrastructure exists but may need capacity improvements.*

According to the Maryland Coastal Resilience Assessment Shoreline Hazard Index, much of the County's shorelines are classified as "low" or "very low" in relation to erosion rate. The only area that is classified as having "high" or "very high" erosion rates is the Deale and Shady Side Peninsula. This area is vulnerable to many hazards, including the special flood hazard area, storm surge, and sea level rise. In fact, it is the presence of these hazards that likely contribute to the peninsula's increased erosion rates compared to the rest of the County. The Shady Side Peninsula is part of the "Peninsula" Development Policy Area.

The Chesapeake Bay Critical Area law requires Anne Arundel County to adopt and implement a Critical Area management ordinance for all land within 1,000 feet of tidal waters. The ordinance is intended to protect both water quality and wildlife habitat, and includes criteria addressing development density, water dependent uses, buffers from waterways, and protections for natural shorelines and wildlife habitats. In addition, Maryland's Living Shoreline Protection Act of 2008 includes provisions for existing development. Any improvements to protect private property from shoreline erosion are required to consist of marsh creation or other nonstructural shoreline stabilization measures that preserve the natural environment.

3.3.12.9 Future Conditions

The risk of shoreline erosion is expected to increase in the future due to more intense weather events and rising sea levels driven by climate change. Both factors contribute to erosion by amplifying natural coastal processes. For example, as sea level rises, storm surges will extend further into the coastal zone, exposing upland areas to destructive wave energy with greater frequency. Areas with high erosion rates identified through the Coastal Resiliency Assessment's Maryland Shoreline Hazard Index should be monitored.

Tide gauge measurements in the Chesapeake Bay and Mid-Atlantic region show that sea level along Maryland's coastline has risen at an average rate of 3-4 mm per year, or approximately one foot per century. This rate is nearly double the global average and reflects both global sea level rise and local land subsidence. Research indicates that land subsidence in southern Maryland is the result of postglacial crustal movement, sediment loading, tectonic activity, and possibly groundwater withdrawals. Future rates of sea level rise along Maryland's coastline are also expected to exceed the global average, resulting in a rise of 2-3 feet in the next 100 years (MGS, 2016). The potential of sea level rise to exacerbate erosion rates requires careful consideration of this factor in any shoreline erosion control plan.

3.3.12.10 Consideration for the Next Planning Cycle

Future monitoring, evaluating, and updating of this Plan should consider the following factors related to erosion:

- Have any erosion events occurred since adoption of this plan?
- Has any new scientific research or methodology changed the ability to predict erosion events or to assess risk and vulnerability?
- Has there been any significant change in the population, built environment, natural environment or economy that could affect the risk or vulnerability to erosion?
- Is there any new evidence related to the impacts of climate change that could affect the level of risk or vulnerability to erosion?

3.3.13 Soil Movement

The Soil Movement section includes the following sub-topics:

1. Description of Soil Movement
2. Location, Extent, Magnitude
3. Past Occurrences
4. Probability of Future Soil Movement Events
5. Soil Movement Risk Assessment
6. Soil Movement Hazards in Highland Beach
7. Impacts to People, Structures, Systems, and Resources
8. Future Land Use and Development Trends
9. Future Conditions
10. Considerations for Next Planning Cycle

3.3.13.1 Description of Soil Movement

For the purposes of this plan, soil movement refers to landslides and sinkholes. Landslides are events in which rocks, earth, debris, or sediment move down a slope.

A landslide is the downward and outward movement of earth materials reacting under the force of gravity. As such, "landslide" can be used to describe several different types of events displaying different movement characteristics and involving different materials. Rockslides, rock falls, mudflows, mudslides, debris flows, and debris avalanches are all types of landslide events involving different materials moving differently. Landslides typically occur when some factor (e.g., increased water content or change in load) causes the force of gravity to outweigh the forces working to hold material in place, resulting in the downslope movement of the subject material. Several natural and human factors may contribute to or influence landslides. These factors include topography, geology, precipitation, steepness of cut and fill slopes, and cut-slope stability.

Landslides are typically unique and occur alongside another hazard, like during a thunderstorm or an earthquake on hills or steep slopes. They can also be triggered by anthropogenic activities like farming and construction. Mudslides and rockslides are the most common types of landslides in Maryland.

Sinkholes are a frequent occurrence in karst areas underlain by calcareous carbonate formations, especially limestone and dolomite. Groundwater flows through cracks, fissures, joints, and other discontinuities in the rock mass, dissolving the carbonate minerals and creating small voids. Over time, continued water seepage and dissolution of minerals enlarges the void to form caves and caverns in the rock. As the void increases in size, so does the load supported by the void roof. If the strength of the roof layer becomes less than the weight of the material above it, the roof fails, and the overburden materials collapse into the void. When the collapse manifests itself at the surface, the resulting depression is referred to as a "sinkhole."

Changes in hydrologic conditions, whether natural or man-made, can increase the occurrence of sinkholes. An increase in the volume and/or velocity of flow through the rock brings more fresh water to dissolve soluble minerals and more energy to erode solid particles, expanding existing voids or creating new ones. Sinkholes vary in size, ranging from a few feet to a mile or more in diameter, and can reach several hundred feet below the surface.

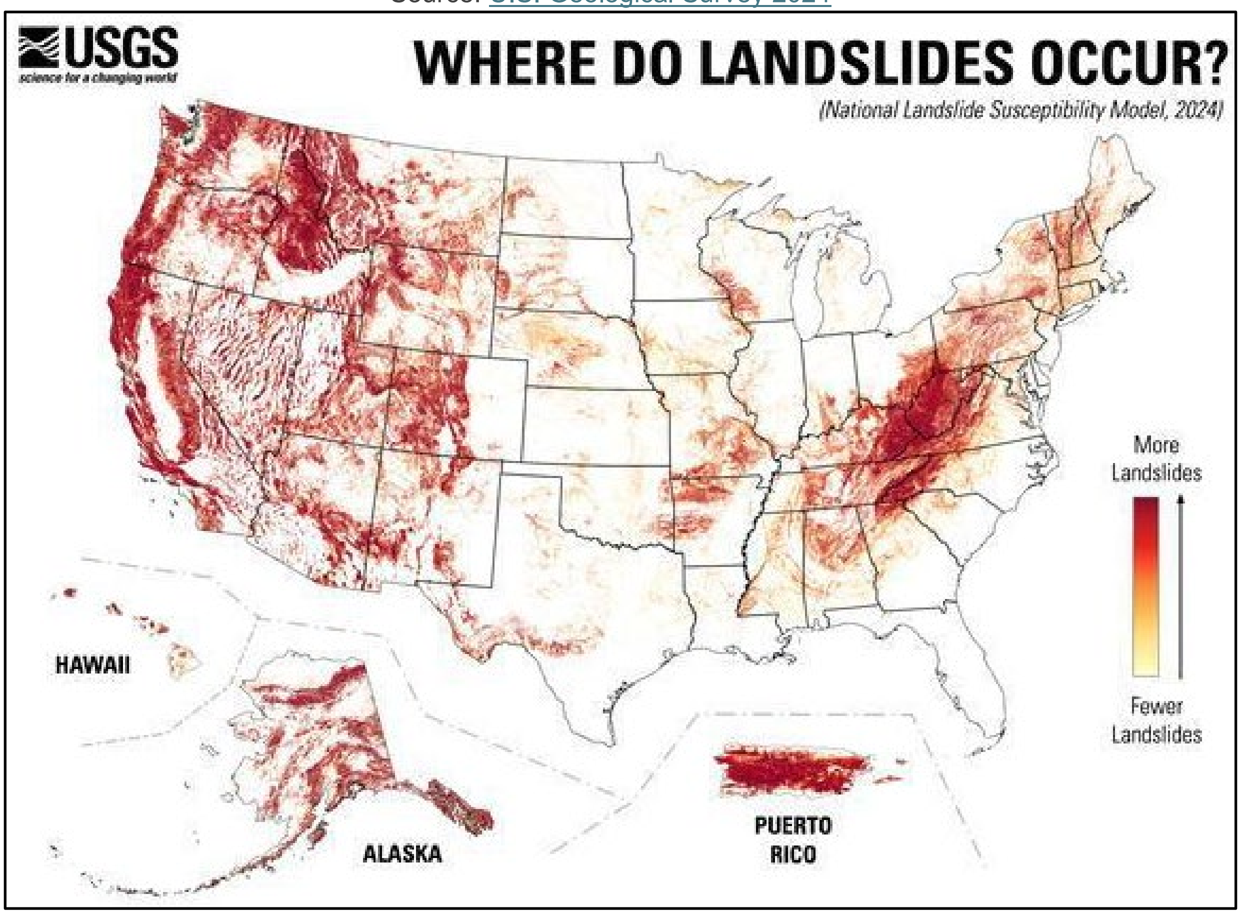
Sinkholes can also occur in most geologic environments—including those not underlain by calcareous carbonate rocks—due to the impacts of constructed facilities. Undetected leaks in underground utility lines can result in subsurface erosion of soil from around the pipe. Left undetected, the erosion creates a void that expands upward until the soil roof cannot support the overburden load and the roof collapses.

3.3.13.2 Location, Extent, & Range of Magnitude of Soil Movement

Although extensive landslides are not common in Maryland, they are more likely to happen in the western mountainous region of the state, as opposed to the Atlantic Coastal Plain where Anne Arundel is located. While there are no specific methods to determine landslide magnitude, like the Palmer Drought Severity used to measure droughts, landslides can be quantified by the volume or length/width of the material moved during the event. Landslides can also be described by the speed at which the material moved down a hill or slope.

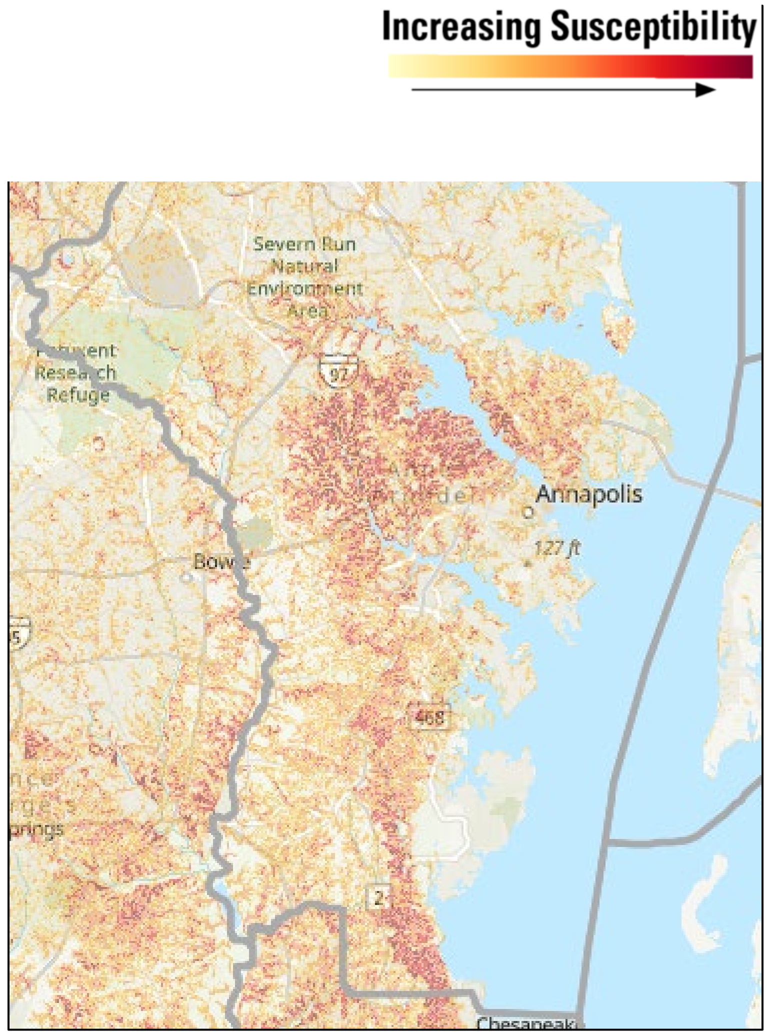
According to the analysis cited by the USGS pictured on Figure 3.3.13-1, Anne Arundel County and Maryland are on the lower end of susceptibility for landslides, while the mountainous regions in Appalachia are on the higher end. The model utilized by the USGS to determine these susceptibility areas considers past landslide events from all states as well as slope and relief of terrain. Susceptibility maps show where landslides are more or less likely, they do not account for frequency, magnitude, or impacts from landslides.

Figure 3.3.13-1. Where Do Landslides Occur?
Source: U.S. Geological Survey 2024



The landslide susceptibility model finds that, of a total land area of about 447 square miles, about 53% of the land area (or 235 square miles) is susceptible to landslide in the County. However, some areas are much more likely to experience a landslide event than others based on their slope and relief. There are areas within the County where landslide susceptibility is higher (i.e. darker red). These areas tend to follow riverine areas (e.g., South River and Severn River) where slopes are steeper. These areas of higher landslide susceptibility are included in Figure 3.3.13-2.

Figure 3.3.13-2. Landslide Susceptibility in Anne Arundel County, Maryland.
Source: USGS National Landslide Susceptibility Model, 2024



Maryland's coastal zone is also less vulnerable to sinkholes than the western side of the state based on karst soil type. Even though sinkholes can be measured by width and length or by geometric area, their extent or magnitude is more closely associated with the damage they cause.

Rockfalls and other slope failure can occur in areas of Anne Arundel County with moderate to steep slopes. However, the elevation and land relief of the County is approximately 235 feet and has a relatively low slope gradient (Maryland Geological Survey, 2016).

Many slope failures are associated with precipitation events – periods of sustained above-average precipitation, specific rainstorms, or snowmelt events. Areas experiencing erosion, decline in vegetation cover, and earthquakes are also susceptible to landslides. Human activities that contribute to slope failure include altering the natural slope gradient, increasing soil water content, and removing vegetation cover.

3.3.13.3 Past Occurrences

No significant landslide or sinkhole events have been recorded in Anne Arundel County in recent history. It is likely that events with minimal damage to human activities, resources, or properties have occurred and were left unreported. The NCEI Storm Event Database does not include information on these events as hazards and no other databases are dedicated to tracking landslide or sinkhole events. The USGS, which considers landslide events in their landslide susceptibility modeling, also does not indicate any reported landslide events having occurred in Anne Arundel County.

The significant events table is populated with soil movement occurrences that have been reported in the State of Maryland over the last ten years.

Table 3.3.13-1: Description of Significant Soil Movement Events in Maryland from 1950 – 2024

Event & Date	Soil Movement Description
April 30, 2014 (Landslide)	On April 30, 2014, in Baltimore, a part of East 26th Street along with 10 parked cars fell and blocked off CSX tracks downhill. The estimated cost of repair from the Baltimore Department of Transportation was around $18.5 million.
May 6, 2015 (Landslide)	The landslide on May 6, 2015, was the largest and most expensive disaster recorded in Prince George's County (Roussey, 2015). This disaster event impacted nearly every aspect of the Piscataway Hills neighborhood and its residents' daily lives. Six homes were completely rendered uninhabitable, while 22 homes were defaced (Roussey, 2015). Storms leading up to May 6 likely caused the landslide that would leave residents without water, sewer, and electricity, and without access to every road leading to and from their homes during construction (Maryland State Hazard Mitigation Plan, 2021).
May 17, 2018 (Landslide)	On May 17, 2018, a landslide forced the closure of Harpers Ferry/Sandy Hook Road in lower Washington County, Maryland, as the area received around twice as much rain than usual. Repairing the damage cost more than $4.5 million and six months of work.
July 8, 2019 (Sinkhole)	A sinkhole in Downtown Baltimore injured a DOT employee caught in a collapse while working to repair utilities underground (Broderick, 2019). The sinkhole also caused train disruptions, flooding, and the collapse of a wheelchair platform for light rail trains (Maryland State Hazard Mitigation Plan, 2021).

3.3.13.4 Probability of Future Soil Movement Events

It is impossible to predict incidents of landslide and sinkholes with precision; they can occur suddenly and without warning or over an extended period of several years. However, some factors associated with a decrease in roof strength are wet conditions, vibrations, and increased surface loading. Land subsidence resulting from a drawdown of the groundwater table is likely to occur over a number of years. Procedures for predicting the occurrence of landslide have not yet been developed.

Areas that are generally prone to landslide hazards include previous landslide areas, the bases of steep slopes, the bases of drainage channels, and developed hillsides where leach-field septic systems are used. Considering Anne Arundel County has had few reported landslides, the occurrences of future landslide activity are possible. Areas that are typically considered safe from landslides include areas that have not moved in the past, relatively flat-lying areas away from sudden changes in slope, and areas at the top or along ridges, set back from the tops of slopes.

Sinkholes have affected parts of Maryland throughout history; however, most impacts have been relatively minor. Because the State's geology makes certain areas susceptible to sinkholes, it is almost certain that future events will take place. Similar to landslide, sinkholes can be triggered by heavy rains and flooding. An increase in the number and intensity of severe storms, and resulting in heavy rains and flooding, may also result in sinkholes developing more frequently.

3.3.13.5 Soil Movement Risk Assessment

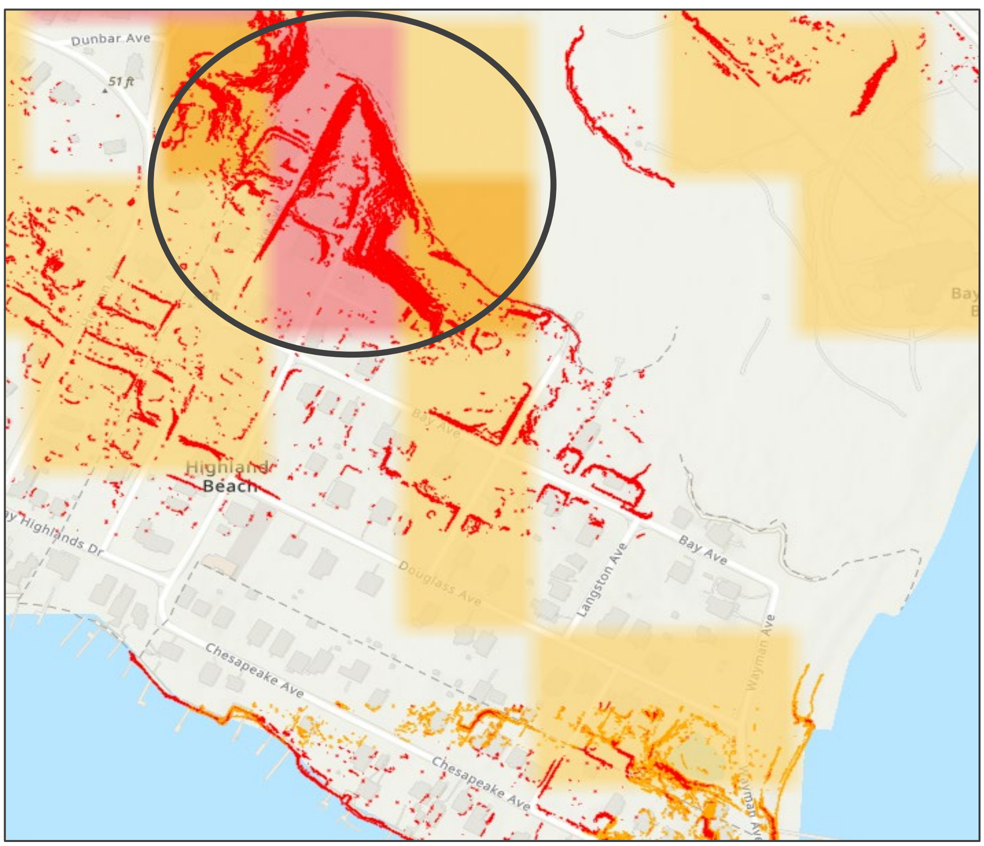
Although Maryland has experienced landslides, most occurrences were not extremely damaging. Most events do not occur near Anne Arundel County, but in the western part of the State where there is more area with drastic slope changes. However, an increase in the number and intensity of storms will likely result in more frequent heavy rains and flooding. Since heavy rains and flooding can trigger landslides, these events may occur more often in suburban and urban areas.

According to the FEMA's National Risk Index, Anne Arundel County's risk rating for landslide is "relatively moderate" which is very much similar to most of Maryland, with the exception of the Eastern Shore where landslide risk is "relatively low" .

3.3.13.6 Soil Movement Hazards in Highland Beach

Like the rest of Anne Arundel County, Highland Beach does not have soil types that make soil movement a significant risk. However, Highland Beach has experienced sinkholes and does have areas of steep slope (i.e. 25% and greater) where landslide susceptibility is higher per the USGS modeling as utilized within this hazard section. This area in Highland Beach is circled on Figure 3.3.13-3.

Figure 3.3.13-4 Area of Greater Susceptibility to Landslide in Highland Beach
Source: USGS National Landslide Susceptibility Model, 2024



3.3.13.7 Impacts to People, Structures, Systems, and Resources

Landslides can have localized impacts or affect large areas, while sinkhole impacts depend on whether it is in a critical location or not. Landslides and sinkholes can progress quickly or slowly, making them challenging events to prepare for. Because it is difficult to predict when landslides or sinkholes will occur, sizeable soil movements tend to be highly consequential.

According to the 2021 State Hazard Mitigation Plan, soil movement could impact Anne Arundel County in the following ways:

People

Although no injuries or deaths have been recorded from landslides or sinkholes in Anne Arundel County, soil movement can still pose danger to people if they are within the vicinity of an event.

Residential and commercial landowners are at risk of property damage, business disruption, injury, or loss of life during a severe incident. Property losses can place a considerable financial burden on owners with the cost of repairs and disruption of activities. Most of these expenses are typically the sole responsibility of the owners, as insurance policies usually only cover structural costs and not the land's real estate value. First responders such as fire and police would be called to respond to an incident, which puts them within the hazard area, thus making them at-risk of injury while they work.

Structures

Property losses and structural damage from sinkholes and landslides are typically limited to the area surrounding the occurrence. While this can mean that the losses are negligible, a sizeable event can result in significant damage.

Expected impacts to critical structures are minimal unless the incident occurred on or near the critical facility's property. The majority of the County's steep slopes follow riverine areas; therefore, it is likely that those critical facilities which are within or adjacent to the special flood hazard area would also be within areas of steep slope and are thus more likely to be impacted by a soil movement event.

Systems

Soil movement impacts on systems are typically limited to the affected area or infrastructure/structure necessary for operations. Property owners within the hazard area might experience damage or loss of property. Other impacts to infrastructure include damage to roads and bridges, temporary closure of roadways, failure of stormwater systems, and power loss. Most structures share the same risk of landslide, but older homes or those constructed of lighter materials such as wood might receive more damage.

Delivery of services is likely to be slowed or disrupted during a major event if roads are blocked. Landslides and slumps that occur on roadways could cause them to be closed temporarily for clearing and repair.

Local governments will carry the burden of repair and recovery costs associated with a landslide event. For example, economic damage can take the form of loss of land, loss of structures, disrupted or damaged transportation routes, and loss of tourism, particularly associated with the natural environment.

Natural, Cultural, and Historic Resources

Erosion and debris flows are the biggest environmental impacts caused by soil movement such as landslides. Land and aquatic ecosystems can be disturbed by the spread of sedimentation and pollution caused by soil movement. In severe cases, this can lead to wildlife and plant losses.

Historic resources sometimes require special care and maintenance. Soil movements can cause severe damage to historic resources within the vicinity of the event if they are in a vulnerable state. A landslide event would heavily damage, or completely destroy, historic structures situated on or near steep slopes.

Community Activities

A landslide can significantly disrupt community activities by damaging infrastructure like roads and bridges, limiting access to essential services like healthcare and education, displacing residents from their homes, causing economic hardship, and creating psychological stress, effectively disrupting the normal rhythm of community life; this can include disruptions to social gatherings, recreational activities, and even basic daily routines like shopping for groceries. Any alerts, updates, or cancellations related to community gatherings or events impacted by a soil movement event would be made through the County's emergency alert channels, social media, website, or a combination thereof.

3.3.13.8 Future Land Use and Development Trends

Maryland's coastal zone, including Anne Arundel and Highland Beach, is less vulnerable to sinkholes than the western side of the State based on locations of karst soil type. That is to say, the coastal zone has less karst soils, which are associated with soil movement and sinkholes.

Other soils aside from karst that are related to increased soil movement, such as subsidence, include saline, non-cohesive soils, gypsum, silt, and clay. Karst is associated with limestone, marble, and gypsum. These soils are not as stable as others and they can dry out due to lowering water tables, which can cause the soil to compact (subsidence) if water is not replenished.

New development can impact the soil movement hazard in multiple ways:

- **Groundwater use:** More than 80% of known land subsidence in the U.S. is due to groundwater use.
- **Improper ground preparation**: Improper soil compaction and grading can lead to subsidence.
- **Heavy traffic and construction:** Vibration and soil disturbance from heavy traffic and construction can cause the ground to move and sink.

Future development in the County needs to take into consideration coastal locations, soil types, and proper construction techniques to minimize the chance of soil movement impacts. Most of the County's highly erodible soils (USDA Web Soil Survey, 2019), which are more susceptible to soil movement events, follow riverine areas. These are highly localized to the center portion of the County, along the South River and Severn River. This land is primarily rural or residential low density land use and is within either the Rural and Agricultural Development Policy Area, or the Neighborhood Preservation Development Policy Area.

Areas with steep slopes are protected by development requirements in the County Code. Steep slopes are defined in the County Code (Article 17-1-101(83)) as those that have a 25% or greater slope and that have an onsite and offsite contiguous area that is greater than 5,000 square feet over 10 feet vertical as measured before development. Development may not occur within steep slopes or within 25 feet of the top of the steep slopes where the onsite and offsite contiguous area of the steep slopes is greater than 20,000 square feet unless development will facilitate stabilization of the slope or the disturbance is necessary to allow connection to a public utility. In the Chesapeake Bay Critical Area and designated sensitive areas, steep slopes are defined as having a 15% or greater slope that is over six feet vertically as measured before development. In the RCA and LDA overlay zones of the Chesapeake Bay Critical Area, development may not occur within slopes of 15% or greater unless development will facilitate stabilization of the slope or the disturbance is necessary to allow connection to a public utility. In addition, steep slopes are considered a primary environmental feature within the Stormwater Practices and Procedures Manual. They must be documented as part of the development process.

3.3.13.9 Future Conditions

Climate change could lead to more landslides in certain parts of the world, particularly areas that regularly experience landslides. A recent quantitative study conducted by NASA's Goddard Space Flight Center and the National Oceanic and Atmospheric Administration (NOAA) has linked more frequent and intense rainfall events due to climate change and increased risk of landslides in High Mountain Asia regions of China, Tibet, and Nepal.

According to the study, rainfall is the most common driver in landslide events, as the increased rainfall reduces the strength of the soil. As identified in this section, Anne Arundel County has experienced landslides and soil movement events caused by heavy rainfall in the past. In addition to projected increases in heavy rainfall events, the study identifies increased occurrences and intensity of wildfire events as another factor that could increase landslides. Wildfires destroy the vegetation that helps keep soil in place, leading to greater soil movement, which can be dangerous in areas with steep slopes.

A NASA article summarizing the study concluded the following:

> *"The full human impact of increasing landslide risk will depend on how climate change affects glaciers and how populations and communities change. When they evaluated their model projections in the context of five potential population scenarios, the team found that most residents in the area will be exposed to more landslides in the future regardless of the scenario, but only a small proportion will be exposed to landslide activity increases greater than 20 percent."* (Kirschbaum, D., 2020)

The study shows new possibilities for research that could help local decision-makers prepare for future disasters related to soil movement and landslides. The future goal of the study is to expand its quantitative method to new study areas including Alaska and regions on the East Coast.

3.3.13.10 Considerations for Next Planning Cycle

Future monitoring, evaluating, and updating of this Plan should consider the following factors related to sinkholes and landslide hazards:

- Have landslides or sinkhole events occurred within the County since the adoption of 2025 HMP update?
- Did landslides or sinkhole events occur in adjacent jurisdictions that impacted the County by virtue of their being in proximity?
- Have new scientific studies, research, or methodology changed the ability to predict landslides or sinkhole events or assess risk and vulnerability?
- Has there been significant change in the population, built environment, natural environment, or economy that could affect the risk or vulnerability to landslides or sinkhole events, including expansion of critical infrastructure in landslide-susceptible areas?
- Is there new evidence related to the impacts of landslides or sinkholes that could affect the level of risk or vulnerability?

3.3.14 Emerging Infectious Disease

The Emerging Infectious Disease section includes the following sub-topics:

11. Description of Emerging Infectious Disease
12. Location, Extent, Magnitude
13. Past Occurrences
14. Probability of Future Emerging Infectious Disease Events
15. Emerging Infectious Disease Risk Assessment
16. Emerging Infectious Disease Hazards in Highland Beach
17. Impacts to People, Structures, Systems, and Resources
18. Future Land Use and Development Trends
19. Future Conditions
20. Considerations for Next Planning Cycle

3.3.14.1 Description of Emerging Infectious Disease

Emerging infectious diseases (EID) are diseases that have existed and are now increasing in incidence as well as infectious diseases that are newly recognized in a geographical location or population. Infectious diseases are unpredictable and can cause global outbreaks. While most infectious diseases have associated vaccines, new infectious diseases are inevitable. Despite ongoing efforts to contain and anticipate emerging infectious diseases, world travel and increasing global interdependence have made it more difficult to contain and diagnose these diseases.

State public health officials rely on local boards of health, healthcare providers, laboratories, and other public health personnel to report the occurrence of notifiable diseases as required by law. An epidemic emerges when an infectious disease occurs suddenly in numbers that are more than normal expectancy. Infectious disease outbreaks put a strain on the healthcare system and may cause continuity issues for local businesses. These outbreak incidents are a danger to emergency responders, healthcare providers, schools, and the public. This can include influenza (e.g., H1N1), pertussis, West Nile virus, and many other diseases. A pandemic is an epidemic that has spread over a large area, that is, it is prevalent throughout an entire country, continent, or the whole world.

On March 11, 2020, the World Health Organization (WHO) officially declared the Coronavirus disease 2019 (COVID-19) outbreak a pandemic due to the global spread and severity of the disease. COVID-19 is a respiratory illness that can spread from person to person. COVID-19 is a highly contagious, viral upper respiratory illness that was first detected in China in late 2019. The virus quickly spread throughout the world and has resulted in a global pandemic ongoing at the time of this plan. COVID-19 symptoms include cough, difficulty breathing, fever, muscle pain, and loss of taste or smell. Severe cases may result in death, especially in individuals over the age of 65 or with underlying medical conditions, such as diabetes, lung disease, asthma, obesity, or those who are immunocompromised. COVID-19 spreads from person to person through respiratory droplets in the air or on surfaces.

3.3.14.2 Location, Extent, & Range of Magnitude

Public health risks, such as those presented by infectious diseases and vector-borne illnesses, are present within every community. An infectious disease is one that is caused by micro-organisms, such as bacteria, viruses, and parasites. A vector-borne illness is an infectious disease that is transmitted to humans by blood-feeding arthropods, including ticks, mosquitoes, and fleas, or in some cases by mammals (e.g., rabies). Infectious diseases cause illness, suffering and even death, and place an enormous financial burden on society.

Most infectious diseases are caused by pathogens that can be spread, directly or indirectly, from person to person. Such diseases may be seasonal (seasonal influenza) or result, in the case of new diseases, result in a global pandemic. Infectious disease dynamics depend on a range of factors, including land use, human behavior, climate, efficacy of healthcare services, population dynamics of vectors, population dynamics of intermediate hosts and the evolution of the pathogens themselves. Many of these diseases require continuous monitoring, as they present seasonal threats to the population.

3.3.14.3 Past Occurrences

Global pandemic influenza episodes were observed in 1918, 1957, 1968, and in 2009 with the novel H1N1 strain. The 2009 H1N1 outbreak, though not considered a serious threat, still affected some residents in Maryland with nearly 1,772 confirmed cases and 46 deaths. The great influenza epidemic of 1918 killed millions worldwide and would likely cause hundreds to thousands of deaths in Maryland should a similar outbreak occur today. It is anticipated that a more serious strain of the usual flu will occur some year and that vaccines might not be ready in time to combat rapid spread.

The most significant recent occurrence of infectious disease for Anne Arundel County is that of COVID-19. Approximately 1.5 million cases and 18,000 deaths have been reported in Maryland. As of September 2024, approximately 129,000 cases were reported for Anne Arundel County.

Vector-borne diseases continue to pose a significant threat to communities across Maryland. Blacklegged (deer) ticks and dog ticks are found throughout Maryland and may spread different diseases. The most common tick-borne diseases in Maryland are Lyme Disease, Babesiosis, and Anaplasmosis. Other diseases that are rare, but still occur, are Tularemia, Rocky Mountain spotted fever, Borrelia miyamotoi, and Powassan virus.

Mosquito-borne diseases are also a seasonal threat. West Nile Virus (WNV) and Eastern Equine Encephalitis (EEE or “Triple E”) are viruses that occur in Maryland and can cause illness ranging from a mild fever to more serious diseases like encephalitis or meningitis. Other diseases spread by mosquitoes may affect people when traveling in other regions of the world such as Zika virus, Dengue fever, and Chikungunya.

Anne Arundel County has had multiple occurrences of public health events in the past few decades. Significant public health events are detailed in Table 3.3.14-1 below.

Table 3.3.14-1 Significant Public Health Events

Date	Event	Impact
May 1, 2009	H1N1 Swine Flu	Swine flu cases caused temporary closures of multiple schools.

Table 3.3.14-1 Significant Public Health Events

Date	Event	Impact
August 30, 2012	H3N2 Flu Variant – Pigs	Five Maryland residents tested positive for H3N2 and had close contact with infected pigs at the Anne Arundel County Fair.
September 26, 2014	Emerging Infectious Disease Outbreak - Ebola	Travel restrictions and heightened disease surveillance.
2015-2016	Emerging Infectious Disease Outbreak – Zika	Travel precautions and local response teams.
March 2017	Opioid Crisis	Ongoing regional event.
March 2020- May 11, 2023	Pandemic – COVID-19	• Closed many local schools and businesses. • Major travel restrictions. • Supply chain disruptions. • Dining restrictions • Indoor and outdoor gathering restrictions. • Visitation restrictions (hospitals, long-term healthcare facilities).
May 16, 2022- October 23, 2022	Mpox	As of August 19, 2024, there were over 787 confirmed cases of Mpox in Maryland since the 2022 outbreak began. Mitigation efforts include contact tracing and vaccine efforts.

Additionally, the Maryland Department of Health routinely collects statistics on reportable illnesses. Table 3.3.14-2 provides case rates for selected notifiable conditions in the County between 2019 and 2023. An increase in the incidence rates triggers a public health response.

Table 3.3.14-2 Selected Notifiable Conditions Case Rates (per 100,000 population) Reported in Anne Arundel County, 2019 to 2023

Condition	2019	2020	2021	2022	2023	5-Year Average
Amebiasis	0.17	0.17	0.51	0.34	0.17	0.27
Anaplasmosis**	0.00	0.17	0.51	0.17	0.17	0.20
Animal Bites	225.73	180.52	199.55	207.66	241.35	210.96
Anthrax	0.00	0.00	0.00	0.00	0.00	0.00
Babesiosis**	0.17	0.00	0.00	0.00	0.50	0.13
Botulism	0.17	0.00	0.17	0.00	0.17	0.10
Brucellosis	0.00	0.00	0.00	0.00	0.00	0.00
Campylobacteriosis	18.80	12.01	16.09	19.55	25.73	18.44
Chancroid	0.00	0.00	-	0.00	0.00	0.00
Chikungunya***	0.00	0.00	0.00	0.00	0.17	0.03
Chlamydia****^	467.33	369.78	-	317.05	-	384.72
Cholera	0.00	0.00	0.00	0.00	0.17	0.03
Coccidioidomycosis	0.00	0.00	0.00	0.00	0.34	0.07
Creutzfeldt-Jakob Disease**	0.17	0.00	0.00	0.00	0.17	0.07
Cryptosporidiosis	3.79	1.03	2.88	4.21	3.36	3.05
Cyclosporiasis	2.41	0.17	2.20	1.52	1.18	1.50
Dengue**	0.52	0.00	0.00	0.00	0.84	0.27
Diphtheria	0.00	0.00	0.00	0.00	0.00	0.00
Ehrlichiosis**	2.59	2.40	3.90	1.85	2.19	2.59
Encephalitis – non-Arboviral	0.00	0.34	0.17	0.17	0.34	0.20

Table 3.3.14-2 Selected Notifiable Conditions Case Rates (per 100,000 population) Reported in Anne Arundel County, 2019 to 2023

Condition	2019	2020	2021	2022	2023	5-Year Average
Epsilon Toxin (C. perf) Associated Illness	0.00	0.00	0.00	0.00	0.00	0.00
Giardiasis	4.31	2.23	4.07	4.72	6.39	4.34
Glanders	0.00	0.00	0.00	0.00	0.00	0.00
Gonorrhea****^	117.44	108.79	-	88.83	-	105.02
H. influenzae – Invasive Disease	1.90	0.69	1.02	1.69	1.85	1.43
Hantavirus Infection	0.00	0.00	0.00	0.00	0.00	0.00
Hantavirus Pulmonary Syndrome	0.17	0.00	0.00	0.00	0.00	0.03
Hemolytic Uremic Syndrome post-diarrheal	0.00	0.34	0.00	0.00	0.17	0.10
Hepatitis A (Acute-Symptomatic)	0.17	6.18	0.85	0.00	0.17	1.47
Hepatitis B (Acute-Symptomatic)	0.00	0.00	0.00	0.00	0.17	0.03
Hepatitis B – Perinatal	0.34	1.20	0.68	0.67	0.84	0.75
Hepatitis C – (Acute-Symptomatic)	0.00	0.00	0.00	0.00	0.17	0.03
Hepatitis C – Perinatal***	0.69	0.69	0.85	0.51	0.67	0.68
Hepatitis D – (Acute-Symptomatic)	0.00	0.00	0.00	0.00	0.00	0.00
Hepatitis E – (Acute Symptomatic)	0.00	0.17	0.00	0.00	0.00	0.03
Influenza Novel A Virus Infection	0.00	0.00	0.00	0.00	0.00	0.00
Isosporiasis	0.00	0.00	0.00	0.00	0.00	0.00
Kawasaki Syndrome	0.00	0.00	0.00	0.00	0.00	0.00
Legionellosis**	5.00	2.57	2.71	3.71	1.68	3.13
Leprosy (Hansen Disease)	0.00	0.00	0.00	0.00	0.00	0.00
Leptospirosis	0.00	0.00	0.00	0.00	0.00	0.00
Listeriosis	0.52	0.86	0.17	0.34	0.00	0.38
Lyme Disease**	18.97	12.01	25.92	21.24	27.08	21.04
Malaria	1.03	0.51	1.19	1.18	2.19	1.22
Measles (Rubeola)	0.00	0.00	0.00	0.00	0.00	0.00
Meningitis, Aseptic	3.97	1.89	1.86	3.20	1.51	2.49
Meningitis, Fungal***	0.52	1.03	0.17	0.00	0.34	0.41
Meningococcal Invasive	0.00	0.00	0.00	0.34	0.17	0.10
MERS-CoV, Mid East Resp Sy.	0.00	0.00	0.00	0.00	0.00	0.00
Microsporidiosis	0.00	0.00	0.00	0.00	0.00	0.00
Mumps (Infectious Parotitis)	0.00	0.00	0.00	0.00	0.00	0.00
Mycobacteriosis, Other than TB & Leprosy	11.55	9.44	10.16	8.76	10.60	10.10
Pertussis	0.52	0.34	0.00	0.00	0.17	0.21
Pertussis Vaccine Adverse Rxns	0.00	0.00	0.00	0.00	0.00	0.00
Plague	0.00	0.00	0.00	0.00	0.00	0.00
Pneumonia – Hospitalized Healthcare Worker	0.00	0.00	0.00	0.00	0.00	0.00

Table 3.3.14-2 Selected Notifiable Conditions Case Rates (per 100,000 population) Reported in Anne Arundel County, 2019 to 2023

Condition	2019	2020	2021	2022	2023	5-Year Average
Poliomyelitis	0.00	0.00	0.00	0.00	0.00	0.00
Psittacosis	0.17	0.00	0.00	0.00	0.00	0.03
Q Fever (Acute)	0.00	0.00	0.00	0.00	0.00	0.00
Rabies – Animal	3.10	2.40	1.19	2.53	1.85	2.21
Rabies – Human	0.00	0.00	0.00	0.00	0.00	0.00
Ricin Toxin Associated Illness	0.00	0.00	0.00	0.00	0.00	0.00
Rubella (German Measles)	0.00	0.00	0.00	0.00	0.00	0.00
Rubella – Congenital Syndrome	0.00	0.00	0.00	0.00	0.00	0.00
Salmonellosis – Other than Typhoid Fever	21.73	16.30	17.45	15.51	21.86	18.57
Severe Acute Respiratory Syndrome (SARS)	0.00	0.00	0.00	0.00	0.00	0.00
Shiga toxin producing E. coli (STEC)	5.86	3.60	6.44	6.57	7.90	6.07
Shigellosis**	3.62	2.57	3.56	3.37	3.53	3.33
Smallpox & Other Orthropox Viruses	0.00	0.00	0.00	0.00	0.00	0.00
Spotted Fever Rickettsiosis**	1.90	0.69	0.34	0.17	0.34	0.69
Staphylococcal Enterotoxin B Illness	0.00	0.00	0.00	0.00	0.00	0.00
Strep Group A – Invasive Disease	7.24	5.49	7.11	7.75	9.42	7.40
Strep Group B – Invasive Disease	9.31	7.04	9.15	6.74	6.56	7.76
Strep pneumoniae – Invasive Disease	6.55	2.40	2.37	5.06	6.39	4.55
Syphilis – Congenital^	0.00	14.76	-	58.26	-	24.34
Syphilis – Primary and Secondary	6.73	5.49	-	8.93	-	7.05
Tetanus	0.00	0.00	0.00	0.00	0.00	0.00
Trichinellosis**	0.00	0.00	0.00	0.00	0.00	0.00
Tuberculosis	2.07	1.20	1.36	0.67	2.19	1.50
Tularemia	0.00	0.00	0.00	0.00	0.00	0.00
Typhoid Fever – Acute	0.34	0.17	0.34	0.17	0.34	0.27
Typhoid Fever – Carrier	0.00	0.00	0.00	0.00	0.00	0.00
Varicella (Chickenpox) – Deaths	0.00	0.00	0.00	0.00	0.00	0.00
Vibriosis (Non-Cholera)	3.10	3.43	2.03	3.20	2.69	2.89
Viral Hemorrhagic Fever	0.00	0.00	0.00	0.00	0.00	0.00
West Nile Virus	0.00	0.00	0.00	0.00	0.00	0.00
Yellow Fever	0.00	0.00	0.00	0.00	0.00	0.00
Yersiniosis**	2.24	1.54	2.20	3.88	5.38	3.05
Zika virus disease***	0.00	0.00	0.00	0.00	0.00	0.00
Zika virus infection***	0.34	0.00	0.00	0.00	0.00	0.07

* Data sources: Maryland's NEDSS and PRISM databases. Data is current as of 11/01/2024. These are active databases and counts may vary slightly over time, as well as differ slightly from counts published by the Centers for Disease Control and Prevention (CDC). HIV/AIDS data are not included here but are available at https://health.maryland.gov/phpa/OIDEOR/CHSE/pages/statistics.aspx. COVID-19 data are available at https://coronavirus.maryland.gov/. Due to a Network Security Incident in December 2021, the Maryland Department of Health

Table 3.3.14-2 Selected Notifiable Conditions Case Rates (per 100,000 population) Reported in Anne Arundel County, 2019 to 2023

Condition	2019	2020	2021	2022	2023	5-Year Average
could not finalize the 2021 STI (Chancroid, Chlamydia, Gonorrhea, and all stages of Syphilis) reporting. Jurisdiction-level STI data is available but varies in completeness by condition and by County. It is not advised to use 2021 STI Data for local planning purposes. Contact sti.datarequest@maryland.gov for more information. ** The case status classifications (confirmed, probable or suspect) included in these totals are specific to the condition and depend in part on the CDC case definitions for surveillance, where those exist (see https://ndc.services.cdc.gov/). There may be additional "suspect" cases for the following conditions: anaplasmosis, babesiosis, Creutzfeldt-Jakob disease, dengue fever, ehrlichiosis, legionellosis, Lyme disease, malaria, mumps, salmonellosis, Shiga toxin producing *E. coli*, shigellosis, spotted fever rickettsiosis, trichinellosis, invasive streptococcal pneumoniae, and yersiniosis. *** The CDC added the following conditions to the nationally notifiable conditions list (https://ndc.services.cdc.gov/) on the noted years: 2013: Meningitis, Fungal 2014: Chikungunya, MERS-CoV 2016: Zika Virus Disease, Zika Virus Infection 2018: Hepatitis C - Perinatal **** Please note that 2022 Chlamydia and Gonorrhea cases include those with unknown jurisdiction: 317 and 71, respectively. ^ Jurisdiction breakdown for 2023 cases are not available for STIs.						

HIV/AIDS data are not included in Table 3.3.14-2; therefore, rates have been collected from the CDC.

Maryland HIV Statistics:

- There were 714 people aged 13 or older diagnosed with HIV in Maryland during 2023.
- At the year-end 2023, there were 31,956 people aged 13+ living with diagnosed HIV in Maryland.
- Among people living with HIV in Maryland in 2022, it is estimated that 93.0% have been diagnosed, while an estimated 2,500 people with HIV in Maryland remain undiagnosed.
- At year-end 2022, 1.1 million (1,093,147) persons in the United States aged 13+ were living with diagnosed HIV.
- Maryland was ranked 14th among states and territories in adult/adolescent HIV diagnoses rates (per 100,000) in 2022 (Maryland Department of Health, Center for HIV Surveillance, Epidemiology and Evaluation).

Well-established scales for characterizing total impacts of infectious diseases are not present for applied uses such as the HMP. Nevertheless, commonly accepted methods are in place for characterizing active transmission, such as color scales (yellow, orange, red). Future editions of this plan will provide updates to measures of extent. Johns Hopkins continues to provide a very comprehensive dashboard of information for all regions of the U.S. including Maryland; County-level data can also be accessed.

3.3.14.4 Probability of Future Emerging Infectious Disease Events

The probability of infectious disease in Anne Arundel County is extremely variable. Many public health risks occur seasonally and are ongoing, such as the common cold and influenza. Major disease outbreaks such as COVID-19 pandemic are much less common but can last for long periods. Based on the information available regarding occurrences of greatest concern, the infectious disease hazard has been assigned a probability of likely for the foreseeable future.

The COVID-19 pandemic has the potential to continue to some degree over the next several years, even as vaccines continue to be developed are distributed. Anne Arundel County is continually updating community mitigation measures and guidance in close consultation with Maryland Department of Health and based on new information from the CDC.

The United States is already seeing a significant increase in vector-borne infectious diseases. According to the CDC, the number of reported disease cases from mosquito, tick, and flea bites tripled from 2004 to 2016, and mosquito-borne disease epidemics are happening more frequently. Annual cases of Lyme disease have increased over the last decade, and with shrinking winters, the potential for infection through tick bite continues to grow. Given increasing trends for global travel, several other diseases not typically observed in Maryland could continue to make their way back to the state through infected travelers. COVID-19 is the most recent and severe example of this threat. Another example is the Zika virus, transmitted from infected mosquitoes to humans, which received international attention during an outbreak in 2015 and persists today.

There is a high probability of future emerging infectious disease events in Anne Arundel County. Due to various factors, the County will most likely see an uptick in new or reemerging diseases. There are environmental, human, healthcare, and zoonotic drivers.

Environmental drivers include climate change, deforestation and habitat loss, and pollution. Human factors include globalization and travel, urbanization, population growth, and intensive agriculture. Healthcare factors include antimicrobial resistance and weak public health systems. Zoonotic transmission factors include wildlife trade and human-animal interactions.

3.3.14.5 Emerging Infectious Disease Risk Assessment

The risk associated with communicable disease in the region has not been formally quantified, due to the difficulty in predicting specific occurrences, and the lack of complete data on impacts. However, the potential risk and impact of communicable diseases is often presumed to be very high in the chaos that follows natural disasters (WHO, 2006).

Natural disasters, particularly meteorological and geological events such as hurricanes, floods and earthquakes, can bring about serious health consequences. These disasters can affect vector breeding sites and vector-borne disease transmission. In a flood hazard area, initial flooding may wash away existing mosquito breeding sites, but standing water caused by heavy rainfall or overflow of rivers can create new breeding sites. This can result (typically with some weeks delay) in an increase of the vector population and potential for disease transmission, depending on the local mosquito vector species and its preferred habitat. The crowding of infected and susceptible hosts, a weakened public health infrastructure and interruptions of ongoing control programs are all risk factors for vector-borne disease transmission.

The major causes of communicable disease from natural disasters can be categorized into four areas: Infections due to contaminated food and water, respiratory infections, vector and insect borne diseases, and infections due to wounds and injuries. The most common causes of morbidity and mortality in this situation are diarrheal disease and acute respiratory infections.

- **Waterborne diseases** – Diarrheal disease outbreaks can arise after drinking water contamination and have been reported after flooding and related movement. Hepatitis A and E have fecal-oral transmission in areas with poor water sanitation.

- **Diseases associated with crowding** – Acute respiratory infections are the main cause of morbidity and mortality among unsettled people and are seen predominantly in children less than 5 years old.
- **Vector-borne diseases** – The most common vector-borne diseases are carried by mosquitoes and ticks and include Lyme Disease, Rocky Mountain Spotted Fever, West Nile Virus, and Eastern equine encephalitis. Environmental changes after disaster could increase vector breeding sites and proliferation of disease vectors.
- **Infections due to wounds and injuries** – The potentially significant threats to persons suffering a wound are tetanus, staphylococci, and streptococci.

3.3.14.6 Emerging Infectious Disease Hazards in Highland Beach

Highland Beach has the same level of exposure and vulnerability to emerging infectious diseases as the rest of the County. The County has a very low risk from this hazard overall.

3.3.14.7 Impacts to People, Structures, Systems and Resources

Emerging infectious diseases can cause considerable damage to people, structures, systems, and activities in Anne Arundel County. However, the overall impact to the planning area from emerging infectious diseases will most likely be low to moderate considering the frequency and magnitude of past occurrences. Impacts on people, structures, systems, resources, and community activities are considered in the following sections.

People

Emerging infectious diseases can impact people in the following ways:

- Cause loss of life, long-term or chronic health issues and behavioral health issues.
- Epidemics/pandemics can cause a strain on available resources.
- First responders and medical personnel are impacted.
- Underserved communities and socially vulnerable populations face more impacts from epidemics/pandemics due to barriers to access.

Emerging infectious diseases can impact all populations, but vulnerable populations are more at risk during a hazard event.

Anne Arundel County participated in the Maryland Department of Health’s 2025 Jurisdictional Risk Assessment and health and preparedness workers in Anne Arundel County identified the following as vulnerable populations to emerging infectious diseases: elderly residents, residents with disabilities, individuals experiencing homelessness, and low-income residents. Essential workers are also at a higher risk due to their inability to avoid work during hazardous conditions.

Structures & Systems

Structures themselves are very unlikely to be negatively impacted by an emerging infectious disease outbreak. However, the County has a robust healthcare system that works to prevent and respond to an infectious disease outbreak. According to the 2025 Critical Facility and Community Lifeline Database developed for this plan update, the County has 2 primary hospitals and 17 health centers.

Hospitals:

- Anne Arundel Medical Center
- UM Baltimore Washington Medical Center

Health Centers:

- Bay Community Health
- Annapolis Health Center
- Magothy Health Center
- Parole Health Center
- Brooklyn Park Center
- Glen Burnie Health Center
- Alcohol and Drug Program Management: Glen Burnie
- North County Health Services Center
- AAMC Community Clinic - Forest Drive
- AAMC Community Clinic - Morris Blum
- Behavioral Health Building - North County
- Behavioral Health Services - South County
- Health Annex
- AAMC Pavilion - Odenton
- AAMC Pavilion - Pasadena
- AAMC - Waugh Chapel
- Shady Side

It is important to maintain these facilities and all public facilities to reduce the transmission of infectious diseases. During an infectious disease event there will likely be increased maintenance costs due to increased cleaning and sanitization efforts. Specific impacts to these health systems, as well as all public systems include shortages of staff during an event, potential delays or failure of services, and school or daycare closures or delays.

Natural, Historic, and Cultural Resources

Emerging infectious diseases can significantly impact natural resources by disrupting ecosystems through changes in wildlife populations, altering animal behaviors due to disease, impacting biodiversity, and potentially affecting the availability of food sources, all of which can be further exacerbated by human activities like deforestation and agricultural expansion that bring humans closer to wildlife reservoirs of disease.

Emerging infectious disease impacts on historic and/or cultural resources is expected to be minimal or none at all.

Community Activities

Depending on the severity of the infectious disease, in person events may be postponed or canceled. For example, both indoor and outdoor gatherings had restrictions early in the COVID19 pandemic. Examples of Anne Arundel County community activities that have been canceled or postponed in the past include Anne Arundel County Fair (2020), and the Spring Fling (postponed).

Most importantly, community events or other large gatherings with many people can facilitate the spread of disease. According to the American Journal of Epidemiology, gatherings at events can create environmental and social conditions that facilitate the spread of pathogens by increasing crowding and contact rates, overextending sanitation and hygiene resources, and encouraging risky behaviors. Health safety and mitigation measures can be put into place to reduce the risk of pathogen transmission at public gatherings – such was the case with social distancing and other recommended guidelines during the COVID19 pandemic.

3.3.14.8 Future Land Use and Development Trends

Increased development such as that projected in Anne Arundel County can affect EIDs in the following ways:

- **Land use changes** – Agricultural expansion and urbanization can lead to habitat conversion, which can cause humans to encounter animals and insects that may carry infectious agents. For example, deforestation and reforestation can influence the emergence of pathogens, such as Lyme disease.
- **Population movement** – As human populations grow and move into new areas; it increases the likelihood of humans encountering animals that may carry infectious agents.
- **Overcrowding** – In rapidly growing cities and urban areas, infrastructure strain can disrupt public health measures, which can allow newly introduced infections to establish themselves.
- **Climate change** – As the Earth's climate warms, diseases can spread into new areas, such as when mosquitoes and the diseases they carry expand their range.

Population and tourism are projected to grow for Anne Arundel County. The new development accompanying this growth will increase the total vectors (i.e., people) of disease spread. More people mean more pathways for an infectious disease to spread. As the population of Anne Arundel County grows, residents and visitors will need to continue to take safety precautions and listen to trustworthy health sources when they warn of potential new infectious diseases.

High-density areas are at risk for EIDs because of the increased contact and interaction between people. This can lead to the rapid spread of EIDs, especially in large urban centers with strong tourism. Guidelines and public health policies for preventing the spread of infectious diseases will have to be enforced in these high-density areas in the County; the best example of this type of development is in North County.

The Town of Highland Beach does not have highly dense development, and new development is not projected. However, EIDs are a concern for residents of the Town, as well as everyone else in the County, due to overall population increase and visitors.

3.3.14.9 Future Conditions

Climate change is a leading cause of new or reemerging infectious diseases. The following excerpt called “Infectious Disease In An Era of Global Change” from the publication Nature Reviews Biology shows the relationship between climate change and increased infectious diseases.

> *“In recent decades, declines in mortality and morbidity, particularly childhood mortality, have been one of the great triumphs of public health. Greater access to care, such as therapeutics (including antibiotics), improved sanitation and the development of vaccines have been core drivers of this progress. Even as medical advances in the twenty-first century have spurred advances in population health, inequalities in access to these*

advances remain widespread between and within countries. Reducing inequities in access to health care and improving surveillance and monitoring for infectious diseases in low-income and middle-income countries, and in underserved populations within countries, should be a priority in tackling pathogen emergence and spread in the future.

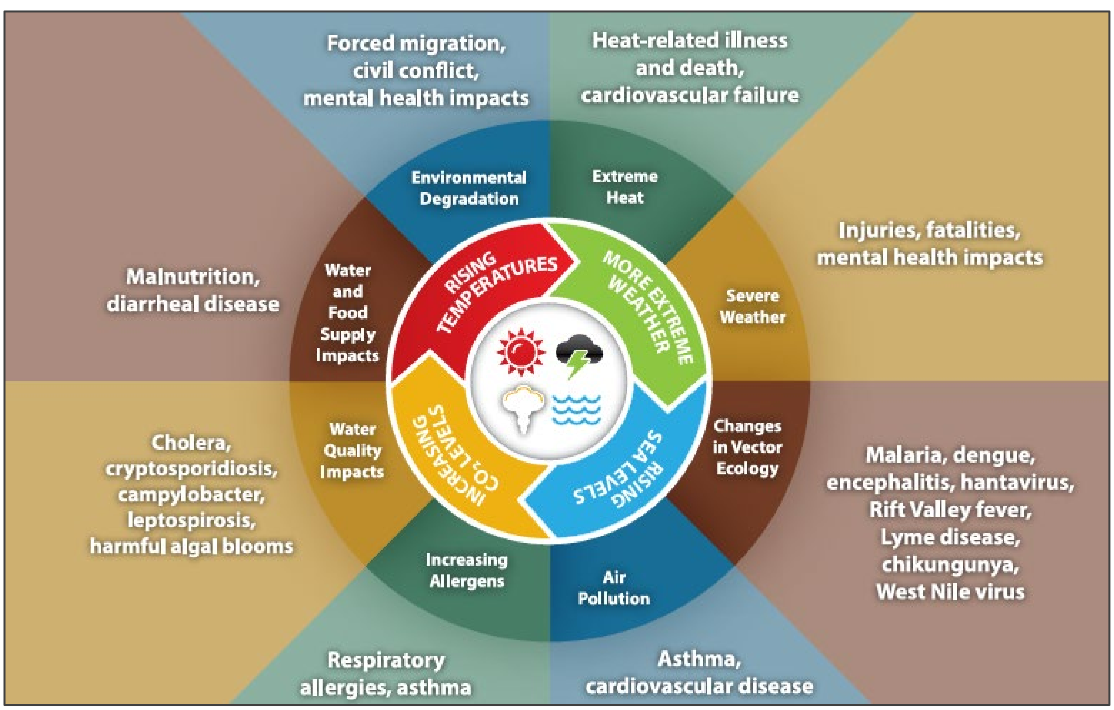
Climate change, rapid urbanization and changing land-use patterns will increase the risk of disease emergence in the coming decades. Climate change, in particular, may alter the range of global pathogens, allowing infections, particularly vector-borne infections, to expand into new locations. A continued uptick in global travel, trade and mobility will transport pathogens rapidly, following emergence.

A changing world requires changing science to evaluate future risks from infectious disease. Future work needs to explicitly address concurrent changes: how shifting patterns of demographic, climatic and technological factors may collectively affect the risk of pathogen emergence, alterations to dynamics and global spread. At the same time, new technologies, including advances in data collection and surveillance, need to be harnessed."

A combination of increased air and water temperatures indicates the possibility of more extreme weather events in the coming years. This can cause an increase in exposure to waterborne and foodborne diseases which will affect food and water safety. Maryland is in the southeast region of the United States, and according to the CDC Preparing for the Regional Health Impacts of Climate Change in the United States report, the Southeast has more favorable conditions for vector-borne diseases. This relationship is visualized by Figure 3.3.14-1.

Figure 3.3.14-1 Preparing for the Regional Health Impacts of Climate Change in the United States, 2024

Source: [Preparing for the Regional Health Impacts of Climate Change in the United States (cdc.gov)]



According to the CDC, the following steps can be taken by the United States to reduce or mitigate the impact climate change will have on emerging infectious diseases:

1. Continued investment in disease surveillance systems to track diseases and determine if they are increasing or shifting over time.
2. Maintain a strong national health system and workforce that can predict, prevent, detect, and respond to new diseases as they expand to new areas.
3. Develop new tools to aid in analyzing and interpreting data that is collected to predict where threats are most likely to occur.
4. Increase understanding of inequalities in how climate change impacts certain populations and use data to inform tailored prevention and response strategies for communities that are disproportionately impacted.
5. Invest in more research, environmental data collection, and disease/climate modeling efforts that help to predict and prepare for future climate scenarios.

3.3.14.10 Considerations for Next Planning Cycle

Future monitoring, evaluating, and updating of this Plan should consider the following factors related to emerging infectious disease:

- Have infectious events occurred within the County since adoption of 2025 HMP update?
- Did infectious events take place in adjacent jurisdictions that impacted the County?
- Has new scientific research or methodology changed the ability to predict infectious events or assess risk and vulnerability?
- Is there new evidence related to the impacts of infectious events that could affect the level of risk or vulnerability?

3.3.15 Public Disorder and Active Assailant

The Public Disorder and Active Assailant section includes the following sub-topics:

1. Description of Public Disorder & Active Assailant
2. Location, Extent, Magnitude
3. Past Occurrences
4. Probability of Future Public Disorder & Active Assailant
5. Public Disorder & Active Assailant Risk Assessment
6. Public Disorder & Active Assailant Hazards in Highland Beach
7. Impacts to People, Structures, Systems, and Resources
8. Future Conditions
9. Land Use and Development Trends
10. Considerations for Next Planning Cycle

3.3.15.1 Description of Public Disorder and Active Assailant

Public Disorder means an act of violence and disorder prejudicial to the public law and order. It includes acts such as riots, acts of violence, insurrections, unlawful obstructions or assemblages, or other disorders prejudicial to public law and order. It also includes all domestic conditions requiring or likely to require the use of federal armed forces. Public Disorder is typically a result of socio-political problems and can include the following hazards (US Legal):

- Famine
- Economic Collapse or Recession
- Public Unrest, Mass Hysteria, and Riot
- Strike or Labor Dispute

An active assailant is one or more subjects actively engaged in killing or attempting to kill or cause serious bodily injury to a person or group of persons in a confined or populated area. Potential warning signs of an active assailant attack include:

- Increasingly erratic, unsafe, or aggressive behaviors.
- Drastic changes in attitude toward others.
- Hostile behavior based on claims of injustice or perceived wrongdoing.
- Drug and alcohol abuse.
- Claims of marginalization or distancing from friends and colleagues.
- Changes in performance at work.
- Sudden and dramatic changes in home life or in personality.
- Financial difficulties.
- Pending civil or criminal litigation.
- Observable grievances and making statements of retribution (“getting even”).

3.3.15.2 Location, Extent, & Range of Magnitude

Typically, the severity of the action coincides with the level of public outrage. In addition to a form of protest against major socio-political problems, Public Disorders can also arise out of union protests, institutional population uprisings, or from large celebrations that become disorderly.

The scale and scope of Public Disorder events varies widely. Most Public Disorder events, should they occur, may have diminished impacts as a result of response training. Additionally, having adequate law enforcement can minimize the chances of a small assembly of people turning into a significant disturbance. However, government facilities, landmarks, prisons, and universities are common sites where crowds and mobs may gather. Public Disorders can take the form of small gatherings or large groups blocking or impeding access to a building or disrupting normal activities by generating noise and intimidating people. They can range from a peaceful sit-in to a full-scale riot, in which a mob burns or otherwise destroys property and terrorizes individuals.

3.3.15.3 Past Occurrences

There have been no documented cases of Major Public Disorder events in Anne Arundel County, however the Anne Arundel County Police Department has responded to mutual aid requests from regional jurisdictions as a result of Major Public Disorder incidents.

On an infrequent, but regular basis, there are Minor Public Disorder incidents in Anne Arundel County, such as minor civil disobedience during planned protest activity, unlawful vehicle exhibition events and spontaneous reactions to public safety response to violent crime incidents.

On June 26th, 2018, there was an active assailant incident at the offices of the Capital Gazette newspaper located at 888 Bestgate Road, Annapolis, Maryland. A subject with grievances directed at the newspaper, entered the offices with a shotgun, and opened fire toward multiple employees. Five employees of the newspaper were killed. The suspect was quickly located in the newspaper offices by law enforcement contact teams formed from various law enforcement agencies who responded to the scene. The agencies who responded had all received active assailant response training.

3.3.15.4 Probability of Future Public Disorder and Active Assailant

Minor Public Disorder incidents will continue to occur in Anne Arundel County, but it is not possible to accurately predict the probability and triggers for a Major Public Disorder event over the long-term. Local law enforcement will continue to anticipate these types of events and be prepared to handle them so that peaceful gatherings are prevented from turning into unlawful public disturbances. Therefore, the probability of Major Public Disorder incidents occurring in Anne Arundel County is considered possible, yet unlikely. The Anne Arundel County Police Department has police officers and supervisors who are credentialed “Level 1” and “Level 2” public disorder teams. Members of these teams maintain their level of capability through initial and annual in-service training.

> **Major Public Disorder:** refers to a large-scale, often violent disruption of public order, like a full-blown riot with widespread property damage, assaults, and significant police involvement.
>
> **Minor Public Disorder:** would be a smaller, less violent disruption, such as a protest that becomes disorderly with shouting, blocking traffic, or minor vandalism, but doesn't escalate to widespread violence or destruction.

It is assumed that the risk of active assailant events will continue to exist in Anne Arundel County in the future. However, these events are hard to predict and intercept. All Anne Arundel County police officers receive initial and in-service Advanced Law Enforcement Rapid Response Training (ALERRT) and Rescue Task Force training; and police supervisors and commanders receive training in Active Assailant Incident Management. The Anne Arundel County Police

Department's Homeland Security and Intelligence Unit Threat Management Squad, staffed by law enforcement investigators and a crisis response mental health clinician, uses recognized methodologies and tools to perform threat assessments and formulate the appropriate responses to those threats. The Anne Arundel County Police Department Community Relations Division has worked with the community to better prepare for future events. An example is C.R.A.S.E (Civilian Reaction Active Shooter Events) and "Stop the Bleed" training. These are courses offered by the Anne Arundel County Police Department and will help prepare residents to have a plan and to be prepared.

3.3.15.5 Public Disorder and Active Assailant Risk Assessment

In general, only small, and localized areas of Anne Arundel County are particularly vulnerable to Public Disorder events. Areas at higher risk include those near government facilities in Anne Arundel Community College, and other landmarks. On the other hand, all communities in Anne Arundel County are vulnerable on some level, directly or indirectly, to Active Assailant activity.

3.3.15.6 Public Disorder & Active Assailant Hazards in Highland Beach

Highland Beach has the same level of exposure and vulnerability to Public Disorder and active assailant as the rest of the County. The County has a very low risk from this hazard overall.

3.3.15.7 Impacts to People, Structures, Systems, and Resources

Table 3.3.15-1: People, Structures, Systems, Resources Vulnerable to Public Disorder & Active Assailant Events

Category	Impacts
People (including underserved communities and socially vulnerable populations)	● Physical harm ○ Victims may suffer from injuries or fatalities. ○ Law enforcement and bystanders may also be injured while trying to intervene. ● Psychological trauma ○ Survivors will often experience PTSD after an active assailant event. ○ Survivors may also experience anxiety and depression following an event. ○ Witnesses may also suffer from psychological trauma. ● Community Impact ○ Schools, workplaces and other public spaces may implement stricter security measures, this can impact day-to-day operations and social interactions. ○ Active assailant events often create a sense of unease, fear and insecurity in the community.

Table 3.3.15-1: People, Structures, Systems, Resources Vulnerable to Public Disorder & Active Assailant Events

Category	Impacts
Structures (including facilities, lifelines, and critical infrastructure)	● Physical damage ○ Active assailants often use firearms or explosives, which can cause extensive damage to buildings, including shattered windows, broken doors and structural damage. ● Operational disruption ○ Events can lead to temporary or permanent closure of facilities. ● Emergency response modifications ○ Buildings will often need to be reevaluated after such events. ○ May need to reevaluate emergency response protocols which includes evacuation routes and safe rooms.
Systems (including networks and capabilities)	● In the case of Public Disorder or active assailant, there may be disruptions throughout the County. These can include: ○ Utility service ○ Healthcare systems ○ Transportation systems ● Demonstrations may occur on major highways and roads.
Natural, Historic, and Cultural Resources	● Active assailants can cause direct physical damage to historic structures and artifacts. ○ This can include bullet holes, fires, or structural collapse due to explosions. ● Loss of Cultural Heritage ○ Unique artifacts, documents and structures that hold historic significance may be lost forever. which mitigation actions are best suited to improve the public disorder and activate assailant hazard in Anne Arundel County?
Activities	● Active assailant events can happen anywhere at any time, community activities that could be impacted include: ● Public Disorders commonly occurs where crowds are already gathered. ○ Parades ○ Sporting events ○ Festivals/fairs

3.3.15.8 Land Use and Development Trends

With increased development and population growth, the potential for Public Disorder and active assailant incidents could possibly increase. However, during the process of building and development, crime prevention can be encouraged through environmental design principles (National Crime Prevention Council, 2003). Future designs could incorporate the following:

- More lighting systems in public places
- Increased pedestrian and bicycle traffic
- Utilization of vacant land
- Increased video surveillance systems
- Increased Red Light Traffic Cameras
- Increased security of homes and commercial space

3.3.15.9 Future Conditions

With the expected growth and development of Anne Arundel County, proper precautions can be taken to discourage the likelihood of Public Disorder, Active Assailant and criminal activity, including the environmental design principles listed above.

3.3.15.10 Considerations for Next Planning Cycle

Future monitoring, evaluating, and updating of this Plan should consider the following factors related to Public Disorder and active assailant:

- Have Public Disorder and active assailant events occurred within the County since the adoption of 2025 HMP update?
- Research effective mitigation efforts that other Counties have in place.
- Did Public Disorder and active assailant events take place in adjacent jurisdictions that impacted the County?
- Has new scientific research or methodology changed the ability to predict Public Disorder and active assailant or assess risk and vulnerability?
- Is there new evidence related to the impacts of Public Disorder and active assailant that could affect the level of risk or vulnerability?

3.3.16 Transportation Accidents

The Transportation Accidents section includes the following sub-topics:

1. Description of Transportation Accidents
2. Location, Extent, Magnitude
3. Past Occurrences
4. Probability of Future Tornado Events
5. Transportation Accidents Risk Assessment
6. Transportation Accidents Hazards in Highland Beach
7. Impacts to People, Structures, Systems, and Resources
8. Future Conditions
9. Land Use and Development Trends
10. Considerations for Next Planning Cycle

3.3.16.1 Description of the Transportation Accidents

Transportation accidents in Anne Arundel County are human-caused hazards that involve air, rail, road, or waterway modes of transport. Because of their prevalence and frequency, transportation accidents cause the highest number of injuries and deaths out of all hazards profiled in Maryland. Examples of road accidents include pedestrian-bicycle and vehicle collisions. Rail accidents include train derailments, both commercial and passenger-carrying. Shipwrecks, grounded planes, and bridge strikes are also under the scope of transportation accidents.

At a minimum, transportation accidents can result in damage to the vehicles and minor injuries to passengers and drivers. At worst, significant transportation accidents can result in death, serious injury, extensive property loss or damage, business interruptions and hours of congestion. Road and railway accidents in particular have the potential to result in hazardous materials releases if the vehicle involved in an accident is hauling hazardous materials. The expected impacts of transportation accidents are amplified by the fact that there is often little warning of accidents.

In addition, there are several other important components to the County transportation infrastructure. These include an airport and a railroad line. Accidents involving aircrafts or trains could also have significant impacts on Anne Arundel County. Additionally, aircrafts traveling to and from Baltimore Washington International (BWI) Thurgood Marshall Airport could cause significant damage to structures, populations, infrastructure, and the environment if an accident were to occur in Anne Arundel County.

3.3.16.2 Location, Extent, & Range of Magnitude of Transportation Accidents

The County's extensive multi-modal transportation network benefits commerce and serves the region's workforce. One of the Mid-Atlantic area's busiest airports, the BWI Thurgood Marshall Airport, is located in the Anne Arundel County. Also, the County's close proximity to the Port of Baltimore benefits commercial enterprises that need to move goods to the Midwest. The area's roads and rail system support high-volume transportation with convenient mass transit lines that serve thousands of residents and incoming workers. With easy access to Interstate 95, businesses located in Anne Arundel County can reach major markets in the Midwest within an overnight drive.

The most heavily traveled roads within the County include East College Parkway, Ritchie Highway, Route US 50/301, Interstate-95, Interstate-695, Interstate-97, and Baltimore-Washington Parkway (Route 295). These roads see a high volume of traffic daily, making them highly vulnerable to disruption from transit accidents.

The Baltimore/Washington International Airport, located in Anne Arundel County, is a potential site of a transportation accident involving aircraft. BWI sees roughly 650 flights per day; however, accidents at the airport are rare. In total, 14 accidents have been reported at BWI. Located in Linthicum the Baltimore/Washington International Thurgood Marshall Airport is the largest airport, by passenger count, serving the Baltimore–Washington Metropolitan Area. In 2020, more than 11 million travelers came through the airport. The airport has over 600 U.S. and international flights daily. The cargo facility includes a 395,000 square foot Air Cargo Center including a 60,000 square foot cargo building, a Foreign-Trade Zone, a 17-acre air cargo ramp, and ramp parking for 17 aircraft. Travelers have easy access to Baltimore and Washington, DC by road, rail service, and airport shuttle.

Tipton Airport is a public airport covering 366 acres in Odenton, neighboring Fort Meade, the National Security Agency, and the Patuxent Wildlife Research Center. The airport's location directly on Route 32 offers travelers' easy access to Route 295, Route 1, and Interstate 95, both of which are straight connections to Baltimore and Washington, DC. The airport is in the midst of planning facilities improvement and runway extension projects. Proposed plans include the addition of 1,200 feet to the east end, widening the runway by 25 feet, and constructing a new parallel taxiway. The improvements will significantly enhance Tipton Airport's ability to cater to more sport, recreational, private, and business aircraft (Anne Arundel County Economic Development Corporation, A Vast Transportation Network).

The railways in Anne Arundel County vary in distance and purpose. The Maryland Transit Administration services a light rail service from BWI in Anne Arundel County up to the City of Baltimore, while the Maryland Area Regional Community rail system helps connect Anne Arundel County to Washington D.C. The Amtrak stop at BWI rounds out the list of rails for passenger transport in the County. On the other hand, Norfolk Southern and CSX are the two freight rail companies that operate in Anne Arundel County.

3.3.16.3 Past Occurrences

Vehicular transportation accidents are a daily occurrence in Anne Arundel County, while aviation accidents are the least frequent type of transportation accident. Table 3.3.16-1 summarizes vehicular crashes in the County for the past 5 years (2019-2024).

Table 3.3.16-1. Anne Arundel County, Maryland Department of Transportation Crash Summary

Crash Type	2019	2020	2021	2022	2023	2024	%
Fatal Crashes	41	49	34	46	42	42	0.4
Injury Crashes	3,232	2,414	2,670	2,688	2,791	2,759	28.8
Property Damage Crashes	7,366	6,097	6,789	6,836	6,803	6,778	70.8
Total Crashes	**10,639**	**8,560**	**9,493**	**9,570**	**9,636**	**9,580**	**100.0**

Source: https://www.cnn.com/us/live-news/baltimore-key-bridge-collapse-03-27-24/index.html

On March 26, 2024, the Francis Scott Key Bridge collapsed in a high-profile ship-to-bridge collision. Connecting Baltimore County through the Patapsco River, Baltimore Harbor, and shortly through Anne Arundel County, the Francis Scott Key Bridge is the third-longest bridge in the world, and the second-longest bridge in the country. The effects from this collision were catastrophic. Six immigrant construction workers filling potholes and working on the bridge were presumed dead, while an estimated 8,000 jobs were impacted. Reconstruction of the bridge is ongoing and is expected to be finalized by the latter half of 2028 (CNN, March 27, 2024).

3.3.16.4 Probability of Future Transportation Accident Events

Anne Arundel County has a high probability of transportation accidents, specifically vehicle-to-vehicle collisions.

With the volume of goods and people moving through Maryland, transportation accidents will continue to occur routinely, especially passenger vehicle accidents. In the case of highway accidents, Maryland has taken great strides to reduce the number of highway transportation accidents through programs such as the Highway Safety Improvement Program and participation in the Pennsylvania Highway Safety Corridor.

The number of rail accidents nationally has been falling for the last 5 years. Additionally, the probability of aviation accidents nationwide was 3.45 accidents per 100,000 flight hours in 2016. The accident rate has decreased each year since 2013 when it was 4.95 accidents per 100,000 flight hours (FAA, 2018). This means that the likelihood of air transportation accidents in the state remains low.

3.3.16.5 Transportation Accidents Risk Assessment

The entire County has been identified as a hazard area for transportation accidents. Transportation hazards could lead to potential losses in categories of human health and life, property, and natural resources. Vehicular accidents, flooded roadways, and other roadway impairments may result in injury or death to drivers and passengers on the road, the public in the immediate vicinity, and emergency services personnel. The number of people exposed to a hazard depends on population density, whether exposure occurs during day or night, and the proportions of the population located indoors and outdoors.

Loss of roadway use, and public transportation services would affect thousands of commuters, employment, day-to-day operations within the County, and delivery of critical municipal and emergency services. Disruption of one or more of these modes of transportation can lead to congestion of another and affect both the County and the region as a whole.

Areas targeted for future growth and development have been identified across Anne Arundel County. Increased development in the County and region will lead to increased road traffic and potential increases in transportation accidents.

3.3.16.6 Transportation Accidents in Highland Beach

There are no airports, state highways, or railways in Highland Beach, making this area less vulnerable to transportation accidents than the rest of Anne Arundel County. There is only one entrance to Highland Beach through Bay Highlands Drive and the primary form of transportation in the town is by road.

3.3.16.7 Impacts to People, Structures, Systems, and Resources

Vulnerability to transportation accidents is limited to critical structures located within one-quarter mile of major Interstates, U.S. Highways, and/or state highways, as well as critical structures located within 5 miles of the state’s three commercial airports, including BWI in Anne Arundel

County. With railways, the state's vulnerabilities extend from approximately one-quarter mile of cargo railway lines.

Table 3.3.16-2: People, Structures, Systems, and Resources Vulnerable to Transportation Accidents

Category	Impacts
People (including underserved communities and socially vulnerable populations)	• Transportation accidents have the highest fatality and injury count out of all the hazards in the State of Maryland (cite state HMP). From 2010 to 2018, the average fatality count was over 500 per year. • In addition to potentially resulting in physical injuries or death, transportation accidents can cause strenuous financial burdens on the people, businesses, or agencies involved.
Structures (including facilities, lifelines, and critical infrastructure)	• Infrastructure and facilities vulnerable to transportation accidents are likely limited to those within close proximity of roadways, airways, railways, and waterways.
Systems (including networks and capabilities)	• Transportation accidents, depending on size and recovery time, can have minimal to significant impacts on networks and capabilities. For example, while the Key Bridge collapse led to nationwide disruptions and delays, a small vehicular accident can have impacts limited to the people involved.
Natural, Historic, and Cultural Resources	• Natural, historic, and cultural resources are likely to be minimally affected by transportation accidents unless they are within close distance to the incident.
Activities	• Community activities are not particularly vulnerable to transportation accidents. Travel routes to activities may be impacted, but the activity itself tends not to be. One exception may be parades or processions that use County or local roads. If an accident were to occur at a certain location at a certain time, it may cause issues for activities such as those.

3.3.16.8 Land Use and Development Trends

Transportation planning decisions influence land use directly, by affecting the amount of land used for transport facilities, and indirectly, by affecting the location and design of development. For example, expanding urban highways increases pavement area, and encourages more dispersed, automobile-oriented development (sprawl), while walking, cycling and public transit improvements encourage compact, infill development (smart growth).

As the population grows in Anne Arundel County, so will the transportation needs of the community. Therefore, maintaining and enhancing transportation infrastructure will be necessary to meet the demand. Some roads in the northern part of the County are heavily trafficked and will be at greater risk of experiencing accidents as the population grows. Similarly, as population grows, the number of housing units and other structures near major highways, active rail lines, and the airport will likely also rise and therefore increase vulnerability.

3.3.16.9 Future Conditions

As the population grows in Anne Arundel County, so will the transportation needs of the community. Therefore, maintaining and enhancing transportation infrastructure will be necessary to meet the demand. Some roads in the northern part of the County are heavily trafficked and will be at greater risk of experiencing accidents as the population grows. Similarly, as the population grows, the number of housing units and other structures near major highways, active rail lines, and the airport will likely also rise and therefore increase vulnerability.

3.3.16.10 Considerations for Next Planning Cycle

Future monitoring, evaluating, and updating of this Plan should consider the following factors related to transportation accidents:

- Have transportation accidents occurred within the County since adoption of 2025 HMP update?
- Did transportation accidents take place in adjacent jurisdictions that impacted the County?
- Has new scientific research or methodology changed the ability to predict transportation accidents or assess risk and vulnerability?
- Is there new evidence related to the impacts of transportation accidents that could affect the level of risk or vulnerability?

3.3.17 Cyber Attack

The Cyber Attack section includes the following sub-topics:

21. Description of Cyber Attack
22. Location, Extent, Magnitude
23. Past Occurrences
24. Probability of Future Cyber Attack Events
25. Cyber Attack Risk Assessment
26. Cyber Attack Hazards in Highland Beach
27. Impacts to People, Structures, Systems, and Resources
28. Future Land Use and Development Trends
29. Future Conditions
30. Considerations for Next Planning Cycle

3.3.17.1 Description of the Cyber Attack

Cyber-attack is a broad term that refers to acts associated with the convergence of terrorism and cyberspace. Generally, cyber-attacks involve unlawful attacks or threats against computers, networks, and the information stored therein to intimidate or coerce a government or its people to achieve political or social objectives (Denning, 2000). Cyber-attacks are an emerging concern of high priority for local, state, and federal governments. According to the Anne Arundel County websites, cyberattacks can lead to loss of money, theft of personal information, and damage to your or your company's reputation and safety. They may be targeted at populations that are likely uninformed about cyber safety such as children or older adults. Cyberattacks can use computers, mobile phones, gaming systems, and other electronic devices. The attack may include identity theft, fraud, or blocking your access to or deleting your personal documents and pictures.

Anne Arundel County's cybersecurity team is responsible for implementing an effective, County-wide information security program that involves the management of information and information system risks. Responsibilities include developing OIT security policies and standards, ensuring security requirements, including necessary security controls, are integrated into the County's enterprise architecture and system development life cycle processes, and aligning information system-related security risks with the County's mission objectives and overall risk strategy.

3.3.17.2 Location, Extent, & Range of Magnitude of Cyber Attack

Cyber-attacks may not always constitute acts of cyber terrorism because some acts may have relatively small impacts and only produce annoyances. A cyber-attack is generally considered an attack when the following motivations are present:

- **Effects-based:** When computer attacks result in effects that are disruptive enough to generate fear comparable to a traditional act of terrorism.

- **Intent-based:** When unlawful or politically motivated computer attacks are committed to intimidate or coerce a government or people to further a political objective, or to cause grave harm or severe economic damage (Rollins and Wilson, 2007).

Cyber-attacks can be further divided into the following categories based on the complexity of the attack:

- **Simple-Unstructured:** Simple-unstructured attacks are the most common. These are amateurish attacks with relatively minimal consequences.

- **Advanced-Structured:** Advanced-structured attacks are more sophisticated and consequential and have a greater emphasis on targeting victims prior to an attack, resulting in a more debilitating effect.

- **Complex-Coordinated**: Complex-coordinated attacks are the most advanced and most troublesome type of attacks where success could mean a network shutdown (Denning, 2000).

Cyber-attacks can cause severe disruptions to transportation, public safety, and utility services, all of which are critical infrastructure that are highly dependent on information technology. Cyber-attacks can take many forms, including attacks through physical means, electronic means, and use of malicious code. Cyber terrorists can also have a wide range of personal, political, or cultural agendas. All state agencies, as well as individuals, businesses, and other institutions are potential targets. Local governments and public school districts are particularly at risk of cyber-attack because they might be operating with outdated systems and budgets that cannot support extensive IT support (Reed et al, 2020).

Table 3.3.17-1 Types of Cyber Attacks

Threat	Description
Malware	Malware is a term used to describe malicious software, including spyware, ransomware viruses, and worms. Malware breaches a network through vulnerability, typically when a user clicks a dangerous link or email attachment that then installs risky software. Once inside the system, malware can do the following: • Block Access to key components of the network (ransomware) • Install malware or additional harmful software • Covertly obtain information by transmitting data from the hard drive (spyware) • Disrupt certain components and render the system inoperable
Botnet	A collection of computers subject to control by an outside party, usually without the knowledge of the owners, using secretly installed software robots. The robots are spread by trojan horses and viruses. The botnets can be used to launch denial of service attacks and transmit spam.
Denial-of-service attack	Flooding the networks or servers of individuals or organizations with false data requests so they are unable to respond to requests from legitimate users.
Phishing	Phishing is the practice of sending fraudulent communications that appear to come from a reputable source, usually through email. The goal is to steal sensitive data such as a credit card and login information or to install malware on the victim's machine. Phishing is an increasingly common cyberthreat.
SQL Injection	A Structured Query Language (SQL) injection occurs when an attacker inserts malicious code into a server that uses SQL and forces the server to reveal information it normally would not. An attacker could carry out an SQL injection simply by submitting malicious code into a vulnerable website search box.
Spoofing	Making a message or transaction appear to come from a source other than the originator. Spyware software that collects information without a user's knowledge and transfers it to a third party.
Trojan Horse	A destructive program that masquerades as a benign application. Unlike viruses, Trojan horses do not replicate themselves, but they can be just as destructive. One of the most insidious types of Trojan horse is a program that claims to rid your computer of viruses but instead introduces viruses onto your computer.
Virus	A program designed to degrade service, cause inexplicable symptoms, or damage networks.

Threat	Description
Worm	Program or algorithm that replicates itself over a computer network and usually performs malicious actions, such as using up the computer's resources and possibly shutting the system down. A worm, unlike a virus, has the capability to travel without human action and does not need to be attached to another file or program.

Cyber terrorists can be difficult to identify because the internet provides a meeting place for individuals from various parts of the world. Individuals or groups planning a cyber-attack are not organized in a traditional manner, as they are able to effectively communicate over long distances without delay. Cyber-attacks are also unpredictable and typically occur without warning.

3.3.17.3 Past Occurrences

In addition to large-scale, state-sponsored cyber-attacks, smaller incidents occur daily. Billions of emails are sent each day, and spam and phishing emails account for a significant share of all email traffic. Additionally, brute force attacks, which are trial-and-error attempts to obtain user passwords and pins, are frequently used by criminals to attempt to crack encrypted data or gain access to private accounts. Most cyber-attacks have disrupted or even halted the provision of municipal services, most notably in St. Mary's County (November 2016), Salisbury (January 2019), and Baltimore City (May 2019). These attacks, along those described in the figure below, have increased the urgency and attention to the need for cyber-security protection policies and measures.

Table 3.3.17-2 Description of Significant Cyber Attack Events in Anne Arundel County from 1950 – 2024

Event & Date	Cyber Attack Description
November 2017	Two cyber-attacks on the Anne Arundel County School District in November 2017 resulted in 36 employees missing a combined $57,000 worth of pay. The cyber-attack originated from phishing emails sent to random employees (Tooten, 2017).
November 2020	The day before Thanksgiving in 2020, the Anne Arundel County School District was alerted that Baltimore County Public Schools were hit with a ransomware attack. The IT department quickly intercepted emails from Baltimore County and warned employees of the attack (Reed et al, 2020). Baltimore County schools were temporarily closed.
December 2021	A ransomware attack on a human resources software used by fire and police employees in the County was targeted in December 2021 (Kirby, 2022).

Anne Arundel County Public Schools were found to have 32 inadequately protected in 2019, which would have allowed hackers from entering the entire system. A spokesperson has confirmed that these issues were resolved and are not appropriately protected (Reed, Knezevich, and Bowie).

3.3.17.4 Probability of Future Cyber Attack Events

A NetworkBuildz study reveals the top ten states most at risk of cybercrime. The study examined each annual FBI Internet Crime Report from 2018-2022 to collect the number of cyber-attacks in each state. Maryland comes in third place on the list. The state saw 58,627 cyber-attacks between 2018-2022, which equates to 951 attacks per 100,000 people, with a victim loss of $479,475,435. Maryland experienced its highest occurrence of cybercrimes in

2020, with a total of 14,804 recorded crimes in one year alone, based on the FBI Internet Crime Report (Rodgers, M. 2023).

Based on past historical data and trends, the future probability of cyber-attacks occurring in the state is high.

3.3.17.5 Cyber Attack Risk Assessment

In recent years, cyber terrorism has become a significant threat and can impact people, businesses, institutions, local governments, and state agencies to varying degrees. Impacts from a large-scale cyber terrorism event could disrupt the County and state's economy and potentially threaten its economic stability. The magnitude of a cyber terrorism attack will vary greatly based on the extent of systems affected and duration of the impact. Additionally, the magnitude will vary based upon which specific system is affected by an attack, the ability to preempt an attack, and an attack's effect on continuity of operations. The largest threat to institutions from cyber-attacks comes from any processes that are networked and controlled via computer. The County should address and take measures to reduce any vulnerabilities that could allow access to sensitive data or processes.

The Office of Security Management (OSM) within the Maryland State Department of Information Technology (DoIT) provides State agencies with a common statewide strategy for secure, effective, and technically sound use of the State's information technology resources. The Office is responsible for the establishment of security policies, security guidance, security awareness, and management of the Statewide Security Operations Center (SOC). OSM provides detection, cyber threat, and incident response capabilities, and is a source of IT security information for State agencies.

3.3.17.6 Cyber Attack Hazards in Highland Beach

The Town of Highland Beach has an equal or less risk of a cyber-attack than the rest of Anne Arundel County. No previous occurrences of cyber-attacks in Highland Beach have been publicized before.

3.3.17.7 Impacts to People, Structures, Systems, and Resources

Table 3.3.17-3: People, Structures, Systems, and Resources Vulnerable to Cyber Attack

Category	Impacts
People (including underserved communities and socially vulnerable populations)	• Cyber-attacks on school districts near Anne Arundel County have caused temporary shutdowns. If these networks are not secure, schools can face prolonged delays to instruction and learning, negatively impacting student performance. • One of the most dangerous effects of cyber-attacks on people is the spread of "personal and financial information, including tax filings, birth and death records, Social Security numbers, medical information, and more" (Maryland State HMP, 2021).
Structures (including facilities, lifelines, and critical infrastructure)	• Facilities and structures are not vulnerable to cyber-attacks, while computer networks and security systems are the primary targets of cyber-attacks.

Table 3.3.17-3: People, Structures, Systems, and Resources Vulnerable to Cyber Attack

Category	Impacts
Systems (including networks and capabilities)	• Private companies and the public sector could face significant disruptions from a cyber-attack if valuable information is breached or access to necessary networks is compromised. This could lead to major financial losses and a decrease in trust. • Cyber-attacks can cause momentary or long-term disruptions to localized or large-scale systems.
Natural, Historic, and Cultural Resources	• Cyber-attacks have minimal or no impact on natural, historic, and cultural resources.
Activities	• In the past, cyber-attacks have affected Anne Arundel's school districts and operations. However, cyber-attacks can delay, cancel, or disrupt any activities that rely on computers, networks, or digital systems.

3.3.17.8 Future Land Use and Development Trends

There are no direct or long-term threats to land use development from cyber-attacks. However, County governments possess and maintain resident personal and financial information, including tax filings, birth and death records, Social Security numbers, medical information, and more. Additionally, many critical facilities that are essential to Anne Arundel County's operations are reliant upon computer networks to monitor and control critical functions.

3.3.17.9 Future Conditions

Cyber terrorism is an emerging hazard that has the potential to impact the region's computer infrastructure and the systems and services that are provided to the public. Concerns about cyber terrorism throughout the United States are growing as its impacts could have potentially crippling effects. Security experts describe the threat of cyber terrorism as imminent.

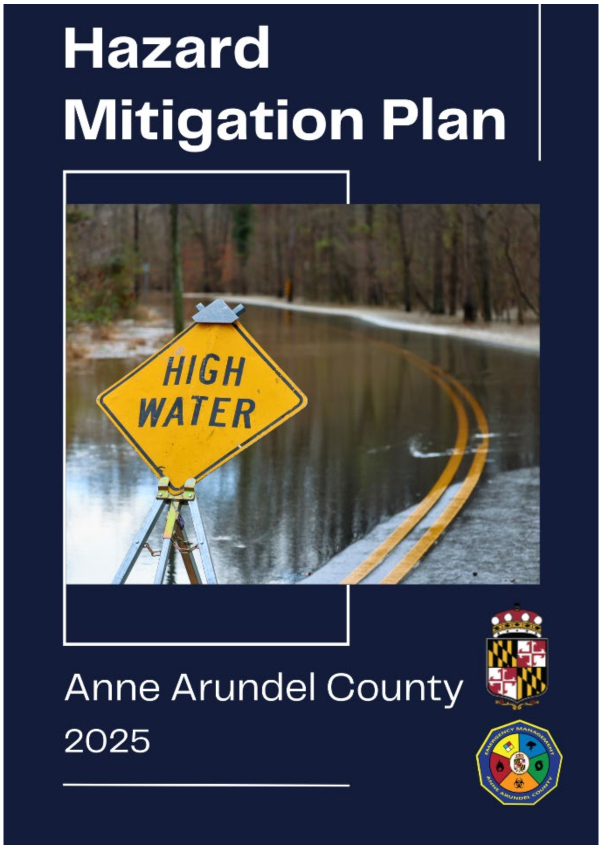
3.3.17.10 Considerations for Next Planning Cycle

Future monitoring, evaluating, and updating of this Plan should consider the following factors related to cyber-attacks:

- Have cyber-attacks occurred within the County since adoption of 2025 HMP?
- Did cyber-attacks take place in adjacent jurisdictions that impacted the County?
- Has new scientific research or methodology changed the ability to predict cyber-attacks or assess risk and vulnerability?
- Is there new evidence related to the impacts of cyber-attacks that could affect the level of risk or vulnerability?

Capability Assessment

Contents of this Section



4.0 Capability Assessment

Requirements

C1. Does the plan document each jurisdiction's existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs? **(44 CFR § 201.6(c)(3))**

C2. Does the plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? **(44 CFR § 201.6(c)(3)(ii))**

Hazard mitigation is any sustained action taken to reduce or eliminate the long-term risk to life and property from hazard events. It is an ongoing process that occurs before, during, and after disasters and serves to break the cycle of damage and societal impacts in hazardous areas. An aim of the 2025 HMP update is to incorporate mitigation into a community's existing authorities, policies, procedures, and programs to reduce or avoid long-term vulnerabilities to the identified hazards. These include programs related to emergency services, planning and growth management, public works, and parks and recreation, as well as functions related to program administration, technical analysis, financing, and outreach. Anne Arundel County also participates in many regional, state, and federal programs that can be coordinated with hazard mitigation goals. Together, these programs and capabilities can help the County build community resiliency through actions taken before, during, and after a hazard event.

This section provides an analysis of current mitigation capabilities, including an assessment of National Flood Insurance Program (NFIP) participation and compliance. Highlighting areas of improvement identified and recognizing strong mitigation capabilities. A ranking table summarizes the capabilities of the County and the Town of Highland Beach

4.1 Aligning Capabilities with Resilience

Assessing mitigation capabilities is an integral part of the mitigation planning process in which communities identify, review, and analyze the resources currently available to them that can be used for reducing the impact of hazards on their communities (FEMA 2016). This assessment of capabilities identifies the framework that is in place for the implementation of mitigation actions that were identified in this plan.

Resilience is the ability of individuals, communities, businesses, institutions, and governments to prepare, adapt, withstand and recover from changing threats and hazards that disrupt everyday life. The assessment of mitigation capabilities is an essential step toward resilience. Building resilience cannot effectively occur unless there has been an honest assessment of the County's capability to plan, manage, and assign resources to facilitate long-term hazard risk reduction (FEMA 2016). Mitigation capacity building is becoming more prominent and realistically achieved with the implementation of FEMA's Building Resilient Infrastructure and Communities (BRIC) program, which began in fiscal year 2020. The BRIC program supports communities through capability and capacity building, encouraging and enabling innovation, promoting partnerships, enabling large projects, maintaining flexibility, and providing consistency.

4.2 Capabilities Assessment Summary

During the planning process, the County and the Town of Highland Beach examined planning and regulatory, administrative and technical, financial capability, education and outreach, and National Flood Insurance Program capabilities. The capability assessment incorporated any new capabilities that have emerged in the past five years. This section provides a summary of the capabilities of Anne Arundel County and Highland Beach.

A capability assessment work session was conducted virtually on December 5, 2024 HMPC mid-point meeting. Participants were asked a series of questions to further determine the current capabilities of Anne Arundel County and the Town of Highland Beach as they relate to hazard mitigation. The FEMA Region III Hazard Mitigation Plan Guidance, Community Capability Assessment Worksheets, were used as reference. To complete the assessment, participating County Departments and the Town of Highland Beach reviewed current legislative and departmental capabilities to identify resources, strengths, and gaps for implementing hazard mitigation efforts. Using the Capabilities Assessment Worksheet, participants documented existing plans, policies, ordinances, programs, and resources that could be utilized in the implementation of mitigation strategies.

Information gathered both during the meeting and from inquiries conducted thereafter, have been integrated into this section. The 2025 HMP update expands upon the capabilities assessment with new surveys of government officials and staff, provides a more thorough review of existing planning mechanisms, and summaries of the plans and programs adopted since 2020.

The County's capabilities were assessed under the following categories:

- Planning and Regulatory
- Administrative and Technical
- Financial Capability
- Education and Outreach

The findings for each category are summarized below and are woven into the mitigation strategies presented in Section 5.

4.2.1 Planning and Regulatory

- Planning and regulatory capabilities are based on the implementation of plans, ordinances, and programs that demonstrate a jurisdiction's commitment to guiding and managing growth, development, and redevelopment in a responsible manner while maintaining the general welfare of the County. Although some conflicts can arise, these planning initiatives present significant opportunities to integrate hazard mitigation principles and practices into the local decision-making process.
- These capabilities are based on the execution of policies, ordinances, State statutes, plans, and programs, as well as local laws that concern managing and guiding development and growth. Certain planning capabilities may either enable or restrain mitigation, for example, capital improvements programs, comprehensive land use plans, region plans, transportation plans, emergency preparedness and response plans, and disaster revival and rebuilding plans. Mitigation plans explain policies or activities that drive decisions and support community objectives. Similarly, the regulatory capabilities include the subdivision regulations, enforcement of zoning laws, as well as the creation of codes that legalize how and where structures are built, and the land is developed.

Both planning and regulatory capabilities refer to the existing plans and regulations, as well as the ability of the community to modify and improve the current plans and regulations as required.

4.2.2 Administrative and Technical

- Administrative capabilities encompass the ability of the County to develop and implement mitigation projects, policies, and programs and are directly tied to its ability to direct staff time and resources for that purpose. These capabilities can be evaluated by determining how mitigation-related activities are assigned to local departments and if there are adequate personnel resources to complete these activities in a jurisdiction. The degree of coordination among departments will also affect administrative capability for the implementation and success of proposed mitigation activities.
- Technical capabilities can be assessed by looking at the level of knowledge and technical expertise of jurisdictional employees, such as personnel skilled in using Geographic Information Systems (GIS) to analyze and assess community hazard vulnerability.
- These capabilities refer to the staff of the community, their skills, and expertise that can be used for the development of the hazard plan and to execute certain mitigation actions. These capabilities also refer to the skills to efficiently coordinate and access these resources. Consider the types of staff associated with each jurisdiction, the resources of the public and private sectors that may be put into use to execute mitigation actions in your community, and the technical expertise and level of knowledge from all these sources. For example, engineers, emergency managers, planners, GIS analysts, floodplain managers, grant writers, building inspectors, and more. Capacity should also be considered for jurisdictions with limited staff resources. It is possible that staff members with specific skills may not be able to devote time to additional work tasks due to existing workload demands.

4.2.3 Financial Capability

- This capability was assessed by reviewing a jurisdiction’s access to or eligibility to utilize routine government funding resources such as capital improvement funding, taxes, fees, State and federal funding sources to fund past and future mitigation actions.
- Such capabilities represent the resources available that can be accessed or used by a jurisdiction to fund its mitigation planning efforts. The expenses associated with the implementation of the mitigation plan may vary. Developing assessment or outreach efforts are some examples of mitigation actions that need little to no costs except existing operational budgets and staff availability. Activities like the possession of flood-prone properties may need a significant monetary commitment from the state, federal, and local funding sources. Certain local agencies may have a recurring revenue source other than sales, property, and income taxes (e.g. development impact or stormwater utility fees). They may utilize the funds to support mitigation efforts autonomously or on a cost-share basis often necessary for grant funding.

4.2.4 Education and Outreach

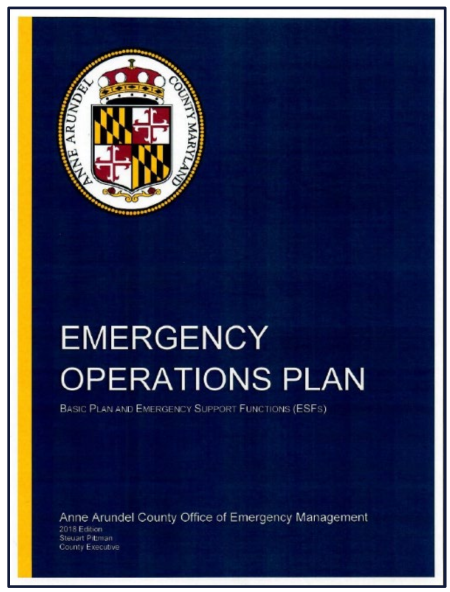
- This capability was assessed by analyzing the education and outreach programs and methods already in place in a jurisdiction that could be used to implement mitigation activities and communicate hazard-related information.

- Such capabilities denote the education and outreach methods and programs that could be utilized to communicate hazard-related information and execute mitigation actions. For example, fire safety programs delivered by fire departments at local schools; conducting activities like hazard awareness campaigns, for example, Flood or Tornado Awareness Month; and involvement in community programs like StormReady or Firewise. Certain communities carry out their outreach activities using their own communications or public information office.

Anne Arundel County has a robust planning and regulatory framework that is highly conducive to comprehensive mitigation planning. First, the County has access to a wealth of planning and regulatory tools that can limit exposure to hazards and reduce the impact when disaster strikes. Second, the County features a highly centralized local government structure. To identify the most promising opportunities for enhancing mitigation planning, this section provides a summary of the key planning and regulatory tools in place in Anne Arundel County, along with their relationship to hazard mitigation. Four program areas are addressed: emergency management, land use and development, natural resources conservation, and floodplain management.

4.3 Emergency Management

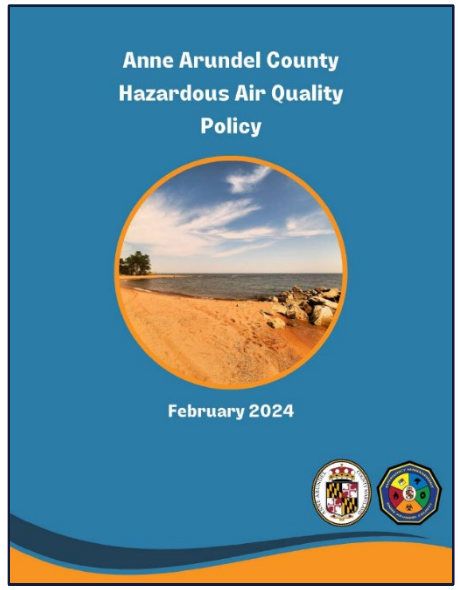
Emergency Operations Plan



Coastal impacts will often result from a combination of more extreme weather events and storm surge with sea-level rise, but additional factors like erosion, subsidence, and wave action also come into play to threaten critical infrastructure. Emergency managers are faced with increased vulnerabilities due to climate risks to roads, airports, water treatment plants, energy facilities, and hospitals related to sea-level rise and associated erosion and flooding. These vulnerabilities are detailed in greater length in many other County plans, and whereas the Emergency Operation Plan examines the impacts as they relate to its mission of protecting the County's people, economy, and environment in the event of emergencies. Climate change is characterized as a condition that will change and potentially exacerbate the impact of other hazards, rather than a distinct hazard with unique impacts. These impacts will all affect the County's emergency management efforts. Increasing hazards resulting from climate change will necessitate a more robust emergency management and response community. An increase in emergency events, and an increase in magnitude of those events, is expected to overwhelm local, County, and regional resources more quickly, and necessitate the use of more resources. Continued coordination and collaboration between all levels of government, and private sector are imperative to ensure continued success and risk sharing among the emergency management community and the public.

The purpose of the EOP is to implement a comprehensive emergency management program for the County that seeks to prevent acts of terrorism, mitigate the effects of hazards, respond during emergencies, take action to protect life minimizing damage and establish a recovery system to return to a pre-disaster state. The EOP establishes a framework and guidance for the management coordination of actions to be taken to prepare for and respond to emergencies and disasters.

Hazardous Air Quality Policy Plan



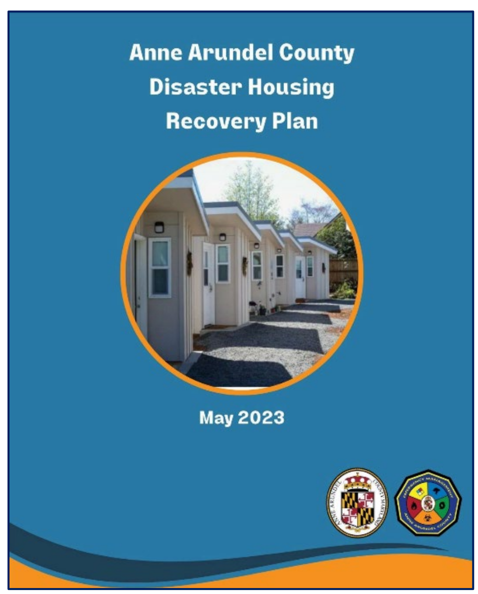
The Hazardous Air Quality Policy Plan addresses the framework for operational concepts, organizational arrangements, responsibilities, and procedures for an event involving hazardous air threats to Anne Arundel County during hazardous air quality situations. It addresses actions in times of disaster and/or emergency events and provides for mitigation, preparedness, response, and recovery operations.

Each of the departments, agencies, and non-governmental organizations who are assigned responsibilities in this policy have participated in the development, review, and revision process. This policy is designed to comply with applicable Federal and State emergency planning criteria and provides the policies and procedures to be followed in dealing with emergency and disaster situations. It replaces all other Hazardous Air Quality Policies and is effective immediately upon receipt for implementation by its provisions.

Continuity of Operations Plan

This Plan is designed to preserve, maintain, and reconstitute the essential functions of the Office of Emergency Management (OEM) within Anne Arundel County. It sets forth procedures when operational disruptions, emergencies or disasters impact or interrupt the day-to-day operations at the Henry L. Hein Public Service Building. The Anne Arundel County Office of Emergency Management COOP plan encompasses the wide range of operations and services performed by the agency and is tailored to OEM's unique operations and essential functions. This plan outlines the essential functions, the order of succession, essential records, information technology and communication systems, and alternate facilities.

Disaster Housing Recovery Plan



This Plan addresses the County’s intent to provide a variety of solutions for transition from mass-care sheltering after a disaster to short-term and long-term housing so that residents can begin rebuilding their communities. The Plan’s guidelines are intended to retain population and offer hope to survivors whose homes and businesses have been destroyed or damaged. Rapid recovery requires that all portions of the community, including businesses and government agencies, quickly rebuild the community’s infrastructure. Ensuring housing for residents after a disaster is essential to long-term recovery and restoration of the County’s economy.

This Plan is designed to comply with applicable Federal and State emergency planning criteria and provides the policies and procedures to be followed in dealing with post-disaster housing recovery in the County. It is effective immediately upon signature and receipt for implementation in accordance with its provisions.

Nuisance Flood Plan

When significant nuisance flooding is expected, it is the responsibility of the Anne Arundel County Office of Emergency Management (OEM) to disseminate information to key stakeholders to prepare for impacts and respond accordingly. In extreme cases where nuisance flooding reaches such a severity that life safety, critical infrastructure, and key resources are threatened, Anne Arundel County OEM may disseminate public safety information via the Alert Anne Arundel Mass Notification System and through additional methods.

As part of the nuisance flood planning process for Anne Arundel County, a thorough inventory of known flood hazard areas was created. One hundred and fifty-four (154) flood prone roads have been modeled, and fifteen (15) flood prone roads have been observed through a collaborative effort by the OEM, DPW, GIS, County Fire and County Police. These areas impacted by nuisance flooding will increase gradually in the coming years as changing climatological patterns elevates water levels to new extremes; likely to accelerate gradually over time. New areas will also become impacted, leading to an increased number of businesses, residents, and critical infrastructure at risk. Public services will also be more frequently impaired as flooding increases.

4.4 Land Use and Development

General Development Plan - Plan2040

Plan 2040, adopted in 2021, establishes a vision, goals, policies, and strategies to guide development of Anne Arundel County over a 20-year time horizon. It reflects the voices of thousands of residents and addresses their priorities for the future of the County. The plan builds on the foundation of the previous General Development Plans and Small Area Plans. It values, promotes, and protects what makes Anne Arundel County "the best place for all," including the Chesapeake Bay and its tributary rivers, forests, farms, quiet suburban neighborhoods, rural landscapes, and thriving economic centers.

Plan2040 lays out a policy framework that informs many of the County's future decisions on land use, environmental protection, transportation, open space, agriculture, community facilities, historic preservation, housing, economic development, and quality of life. Plan 2040 will be implemented through Region Plans, functional plans, the County Code, design manuals, the capital budget, and the work programs of County departments.

Plan 2040 is based on a vision and five themes that are integrated into a comprehensive set of goals and policies. The plan is based on an integrated approach to sustainable development that considers the interaction of the environment, economy, and social equity. To emphasize those connections, the plan is organized in four chapters:

- Natural Environment
- Built Environment
- Health Community
- Healthy Economy

The Office of Planning and Zoning (OPZ) have developed climate change policies and strategies that are used as a framework for discussion purposes and inclusion in the Anne Arundel County General Development Plan update, Plan2040. The policies and strategies were developed based on three County reports and initiatives including the Sea Level Rise Strategic Plan (2011), Energy Efficiency and Conservation Plans (2009 and 2013), and the Climate Resilience Action Strategy.

Zoning Ordinance-Subdivision and Development Ordinance

Land development is regulated by an interrelated set of Federal, State, and local laws. Maryland law requires local governments to prepare growth management plans, like Plan2040. The Plan is implemented through investments in public infrastructure and through local ordinances, including the zoning ordinance (Title 18 of Anne Arundel County Code) and the subdivision and development ordinance (Title 17). There are multiple Federal, State, and local laws designed to protect natural resources from adverse impacts from land development. The local laws include the Critical Areas ordinance that protects shoreline areas, the Forest Conservation ordinance, floodplain ordinance, stormwater runoff management ordinance, and sediment and erosion control ordinance.

Anne Arundel County's zoning ordinance, zoning maps, and subdivision and development ordinance are the primary mechanisms for implementing its comprehensive plan. The zoning ordinance establishes a series of zoning districts and defines the permitted uses, and bulk and design standards for each district. This Code language works in concert with the zoning maps, which designate where residential, commercial, and industrial development is allowed. These features of the zoning ordinance and maps support hazard mitigation.

Anne Arundel County's subdivision and development code guides the division and development of the County's land through a series of requirements for the preparation, submission, and review of subdivision and land development plans. This ordinance is intended to provide adequate sites for development and public use, to maintain reasonable design standards, and to coordinate public improvements with private development interests.

Among the Anne Arundel County subdivision regulations supporting hazard mitigation are the general site design standards and the subdivision application criteria. Site design standards require a site design and environmental feature analysis and require that sensitive natural features be preserved as open space to the extent practicable. To implement this requirement, a list of criteria is provided for all subdivision applications. At all stages of development (pre-application concept, minor subdivision plat, major subdivision preliminary plat, and major subdivision final plat), extensive environmental information must be included in the plans.

Stormwater Management Ordinance

The purpose of stormwater management in Anne Arundel County is to protect and promote the public health, safety, and general welfare through the management of stormwater, to protect public and private property from damage, to reduce the effects of land use changes on stream channel erosion, to assist in the maintenance and attainment of water quality improvement, to preserve and enhance the environmental quality of streams and stream valleys, to minimize adverse impacts on water quality and conserve plant, fish, and wildlife habitat, to reduce flooding, to maintain as near as possible predevelopment runoff characteristics, and to establish the minimum requirements and procedures to control the adverse impacts associated with increased stormwater runoff.

The primary goal of the Anne Arundel County Stormwater Management Program is to maintain after development, as possible, the pre-development runoff characteristics and to reduce stream channel erosion, pollution, siltation and sedimentation, and local flooding which would otherwise have adverse impacts on the water and land resources of this County and State.

The Anne Arundel Soil Conservation District (AASCD) reviews all sediment and erosion control plans for pending construction projects in Anne Arundel County to ensure that developers take the necessary steps to manage runoff during construction to control soil erosion. All plans must adhere to the current Maryland Department of the Environment’s Standard and Specifications for Soil Erosion and Sediment Control.

Building Codes

The County’s building code establishes regulations for the design, construction, alteration, and maintenance of structures. These regulations ensure both that new construction uses sound methods and materials, and that existing buildings are kept in a state of good repair. The use of strong building codes supports hazard mitigation by limiting the loss of life and property when disaster strikes.

Anne Arundel County has adopted model building codes maintained by the International Building Code 2021, FEMA has developed recommendations for making building codes more hazard resistant, through FEMA’s Mitigation Assessment Teams (MATs). For more than 30 years, MATs have been working with state and local officials to investigate the performance of buildings and infrastructure after disasters, down to the types of nails that are used to join wood framing members and the spacing of the nails. The investigations have shown that strengthening buildings reduces losses. MAT reports develop recommendations for changes in construction methods based on field investigations and building science research. Priority recommendations are then adapted into building code amendment proposals.

FEMA’s advocacy of building codes extends to code adoption by states and communities. For example, the Community Rating System, which is part of FEMA’s National Flood Insurance Program (NFIP), is a voluntary incentive program that encourages community adoption of hazard-resistant building codes to exceed the minimum NFIP requirements. The incentive is that the community’s flood insurance premiums are discounted.

4.4.1 Town of Highland Beach

The Town of Highland Beach Comprehensive Plan was prepared in 2020, and formally adopted by way of resolution on December 19, 2020, split into two sections. The first section concentrates on background and contemporary character and the second section concentrates on external factors impacting life in Highland Beach. The second section mirrors the results of the 2018 County HMP and provides a local perspective on the following hazards:

- Coastal Flood
- Nuisance Flood
- Groundwater and Flooding – precipitation, stormwater runoff, and subsidence
- Hurricane, Tropical Storm, and Nor’easter
- Drought

- Earthquake
- Extreme Heat
- Thunderstorm
- Severe Winter Storm
- Tornado
- Wildfire
- Erosion

Hazard mitigation related goals, policies, and implementation strategies presented in the plan include Sensitive Areas and Weather Hazard Mitigation:

Sensitive Areas

Highland Beach enacted a Sensitive Areas Element in December 1998 to protect four sensitive areas of Highland Beach. This was particularly to recognize the Town's proximity to the Chesapeake Bay as well as to Black Walnut and Oyster Creeks, and to acknowledge the Town's continuing commitment to environmental protection. The four areas include: creeks and their buffers; the 100-year floodplain; steep slopes; and habitats of rare, threatened, and endangered species.

- Goal: Riparian forest ecosystems are enhanced and restored; and stormwater is managed to prevent degradation of creeks.
- Goal: Protect the 100-year floodplain from the adverse effects of development.

Weather Hazard Mitigation

Highland Beach has established an overarching goal to reduce or avoid long-term vulnerabilities to identified hazards.

- Goal: Educate and protect residents and minimize loss of human life and damage to property from natural hazards affecting the Town.
- Goal: Educate residents and minimize damage to property and inconvenience resulting from flooding due to stormwater events.

Through the completion and adoption of the 2020 Town of Highland Beach Comprehensive Plan, that includes hazard mitigation profiles, related goals, policies, and implementation strategies, the Town's capabilities have been enhanced since the previous planning cycle.

The Town of Highland Beach Emergency Operations Plan provides a framework for use in performing emergency functions during a major emergency or disaster. The Town Hall is available to provide temporary protection from the effects of a disaster or impending disaster, is suitable for a temporary (2 day) shelter and is equipped with power generator, AED, first aid supplies, and water.

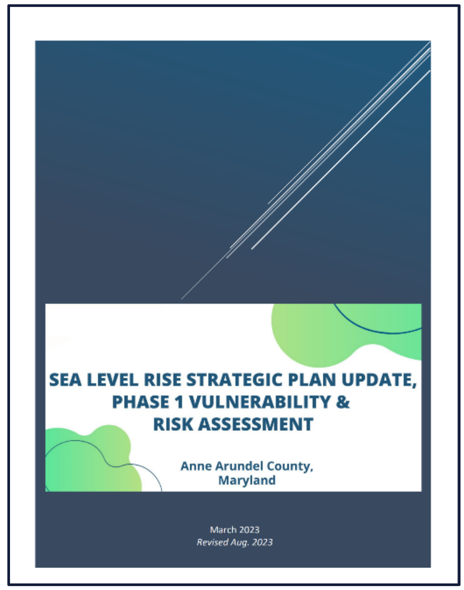
The Mayor and Commissioners have the responsibility for assuring that the Town Hall is physically opened, on demand, during power outages when there is the need for shelter during an emergency. If an evacuation is ordered by the State or County the Town Hall will not be available for shelter. Notice of a recommended or ordered evacuation is accomplished by Anne Arundel County Police and Fire Department personnel.

The Town of Highland Beach does not have a floodplain manager on staff. Implementation and enforcement of local floodplain management regulations and permit development in Highland

Beach is conducted by the County.

4.5 Natural Resources Conservation

Sea Level Rise Strategic Plan



In addition to the detailed vulnerability assessment and overall analysis, the Sea Level Rise Strategic Plan incorporates a series of goals and recommendations related to sea level rise. These are briefly summarized below, and the document is incorporated by reference. The 2025 HMP update includes an additional mitigation strategy that asserts that the County will work to incorporate these goals and strategies into that document. The County has requested that specific goals and recommendations that are included in the 2010-2011 Strategic Plan not be included in the 2025 HMP update, as they have not been formally adopted or approved. The goals are general and focus on the need to incorporate sea level rise considerations into County policies and activities, and to further study the issue going forward. The recommendations include a very detailed series of actions and policy updates that are aimed at increasing the level of technical knowledge about sea level rise and its effects, and in mitigating such effects on existing and future development. The goals are listed below, and the recommendations may be reviewed via the Strategic Plan.

- Incorporate sea level rise planning into all related County functions.
- Protect coastal ecosystems to reduce the impacts of sea level rise, coastal flooding and shoreline erosion.
- Reduce sea level rise impacts to existing and future development.
- Reduce potential impacts to public infrastructure serving existing communities and future development.
- Protect significant cultural resources from loss or damage due to sea level rise impacts. Develop a schedule to complete investigations of all priority sites that have had little or no previous investigation.
- Ensure safe and adequate water supply and wastewater management for communities vulnerable to sea level rise impacts.
- Ensure that citizens in the County are educated and informed about sea level rise and have access to current information and resources.

Climate Resilience Action Strategy

The goal of the strategy is to accelerate resilience planning and financing in three Chesapeake Bay communities: Anne Arundel, Charles and Queen Anne's counties. The approach identifies and leverages the linkages between water quality restoration and protection and climate change resilience. In addition, one of the strategies was to create connections between public financings of resilience and water quality restoration with market-based investments by:

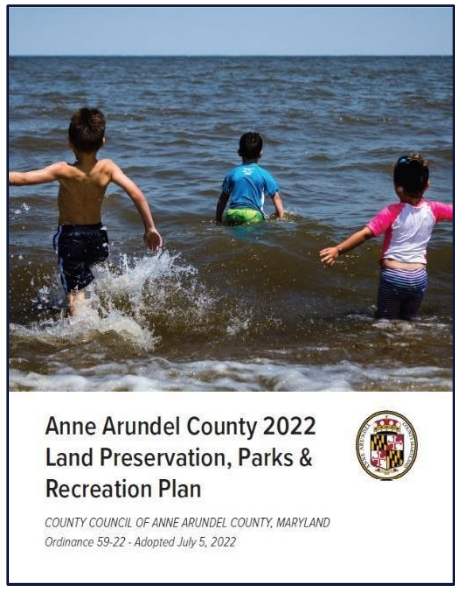
- Developing and implementing actionable, scalable, and innovative resilience and natural infrastructure planning and financing strategies.
- Incentivizing the implementation of new and innovative technologies and policies; and

- Incentivizing efficiency, thereby ensuring that every dollar invested achieves the maximum level of water quality restoration and resilience possible.

This approach will enable communities to focus on identifying the co-benefits and connections between water quality restoration and protection and local resilience. Creating a robust and actionable resilience plan and implementation strategies creates a unique opportunity to expand investments in water quality and water resource management.

The County's resilience Imitative is being implemented in three core phases, each designed to bring our partner communities closer to long-term resilience through action and aggressive implementation and financing. The first of the three phases resulted in the creation of Climate Resilience Action Strategies. Phases two and three will result in the development and implementation of comprehensive financing systems and processes.

Land Preservation, Parks, & Recreation Plan

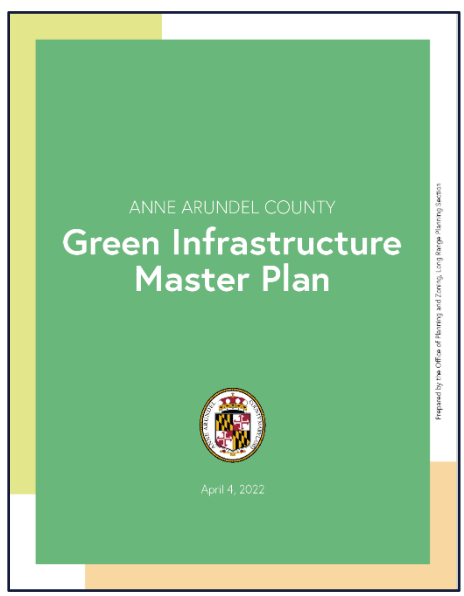


An updated Land Preservation, Parks and Recreation Plan (LPPRP) is required to be submitted by each County to the State of Maryland every five years. The LPPRP serves as a guide for park development, program improvements, and land preservation in Anne Arundel County. The 2022 round of LPPRPs is intended to provide a common benchmark to assist the State's evaluation of County land preservation and recreation programs, to ensure good return on public investment. LPPRPs qualify local governments for State Program Open Space (POS) grants, and include three elements:

- Parks, Recreation, and Open Space
- Agricultural Land Preservation
- Natural Resource Conservation

In April 2022 County Council adopted the LPPRP and it became an amendment to the Anne Arundel County General Development Plan.

Green Infrastructure Master Plan



The Green Infrastructure Master Plan is a guide to conserving an interconnected network of the most significant remaining natural lands in Anne Arundel County through voluntary actions. The Plan was adopted by the County Council in 2022. The lands identified in the Green Infrastructure Network (Network) help protect water quality and air quality, provide habitat for plants and wildlife, create opportunities for recreation, and support mitigation of, and adaptation to, climate change. The Green Infrastructure Network supports the land use policies of the County's General Development Plan (GDP) by prioritizing areas for natural resource conservation, providing open space, and maintaining rural character.

This Plan establishes a goal to conserve an additional 5,000 acres of land in the Network by 2030 (using 2020 as a baseline), representing 30% of the County land area. In comparison, approximately 5,075 acres of land in the Network were conserved through public acquisition and voluntary conservation easements from 2010-2020.

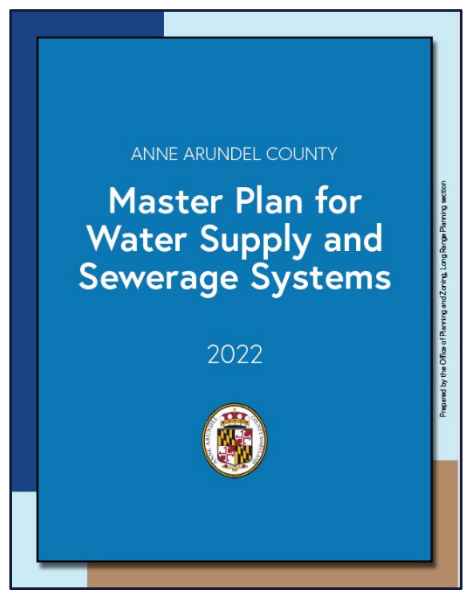
Green Infrastructure plays an important role in mitigating and adapting to the effects of flood hazards and climate change. Forests and wetlands capture and store carbon, acting as a sink for greenhouse gases. Shading from tree canopy reduces heat at a local scale. This is especially important in more developed areas of the County where high amounts of concrete and asphalt reflect heat from the sun. Floodplains, wetlands, and low-lying natural areas also provide storage of stormwater runoff and floodwater, reducing impacts to developed areas. Protection of natural shorelines also can reduce risk of inundation from sea level rise.

A broader set of policies to address climate change are included in Plan2040 to reduce greenhouse gas emissions, promote green building design, transition to electric vehicles, and invest in resilient infrastructure.

Chesapeake Bay TMDL Phase II Watershed Implementation Plan

Anne Arundel County's Phase II Watershed Implementation Plan (WIP) identifies programs, policies and practices and establishes a commitment to implementation that ensures achievement of the nitrogen, phosphorus, and sediment load reductions assigned to the County by the Maryland Department of the Environment (MDE) in compliance with the Chesapeake Bay TMDL. The County's Phase II WIP sets forth a strategy for implementation that identifies statutory authority, capital projects, funding mechanisms and timelines for achieving its allocated loads using Total Nitrogen as the keystone nutrient.

Master Plan for Water Supply and Sewerage Systems



Water and Sewer Master Plan (WSMP) designates where public water and sewer facilities are planned or available. The WSMP can be used as a tool to implement the County's growth management policies and can assure that the rate of growth does not outstrip the County's ability to provide essential public services. The WSMP and the County's Zoning Ordinance work in conjunction to fulfill many of the goals and objectives of the Comprehensive Plan and is particularly useful in relation to its policies on growth management and the provision of public facilities. The Plan has a 25-year outlook and is updated every 3 years; however, the County amends the text and maps of the Water and Sewer Plan every year, or as is deemed appropriate.

The 2022 update to the WSMP reflects the land use policies of Plan2040, the County's most recently updated General Development Plan that was adopted in May 2021. This update to the WSMP reflects the most recent data for population, land use, flow projections, non-County water systems, water quality problem areas, financial data and other data. As planning policies increasingly focus on protection of water resources, the focus of public utility planning will continue to shift toward enhanced treatment, established TMDL requirements, and watershed planning.

4.6 Floodplain Management

As part of the 2025 Plan Update, NFIP Capabilities were assessed via completion of FEMA Region 3 evaluation document "Checking In on the NFIP community questionnaires." These questionnaires include local capabilities related to: Floodplain Identification and Mapping, Floodplain Management, and Flood Insurance

FLOODPLAIN IDENTIFICATION & MAPPING	
1. Who is your FPA or floodplain manager? Please provide office/agency name, position title, and contact information.	Jay Leshinskie Anne Arundel County Inspections & Permits (I&P) Assistant Director & NFIP Coordinator iplesh00@aaCounty.org 410-222-7726
2. Where do you keep your FIRM and FIS report?	Hard copies of the FIRM, FIS, & LOMCs are available in the Anne Arundel County Department of I&P. Digital versions are available for review at www.mdfloodmaps.net
3. Has your community adopted the most recent FIRM? When was the adoption? Where is that information stored? Has your community updated the floodplain ordinance language to include the current FIRM and FIS?	Anne Arundel County, Maryland has adopted the most recent FEMA FIRM, effective date of February 18, 2015. The Anne Arundel County Floodplain Management Ordinance language is in compliance with the current FIRM and FIS, and is available online at the County's website; hard copies are available for review in the County's Department of I&P.
4. Does your jurisdiction support requests for map updates (LOMAs, LOMRs)?	Yes. Anne Arundel County reviews and may provide support for LOMC applications.
5. Is there a specific agency/department responsible for compiling these updates and tracking LOMCs?	Yes. Anne Arundel County tracks and compiles updates for LOMCs.
6. Do you collect updated technical or scientific data and modeling? How do you share this with FEMA?	Data is collected and added to OpenArundel at maps.aaCounty.org. Data collected that impacts mapping must be shared with FEMA within 6 months.
7. Does your jurisdiction provide assistance with local floodplain determinations? If yes, specify how.	Yes, The County offers a web-based GIS map viewer called "My Anne Arundel". More
8. Do the people/agencies responsible for using these tools in your community have the access they need? Which tools does your community rely on?	Yes, employees have access to the data and tools they need for floodplain management. However, public-facing GIS data can be more limited, for flood data. The Office of Planning & Zoning is responsible for the floodplain layer.
Floodplain management requires that you understand the mapping and data side when working with the public.	

FLOODPLAIN MANAGEMENT	
1. Does your jurisdiction issue permits for all proposed development in the SFHA? What office/position is responsible?	Yes. The Anne Arundel County Department of Inspections and Permits (I&P) and the floodplain manager are responsible for permit issuance within the SFHA.
2. Does your jurisdiction obtain, review, and utilize BFE and floodway data, or require BFE data for subdivision proposals and other development proposals larger than 50 lots or 5 acres? If so, what department or office is responsible?	Yes. Any new development/subdivision lots within the SFHA is prohibited, unless it is demonstrated that new structures cannot be located out of the floodplain and shall be designed in accordance with the Floodplain Ordinance. The County is responsible. *§ 16-2-202. Development requirements.*
3. How does your community identify substantially improved structures? When do they intervene to ensure construction increases the resilience (e.g., building above the BFE, anchoring, using flood-resistant materials, and/or elevating utility locations to prevent water damage)?	Anne Arundel County is a participant in the National Flood Insurance Program (NFIP) and has adopted a local ordinance to manage development and minimize risk from future damage and losses on properties within the 100- year floodplain from floods. Anne Arundel County requires documentation to be submitted regarding substantially improved structures, including market value, damage assessments, engineer certifications, etc. for compliance with floodplain management requirements. *"The Department shall maintain a record of all floodplain district permit actions and shall make the record available on request by FEMA or by the State. The record shall include the date the permit was issued, the as-built lowest floor elevation of all new construction or substantial improvement, the issuance date of a certificate of occupancy, a copy of the completed elevation certificate, and any map amendments issued by FEMA."* *§ 16-2-206. Record of permit actions; tracking.*
4. Does your community have a coordinated process to determine substantial damage and to permit repair and improvement? Does the jurisdiction conduct substantial damage assessments in the SFHA? Does your community have a plan for who will conduct substantial damage assessments and a procedure for assessment?	While inspections are completed from time to time, the identification of substantial damaged structures is primarily complaint driven in structure. It is the goal of the County to complete routine inspections with additional personnel in the future. Additionally, inspections are completed during the permitting process. The Department of Inspections and Permits is the agency responsible for administering and enforcing the Building and Construction Code and the local Floodplain Ordinance for the County and is required to maintain all records associated with floodplain district permit actions.
5. Does your jurisdiction require Elevation Certificates for new or substantially improved structures? If yes, how is it documented and which office/agency/department is responsible?	Yes. Applicants for construction within the SFHA must submit an Elevation Certificate prepared by a licensed engineer or surveyor. Anne Arundel County reviews the applications and certificates.

FLOODPLAIN MANAGEMENT	
6. How does the jurisdiction enforce the floodplain ordinance sections? How does the jurisdiction address SI/SD violations?	The Anne Arundel County floodplain manager makes periodic inspections of properties, structures, and utilities for compliance with the ordinance and can issue violations, stop work orders, and penalties. The Anne Arundel County floodplain manager and the code enforcement officer is responsible for enforcing violations. Complaint driven to address violations or associated with a building permit.
7. Has your jurisdiction had a Community Assistance Visit? If so, were any corrective actions required?	The County had a FEMA CAV on June 15, 2023.
8. Does your jurisdiction have or is considering higher ordinance standards than the NFIP? Please describe the higher standards and where they are documented.	• All new or substantially improved structures shall have the lowest floor elevated to or above the flood protection elevation. The Anne Arundel County Flood Protection Elevation is the base flood elevation plus one foot of freeboard. • Materials that are hazardous, buoyant, flammable, or explosive, or that in times of flooding could be injurious to human, animal, or plant life, are prohibited below the flood protection elevation. • Reconstruction, rehabilitation, or restoration of a historic structure may not cause an increase in the elevation of the 100-year flood level. No higher standards planned at this time.
9. Are any local officials/departments in your community interested in additional training? What topics relate most to your community?	Yes, Anne Arundel County personnel are always interested in additional training in reviewing and administering the requirements of the NFIP.

FLOOD INSURANCE	
1. How does the jurisdiction educate community members about the availability and value of flood insurance?	Anne Arundel County personnel and/or the floodplain manager educate the community and property owners regarding the value of flood insurance through press releases, public service announcements, website content, and/or direct contact with property owners within the SFHA.
2. Does the jurisdiction inform community property owners about changes to the FIRM that would impact their insurance rates?	Yes, Anne Arundel County and/or the floodplain manager notifies property owners within the SFHA regarding changes to the FIRM through press releases, public service announcements, social media posts, and where applicable, direct correspondence. Two minor FIRM updates were completed in the last 5 years; property owners were directly contacted.
3. How does the jurisdiction provide general assistance to community members regarding insurance issues?	The floodplain manager and Anne Arundel County personnel are available to advise, assist and answer any questions of community members regarding the NFIP program and/or floodplain regulations.
4. Does the jurisdiction keep track of the number of residential and non-residential structures in the SFHA? How many structures are in the SFHA in your community?	Yes. A database of the number of residential and non-residential structures is maintained by the County. As of July 30, 2024 the County had 109 RLP, based on a query of the FEMA BureauNet NFIP interface. Of this number, eight qualify as severe repetitive loss properties, there are none located in the Town of Highland Beach.
5. Does the jurisdiction have any levees or levee systems in its jurisdiction?	No, according to the USACE national levee database, Anne Arundel County has no levees in its jurisdiction.
6. Is the levee or levee system certified and accredited?	N/A.
7. Is the levee or levee system a Provisionally Accredited Levee (PAL)?	N/A.
8. Is the levee or levee system part of the USACE Rehabilitation and Inspection Program?	N/A.
9. Does your community have any Major Dams or High Hazard Dams, and if so, have you applied for FEMA's High Hazard Potential Dam grant?	According to the National Inventory of Dams and the MDE's Dam Inventory, there are no high hazard dams in the County.

As required by FEMA Interim Final Rule that governs mitigation planning, the other local planning tools and mechanisms will be reviewed and updated during the routine evaluation and update cycle.

Anne Arundel County is a participant in the National Flood Insurance Program (NFIP) and has adopted a local ordinance to manage development and minimize risk from future damage and losses on properties within the 100- year floodplain from floods. The County has adopted a local Floodplain Ordinance in Article 16, Title 2 of the Anne Arundel County Code. The program enables properties in the floodplain district with the ability to obtain flood insurance. The Floodplain Ordinance establishes areas within the County subject to inundation of waters of a 100-year flood as the floodplain district. The floodplain district consists of the following subdistricts: Zone A, Zone AE and Zone A1-30, Zone AH and Zone AO, Zone B and Zone X (shaded), Zone C and Zone X (unshaded), and Zone VE and Zone V1-30. Floodplain identification and mapping risks are determined by the Flood Insurance Study for Anne Arundel County, Maryland and Incorporated Areas and accompanying flood insurance rate and floodway maps, and all subsequent revisions, as developed by FEMA. The general provisions of Floodplain Ordinance apply to all development, construction and substantial improvements to existing structures in the floodplain, and includes applications for subdivision development, and building and grading permits.

In addition to the County Floodplain Ordinance, the County has adopted the 2015 International Building Code and 2021 International Residential Code and the administrative changes of each supplement, as the local Building and Construction Code of the County. The Building and Construction Code and the local Floodplain Ordinance are used in conjunction with the FEMA Floodplain maps to determine compliance for development, new construction, and substantial improvements to existing structures on properties located in the floodplain. The Department of Inspections and Permits is the agency responsible for administering and enforcing the Building and Construction Code and the local Floodplain Ordinance for the County and is required to maintain all records associated with floodplain district permit actions.

The floodplain ordinance applies to all development, construction and substantial improvements to existing structures in the floodplain, and includes applications for subdivision development, and building and grading permits. The following is a summary of the local floodplain ordinance in the review and approval of applications by the Department of Inspections and Permits within the 100-year floodplain:

A. The local floodplain ordinance limits development in the floodplain if an alternative location exists. The local floodplain ordinance also limits encroachment inside the floodplain for structures when a disturbance of the 100-year floodplain is unavoidable.

B. The local floodplain ordinance provides authority to repair or rehabilitate existing dwellings in flood hazard areas. The applications are initially reviewed to determine whether the proposed cost of work meets the definition of a substantial improvement. If the proposed cost of work equals or exceeds 50 percent of the current market value before the damage occurred, full compliance with Building and Construction Codes including raising the lowest habitable level of the structure to an elevation of one foot above the flood protection elevation level for the property is required.

C. The local floodplain ordinance provides authority to issue permits for new construction or substantial improvements to nonresidential structures when the following conditions are met:

    - A floodproofing design is submitted to ensure areas below the flood protection elevation are watertight with walls substantially impermeable to the passage of water and with structural components capable of resisting hydrostatic and hydrodynamic loads and effects of buoyancy for flooding to the flood protection elevation; and
    - A FEMA floodproofing certificate is provided.

D. The local floodplain ordinance requires new construction, substantial improvements, and habitable space applications within the 100-year floodplain to elevate the lowest floor to one foot above the flood protection elevation level of the property unless the construction, reconstruction, and rehabilitation involves:

    - An expansion to address a violation of State or County health, safety, or sanitary codes; or

- The construction consists of an accessory structure, attached garage, or non-substantial improvement to an existing dwelling that meets the following criteria:
    - The structure is constructed to minimize flood damage
    - The structure is firmly anchored to prevent flotation
    - The structure is used for parking, storage, or building access
    - The floor elevation of the structure is at or above existing grade and does not qualify as a basement
    - The structure is equipped with flood equalization vents in accordance with the Building and Construction Code

Applications for building and grading permits must include the following information to ensure the Construction and Building Code and the local Floodplain Ordinance are capable of being met:

- the elevation of the 100-year flood; high-velocity water and wave action including its relation to a stream channel, shoreline, floodplain district, and floodplain subdistrict; elevations of the existing ground contour and proposed final grade of the property; and the elevations of the lowest floor level(s) and the floor area below the lowest floor
- the methods used to elevate a proposed structure, including details of proposed fill, pile structures, retaining walls, foundations, and erosion protection measures
- the methods used to protect electrical, plumbing, and mechanical systems and utilities from flooding
- the assessed value of existing structures or an “as is” appraisal of the market value of the existing structure, excluding land value
- a statement on the building plans for accessory structures indicating there will be no conversion of the area to habitable space unless the lowest floor is elevated to one foot above the 100-year flood elevation

A substantial improvement is defined as any reconstruction, rehabilitation, addition, or other improvement of a building, the cost of which equals or exceeds 50 percent of the market value of the building before the start of construction of the improvement. The term includes buildings that have incurred substantial damage, regardless of the actual repair work performed.

A non-conversion agreement is required before an accessory structure, attached garage, and non-substantial improvement of an existing dwelling may be constructed within the 100-year floodplain. The non-conversion agreement prohibits conversion of the accessory structure, garage, and non-substantial improvement unless the structure is raised to the flood protection elevation. The County requires the non-conversion agreement to be recorded in land records to ensure future property owners are notified of the use and occupancy limitations.

When the County undergoes an update to its local Floodplain Ordinance, Building and Construction, and Development Codes, the mitigation strategies and actions identified from the 2025 HMP update, and future updates will be requested to be reviewed and incorporated in the appropriate sections of the Anne Arundel County Code as well as integrated into programs, policies and other documents. Following local adoption, the 2025 HMP update will be made available to each planning committee member involved in the 2025 HMP update. The County follows the International Building Code guidelines, and maintains a General Development Plan, a Capital Improvement program, and Site Development Regulations. Anne Arundel County periodically reviews and updates its standards and guidelines. As part of these future reviews and updates, the County will explore opportunities on how to integrate and adopt hazard mitigation strategies and actions into existing ordinances, regulations, policies and standard practices. The County intends to use the actions and projects described in the mitigation strategy as the local process for prioritizing and recommending hazard mitigation and risk reduction projects for consideration in the County Capital Improvement program.

4.7 Capability Assessment Findings

After the assessment was completed, each capability category was ranked on a qualitative basis as demonstrated by the jurisdiction's authorities, programs, plans, and/or resources:

- **Limited:** the jurisdiction has limited capabilities within this category and is unable to implement most mitigation actions.
- **Low:** the jurisdiction has some capabilities within this category and can implement a few mitigation actions.
- **Moderate:** the jurisdiction has some capabilities within this category, but improvement is needed to implement some mitigation actions.
- **High:** the jurisdiction has significant capabilities within this category as demonstrated by its authorities, programs, plans and/or resources, and can implement most mitigation actions.

A summary of mitigation capability rankings for the County and the Town of Highland Beach is presented in Table 4.1-1. Highlights of mitigation capabilities include:

- Moderate to High Planning and Regulatory Capabilities - The County has strong relationships with their County partners and can collaborate and share resources to fill any gaps that may exist. Public Works, Office of Law, Planning and Zoning as well at the Resilience Authority responded with high capacity responses. Lack of staffing was noted as a need to properly enforce floodplain management tasks. No limited capacity responses were recorded.

  The following recommendation was presented by the Resilience Authority and will be carried over to the mitigaiton strategy and integrated as an action item of this plan.

  > *Continued coordination of project opportunities through the Resilience Authority Advisory Committee as well as the Environmental Committee.*

- Moderate to High Administrative and Technical Capabilities - The overall strength of these capabilities were presented by the Planning and Zoning, Permitting and Inspections and the Office of Law,

  The following recommendation was presented by the Resilience Authority and will be carried over to the mitigaiton strategy and integrated as an action item of this plan.

  > *The County would benefit with the development of the region's first integrated portfolio of projects and actions aimed at mitigating the impacts of climate change by reducing greenhouse gas emissions and accelerating the transition to reliable and affordable renewable energy in the area.*

- Moderate to High Financial Capabilities - Public Works, Office of Law, Inspections and Permit, responded with high capacity responses. The Office of Planning and Zoning responded with Limited capacity but gave no reason or support for the rating.

The following recommendation was presented by the Resilience Authority and will be carried over to the mitigation strategy and integrated as an action item of this plan.

> *The Authority needs to establish enough revenue to finance necessary resilience projects and programs across both jurisdictions. Successfully financing community resilience in the long-term will likely require a suite of funding resources to support a variety of infrastructure and programmatic needs.*

- Moderate Public Education Capabilities – Educating the public about natural and human-caused hazards is necessary to better prepare the Anne Arundel County residents, especially vulnerable populations. Planning and Zoning responded with a high capacity response but cited the Plan 2040 and the Green Infrastructure Plan as gaps in education and outreach. A second comment from Inspections and Permits noted that the public is unaware of the most mitigation actions that are undertaken by the County. The Department of Health cited a need for improved intra-agency coordination among programs.

No matter the strength of mitigation capabilities, there is always room for improvement due to constantly changing factors such as population, staffing, finances, and different types and magnitudes of hazards. During the assessment, a gap analysis was performed to identify ways in which capabilities could be expanded and improved to reduce risk. Key areas for improvement include:

- Provide additional staff, such as a new CRS administrator, to Planning and Zoning to properly enforce the County's floodplain management program.
- Develop a greenhouse gas reduction plan with an integrated portfolio of projects and actions aimed at mitigating the impacts of climate change
- Improved intra-agency coordination among department programs
- Develop a strategy to make the public more aware of completed hazard mitigation actions.

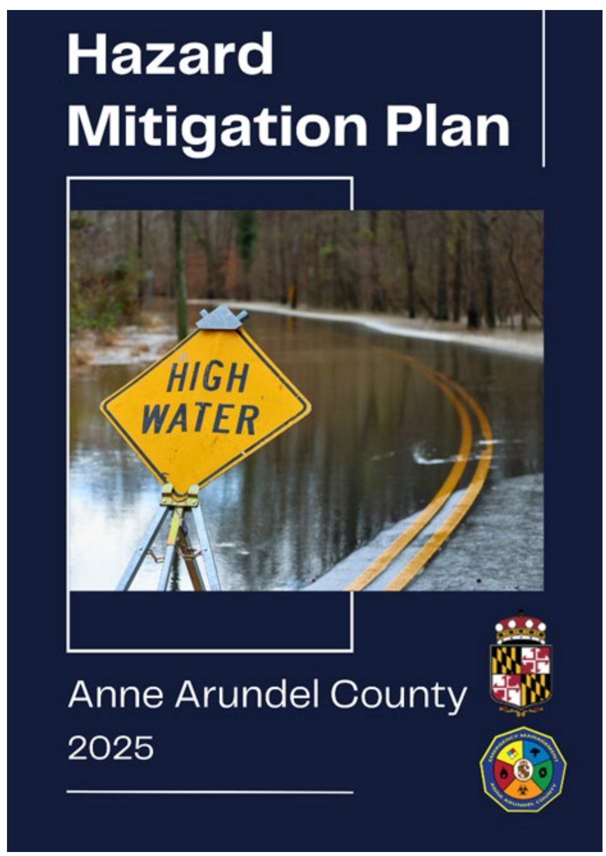
Components of these items are included within the action items developed in the HMP mitigation strategy section.

Table 4.1-1 Capability Assessment Survey Results

Name of Department, Agency or Office	Self Assessment How would you rank the current planning and regulatory capabilities within Anne Arundel County? [Planning and Regulatory]	What gaps, if any, exist to the Planning and Regulatory capabilities?	Self Assessment How would you rank the current administrative and technical capabilities within Anne Arundel County? [Administrative and Technical]	What gaps, if any, exist to the Administrative and Technical capabilities?	Self Assessment How would you rank the current financial capability within your Department/Agency/Office to support mitigation efforts? [Financial]	What gaps, if any, exist for Financial capabilities?	Self Assessment How would you rank the current education and outreach activities within your Department/Agency/Office to support mitigation efforts ? [Education and Outreach]	What gaps, if any, exist for Education and Outreach?	List any additional areas of concern
Public Works	High		Moderate		High		Moderate		
Office of Law	High	From my seat, none that I am aware of.	High	None	High	All of you staff is well equiped to work remotely if required by hazard	Limited	Our clientele are all County staff	None
Planning and Zoning	High		High	Please note that Jane Cox has retired. Darian Beverungen is acting Planning Administrator	Limited		High	Plan 2040, Green Infrastructure Plan	
Department of Health	Moderate	None known	Moderate		Moderate		Moderate	Improved intra-agency coordination among programs	
Inspections and Permits	Moderate	Lack of staffing to properly enforce floodplain management.	High		High		Moderate	The general public is unaware of most of what hazard mitigation actions we do.	
OCS, Risk Management	Moderate	Is it possible to link the documents to the planning and regulatory capabilities list?	Moderate				Moderate		
Resilience Authority of Annapolis and Anne Arundel County	High	Continued coordination of project opportunities through the Resilience Authority Advisory Committee as well as the Environmental Committee.	Moderate	County would benefit with the development of the region's first integrated portfolio of projects and actions aimed at mitigating the impacts of climate change by reducing greenhouse gas emissions and accelerating the transition to reliable and affordable renewable energy in the area. Leveraging studies and initiatives already underway across the region, the Resilience Authority could work with experts in County and City agencies as well as nongovernmental partners to identify and develop a plan and portfolio of the most impactful projects to support flood control, ecosystem resilience, shoreline protection, structural resilience, energy resilience, and other community-based projects. The portfolio of projects could become the focal point of the region's climate mitigation and resilience financing system moving forward. Assuming this important leadership role will require establishing transparent and defensible investment decision-making processes that can provide both immediate community-wide impacts while at the same time establishing the systems required for scaling and sustaining long-term resilience. The strategic planning process itself should be dynamic and ever-evolving, thereby providing the Authority and its leadership with an opportunity to continuously address inherent biases by examining and explaining why each decision is being made and supporting those decisions with data, projections, or case studies	Moderate	The cost for Anne Arundel County to become resilient to the impacts of climate change can vary widely depending on the specific strategies and projects implemented. Annual estimates can run into millions of dollars, considering infrastructure improvements, flood mitigation systems, and community education programs. Funding often comes from a mix of state and federal grants, private investments, and local budgets. The total financial commitment is influenced by the severity of projected climate impacts and the level of preparedness desired by the community. In 2021, Anne Arundel County established the Resilience Authority to create a structured approach to addressing the increasing threats posed by climate change and other environmental challenges. The authority aims to coordinate resources, implement cross agency strategies, and enhance community preparedness and response through targeted projects. By centralizing efforts, the Resilience Authority seeks to improve funding access, foster partnerships, and ensure a comprehensive strategy for building a resilient community that can adapt to and recover from climate-related impacts. With that said, there is a issue with scale. The Authority needs to establish enough revenue to finance necessary resilience projects and programs across both jurisdictions. Successfully financing community resilience in the long-term will likely require a suite of funding resources to support a variety of infrastructure and programmatic needs.	Moderate		Beyond an actionable grant portfolio strategy, the Resilience Authority needs to develop a more comprehensive long-term revenue plan. The focus should be on establishing strategies for identifying, investing, and when necessary leveraging long-term revenue streams, including innovative taxes and fees, as well as asset-based revenues through the use of Urban Wealth Funds (UWF).

Mitigation Strategy

Contents of this Section



5.0 Mitigation Strategy

This section contains the goals, objectives, and mitigation action items that will help the County mitigate hazards and become more resilient in the next 5-year planning period and beyond. The goals, objectives, and actions outlined make up Anne Arundel County's mitigation strategy.

5.1 Overview

The mitigation strategy serves as the long-term blueprint for reducing the potential losses identified in the risk assessment. The Stafford Act directs hazard mitigation plans to describe hazard mitigation actions and establish a strategy to implement those actions. Therefore, all other requirements for a hazard mitigation plan lead to and support the mitigation strategy.

This Plan update is an opportunity for Anne Arundel County and the Town of Highland Beach to assess previous goals and adjust them to address current realities. Updated and streamlined mitigation goals and objectives are presented in this section. The mitigation strategy is designed to support these goals and objectives.

Requirements

§201.6(c)(3)(i) - [The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long - term vulnerabilities to the identified hazards.

§201.6(c)(3)(ii) - [The hazard mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure. All plans approved by FEMA after October 1, 2008, must also address the jurisdiction's participation in the NFIP, and continued compliance with NFIP requirements, as appropriate.

§201.6(c)(3)(iii) - [The hazard mitigation strategy shall include an] action plan, describing how the action identified in paragraph (c)(3)(ii) of this section will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost-benefit review of the proposed projects and their associated costs.

§201.6(c)(3)(iv) - For multi - jurisdictional plans, there must be identifiable action items specific to the jurisdiction requesting FEMA approval or credit of the plan.

§201.6(c)(4)(ii) - [The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvements, when appropriate.

5.1.1 National Mitigation Framework

The National Mitigation Framework covers one of the five mission areas that make up FEMA's National Preparedness System: Prevention, Protection, Mitigation, Response, and Recovery. It focuses on a culture of preparedness which means recognizing risk and building resilience as a whole community to withstand future disasters and bounce back better. The 2025 HMP update follows the seven core capabilities for those involved in mitigation outlined in the (FEMA

National Mitigation Framework, 2020):

- **Threats and Hazards Identification**: Identify the threats and hazards that occur in an area using the best available data.
- **Risk and Disaster Resilience Assessment:** Assess hazard risks using scientifically recommended techniques that consider current and future conditions.
- **Planning:** Incorporate the risk assessment results into the mitigation planning process.
- **Community Resilience:** Engage the whole community in a planning process that considers the built environment, natural environment, economy, and human health.
- **Public Information and Warning:** Share the risk assessment and mitigation strategy with the public through clear, consistent, and accessible messaging.
- **Long-term Vulnerability Reduction:** Implement the mitigation and adaptation plan to build and sustain resilient systems, communities, and critical infrastructure and key resources lifelines.
- **Operational Coordination:** Use the action plans to coordinate with relevant stakeholders and leaders while consistently integrating mitigation plans and actions into other community plans and systems.

Whole Community

"A focus on enabling the participation in national preparedness activities of a wider range of players from the private and nonprofit sectors, including nongovernmental organizations and the general public, in conjunction with the participation of all levels of government in order to foster better coordination and working relationships." – The National Preparedness Goal

The status of mitigation actions included in the 2018 HMP is discussed, as are new action items and how these action items were prioritized. All actions support the goals and objectives and promote an inclusive mitigation strategy. A summary of the types of actions identified by participants is presented to display the wide range of strategies chosen, which represents a broad and inclusive approach to mitigation in the County.

FEMA identifies four primary types of mitigation actions to reduce long-term vulnerabilities: local planning and regulations, structure and infrastructure projects, natural systems protection, and education and awareness programs.

1. **Local Planning and Regulations (LPR)**: Government administrative or regulatory actions or processes that influence the way land and buildings are developed and built. These actions also include public activities to reduce hazard losses. Examples include:
    - Comprehensive plans
    - Land use ordinances
    - Subdivision regulations
    - Development review
    - Building codes and enforcement
    - NFIP Community Rating System (CRS) participation
    - Capital improvement programs
    - Open space preservation
    - Stormwater management regulations and master plans

- Community wildfire protection plans, fuels management, and fire breaks.

2. **Structure and Infrastructure Projects (SIP)**: Actions that involve the modification of existing critical and public facilities, buildings, structures, and public infrastructure to protect them from hazards. Examples include:
   - Acquisitions and elevations of structures in flood-prone areas
   - Utility undergrounding
   - Structural retrofits (e.g., shelters)
   - Floodwalls and retaining walls
   - Detention and retention structures
   - Culverts
   - Safe rooms
3. **Natural Systems Protection (NSP)**: Actions that, in addition to minimizing hazard losses, also preserve or restore the functions of natural protection systems. These actions include:
   - Sediment and erosion control
   - Stream corridor restoration
   - Forest management
   - Conservation easements
   - Wetland restoration and preservation
4. **Education and Awareness Programs (EAP)**: Undertake actions to inform and educate citizens, elected officials, and property owners about potential ways to mitigate hazards that can occur in the County and its municipalities. Such actions include:
   - Radio or television spots
   - Websites with maps and information
   - Social media
   - Real estate disclosure
   - Presentations to school groups or neighborhood organizations
   - Mailings to at-risk populations and residents in hazard-prone areas
   - StormReady certification
   - Participation in the Firewise USA program

5.2 2025 Goals and Objectives

The goals and objectives presented herein help to guide Anne Arundel County and Highland Beach in identifying and selecting mitigation strategies to address hazard vulnerabilities as identified and discussed in Section 3. The selected mitigation actions will help the County avoid, prevent, or otherwise reduce damages from hazards. The goals and objectives represent Anne Arundel County's vision for reducing damages caused by the hazards identified in the 2025 HMP update.

> **Goals** are general guidelines that explain what you want to achieve; usually broad, long-term policy statements representing global visions
>
> **Objectives** define strategies or implementation steps to attain the identified goals; specific and measurable.

The goals and objectives from the 2018 hazard mitigation plan were reviewed by the HMPC during the Mitigation Solutions Workshop held on February

26, 2025, at Maryland Department of Emergecy Management (MDEM). Hazard Mitigation Planning Committee (HMPC) members in attendance at the workshop revised the goals and objectives as necessary and created additional goals and objectives for inclusion in the 2025 Plan Update. These goals and objectives represent Anne Arundel County and Highland Beach's vision for reducing damage caused by natural hazards identified within the plan for the next five years and beyond.

Goal 1: Protect residents and minimize loss of human life and damage to property from natural and non-natural hazards affecting the County.

Objective 1.1: Educate the public and implement actions that protect lives and property to natural and human made hazards.
Objective 1.2: Evaluate existing shelters to determine adequacy for current and future population needs.
Objective 1.3: Use technology to warn the public about hazard events and other types of advisories, warnings, and watches affecting the community.
Objective 1.4: Advise the public on when to evacuate at-risk hazard areas to reduce risk and save lives.
Objective 1.5: Promote the use of evacuation routes during emergency events impacting the County.

Goal 2: Increase public awareness to natural and non-natural hazards affecting the community.

Objective 2.1: Develop education and outreach presentations and materials to increase public awareness of the risks associated with natural and human-made hazards affecting the community.
Objective 2.2: Educate the public on actions they can take to prevent or reduce the loss of life or property from natural and human made hazards affecting the community.
Objective 2.3: Foster a spirit of trust and cooperation between County government and residents that ensures an ongoing commitment to future mitigation projects and actions.

Goal 3: Build community resilience through the adoption of building, construction, and development standards for existing and new development and critical infrastructure.

Objective 3.1: Reduce losses and repetitive damages from chronic hazard events by promoting insurance coverage.
Objective 3.2: Use cost-effective mitigation actions and projects to minimize risk and potential damage to existing infrastructure, critical facilities, and community lifelines.
Objective 3.3: Ensure development is consistent with building codes that minimizes risk to human life and damage to property.
Objective 3.4: Assess unsafe and uninhabitable repetitive loss properties and structures and implement measures to protect public health and safety.
Objective 3.5: Adopt latest version of building codes.

Goal 4: Build local capacity and commitment to adapt to the natural and non-natural hazards and changing conditions affecting the community.

Objective 4.1: Build and support local partnerships to increase resilience to natural and human-made hazards affecting the community.
Objective 4.2: Provide information on tools, partnership opportunities, and funding resources to assist in implementing mitigation efforts before, during, and after emergencies and disasters.

Objective 4.3: Ensure adequate plans, training, exercise, and resources are made available to partner agencies that support preparedness, response, mitigation, and recovery efforts.
Objective 4.4: Partner with volunteer organizations to assist in safeguarding the community before, during, and after a disaster.
Objective 4.5: Partner with County departments to ensure hazard mitigation is incorporated into County plans and operations (i.e. budgeting, planning, and zoning).
Objective 4.6: Ensure public infrastructure and critical facilities are adequately designed and protected to withstand the hazards affecting the community.
Objective 4.7: Collect and share accurate and timely data on hazards in Anne Arundel County to help build community resilience.

Goal 5: Prioritize funding for hazard mitigation projects that maximizes the investment of County and grant-funded projects.
Objective 5.1: Strengthen communication between public agencies, citizens, non-profit organizations, businesses, and industry to engage the whole community in the mitigation process.
Objective 5.2: Maximize the use of County and grant funding that prioritizes mitigation actions in high-risk natural hazard areas.
Objective 5.3: Encourage community participation in hazard mitigation projects in high-risk natural hazard areas.
Objective 5.4: Encourage continuity of operations plans among County government and partner agencies to ensure essential services, critical facilities, and community lifelines are available during emergencies or disasters.
Objective 5.5: Evaluate critical infrastructure to harden and improve security.

Goal 6: Reduce the potential impact of natural hazards on the County's historic assets.
Objective 6.1: Identify and protect historic assets throughout the County that are at risk from natural hazards.

Goal 7: Reduce the potential impact of natural hazards on the County's natural systems.
Objective 7.1: Balance natural resource management and land use planning with natural hazard mitigation techniques.
Objective 7.2: Preserve, rehabilitate, and enhance natural ecosystems that serve to protect property and mitigate the effects of natural hazards on the community.

Goal 8: Protect public infrastructure.
Objective 8.1: Incorporate data from sea level rise, climate change projections, and other related studies into the design and rebuild of public infrastructure projects when substantial improvements or investments are undertaken by the County.
Objective 8.2: Utilize the results of the various studies (i.e. sea level rise, roadway vulnerability, community adaptation, and other applied research efforts) to prioritize the at-risk public infrastructure and ensure emergency services are capable of responding during emergencies or disasters.
Objective 8.3: Ensure the design of new bridges and culvert infrastructure are capable of withstanding the effects of future hazards affecting the community.

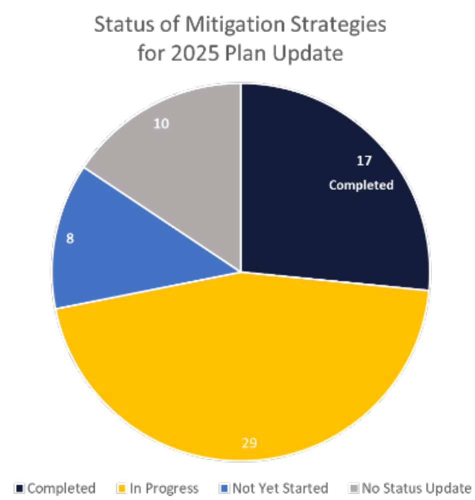
Goal 9 Integrate plan and policies across disciplines and agencies within the County through the consideration of potential hazards and future development.

Objective 9.1: Integrate hazard mitigation into areas such as land use, transportation, climate change, natural and cultural resource protection, water resources, and economic development.
Objective 9.2: Collaborate with partner agencies to develop plans, mitigate hazards, and recover from emergencies and disasters affecting the community.
Objective 9.3: Integrate the new 2025 Hazard Mitigation Plan into existing plans, policies, codes, and programs that assist to guide development.

5.3 Status of 2018 Mitigation Actions

Mitigation Action items included in the 2018 Plan were reviewed by lead departments and received a status update. These updates were presented to HMPC members:

- 65 Mitigation Action Items were reviewed
- 17 "Completed"
- 29 "In Progress"
- 8 "Not Yet Started"



Action items **completed** in the previous 5 year planning cycle are shown below:

- Acquire repetitively flooded structures and non-repetitive loss structures
- Cape St. Claire-Stormwater Runoff Controls
- Create a plan for cooling centers and shelters
- Create and build upon cooperative relationships with news media outlets for distributing information about All Hazards and future HMP updates
- Create cooperative relationships with news outlets for distributing information about winter storms
- Develop coordinated interagency debris removal plan
- Encourage citizens and County personnel to take CERT course
- Ensure adequate plans, procedures, and capabilities to respond to a dam failure
- Establish a relationship with BGE to reduce power outages
- Harmans Road Culvert replacement
- Identify roles and responsibilities of County response agencies
- IPAWS certification
- Maintain public awareness and education campaigns for all hazards
- NWS StormReady program
- Promote use of NOAA "All Hazards" radios for early warning and post-event information to critical facilities
- Shipley's Choice Dam Rehab
- Update General Development Plan, Plan 2040

The complete 2018 Mitigation Action Update is available in Appendix H.

5.4 New Mitigation Actions

Mitigation strategies in the form of action items address the goals and objectives developed by the HMPC. Mitigation strategies have been developed with County and municipal capabilities and gaps in mind, which were identified in Section 4: Capability Assessment.

Mitigation action items were developed throughout the planning process. Opportunities provided to HMPC to develop and submit mitigation ideas throughout this plan update included, but were not limited to:

- Following review of the Mitigation Status Report both incomplete and new mitigation ideas were collected
- During the drafting of the hazard profiles included in Section 3 Risk Assessment
- During the identification of local capabilities as included in Section 4 Capability Assessment
- Responses gathered from the SurveyMonkey public survey
- During HMPC meetings and topical small group meetings (i.e., Floodplain Management, Social Vulnerability)
- Direct feedback from community engagement
- During HMPC review of the draft plan components
- During and following the Mitigation Solutions Workshop

Mitigation ideas collected throughout the planning process were kept as a master listing for reference during the development of mitigation strategies.

5.4.1 Mitigation Solutions Workshop

The Mitigation Solutions Workshop was a culminating event of the planning process. HMPC members were able to attend an all-day workshop at MDEM in order to review and modify existing goals and objectives, as well as develop existing or new mitigation action items for inclusion in the plan update.

Mitigation action item worksheets were developed prior to the workshop and completed to the greatest extent feasible before the workshop. At least two mitigation action items were developed for each hazard. Committee members worked in 5 small groups, based on hazards. To the extent possible committee members were grouped based upon their professional position and individual expertise. Committee members reviewed action items in the following groups:

- **Group 1:** Flood, Dam Inundation, Coastal Hazards
- **Group 2:** Hurricane, Tropical Storm, and Nor'easter, Winter Storm, Thunderstorm, Tornado
- **Group 3:** Public Disorder & Active Assailant, Transportation Accidents, Cyber Attack, Emerging Infectious Diseases
- **Group 4:** Drought, Extreme Temperatures, Wildfire
- **Group 5:** Soil Movement, Earthquake, Erosion

Pictures (top and bottom): Participants attend the Mitigation Solutions Workshop held on February 26, 2025, at MDEM. They worked in 5 small groups to review goals and objectives and develop new mitigation strategies.
Source: SP&D.

5.4.2 Public Preference for Mitigation Actions

In addition to the expertise and guidance of stakeholders, results from the public survey (see Appendix E: *Public Survey Results*) were considered in the development of mitigation action items. The public indicated a strong desire for the following 5 types of mitigation projects. Associated with each of these preferences are action items that were developed that address these preferences.

1. **Work on improving damage resistance of utilities (electricity, communications, water/sewer, etc.)**
   Related Action Items:
   - FL-5, FL-10
   - CH-2
   - DF-3
2. **Retrofit infrastructure, such as elevating roadways and improving drainage systems.**
   Related Action Items:
   - FL-7, FL-8, FL-9, FL-11
3. **Inform property owners of ways they can mitigate damage to their property.**

Related Action Items:

- FL-2, FL-3
- CH-3, CH-4
- HTN-1, HTN-2
- D-1, D-2
- EQ-1
- ET-1
- SWS-1
- WF-1
- SM-2

4. **Replace inadequate or vulnerable bridges.**
5. **Retrofit and strengthen essential facilities such as police, fire, emergency medical services, hospitals, schools, etc.**

Related Action Items:

- CH-1, CH-6
- EQ-2
- TH-1
- SWS-2
- AH-2

5.4.3 Mitigation Action Items

In total, HMPC members working in these groups reviewed 63 mitigation action items. Of these, 46 action items were further developed for inclusion in the plan update. The HMPC also added 6 new mitigation action items – 3 flood, 1 tornado, and 2 erosion action items. Therefore, **52 mitigation action items** are included as part of the 2025 mitigation strategy.

These 52 action items are included in tables at the end of this section **(beginning on page 17).** For each action item, the following relevant information is included:

1. Primary Hazard
2. Associated Goals and Objectives,
3. Action Type
4. Implementation Schedule, i.e., ongoing, short-term (1-3 years), mid-term (3-5 years), and long-term (5+ years)
5. Estimated Cost
6. Potential Funding
7. Lead Entity
8. FEMA Community Lifeline(s)
9. Social Vulnerability
10. Jurisdiction(s)
11. Action Item Description/Background

5.5 Prioritization of Mitigation Actions

During the Mitigation Solutions Workshop each of the 5 groups were asked to identify 3 action items that resonated with them the most. These 3 action items were selected for further prioritization. Prioritization of these action items was based upon a modified STAPLEE evaluation criterion. **STAPLEE** considers: **S**ocial, **T**echnical, **A**dministrative, **P**olitical, **L**egal, **E**conomic, and **E**nvironmental factors.

The method was modified to a more user-friendly survey that consists of 6 questions that correspond to a point system for prioritization purposes. There were a total of **19 action items** selected for further prioritization. Individually, participants completed the 6 STAPLEE questions for each of these action items.

Prioritizing Selected Mitigation Actions		
Answer Yes, No, or Null to Each Question		**Circle One**
Project Number ______	**1. Do you think there would be community acceptance/general support for this mitigation project?**	**Yes No Null**
	2. Do you think implementation of this mitigation project will enhance the health and safety of the community?	**Yes No Null**
	3. Do you think the community will be able to sufficiently staff and/or provide technical support to implement this mitigation project?	**Yes No Null**
	4. Do you think the benefits of this mitigation project will exceed the likely costs?	**Yes No Null**
	5. Do you think the maintenance requirements for this option will be affordable and not provide an undue burden on the County?	**Yes No Null**
	6. Is this project consistent with environmental goals?	**Yes No Null**

ADD PROJECT NUMBER HERE

Example of prioritization questions (modified STAPLEE) for action items. This process was completed by each workshop participant for all 19 selected action items.

Results of the prioritization process are included in Table 5.1.5-1. The 19 selected action items are sorted from highest priority to lowest priority (e.g., high, medium-high, medium, low).

Table 5.1.5-1 Action Item Prioritization Results

Action Item	Priority
ET-2: Minimize the impact of extreme temperatures on vulnerable populations by notifying the public of the opening of warming and cooling centers and promoting their use with Dept of Aging, Dept of Social Services, Dept of Health, and other agencies that provide services to socially vulnerable groups.	**HIGH**
AH-4: Develop a Countywide Continuity of Operations Program.	**HIGH**
FL-8: Prioritize at-risk pumping station identified in the State of Maryland Flood Risk Report (12/31/2019) for retrofits.	**HIGH**
ER-1: Continue working with partners (e.g., Chesapeake Bay Trust, City of Annapolis, Department of Natural Resources, and local watershed groups) to prioritize identified riparian and shoreline buffers in need of restoration. Identify potential new partners as needed.	**HIGH**
FL-9: Prioritize at-risk facilities for retrofits identified in the State of Maryland Flood Risk Report (12/31/2019).	**HIGH**
CH-4: Continue outreach to coastal flood prone communities.	**MEDIUM-HIGH**
CH-3a: Continue to implement construction standards that protect private wells from the hazards and impacts from saltwater intrusion and flooding. **Ch-3b:** Implement outreach and planning to connect households and businesses to	**MEDIUM-HIGH**

Table 5.1.5-1 Action Item Prioritization Results

Action Item	Priority
public sewer in communities identified as an on-site wastewater problem area. **CH-3c:** Implement outreach and planning to connect households and businesses to public water in communities identified as a water quality problem area.	
HTN-1: Collaborate with BGE to educate property owners on tree removal and trimming to prevent power outages during a high wind event resulting from hurricane, tropical storm, and nor'easter. Educate the public about securing debris, propane tanks, yard items, or stored objects that may otherwise be swept away, damage, or pose a hazard to people and property during high wind event.	MEDIUM-HIGH
TH-1: Survey prioritized critical facilities to determine the status of grounding and surge protection capabilities for each facility. a. Identify which critical facilities are lacking and/or need additional grounding protection. b. Survey outside grounding and inside surge protection capabilities simultaneously. c. Prioritize critical facilities from highest to lowest for upgrades.	MEDIUM-HIGH
SWS-2: Review listing of essential facilities and determine the status of backup generators for each one. Prioritize facilities without generators or those with undersized generators for new generators or replacements	MEDIUM-HIGH
EID-2: Increase ongoing and long-term health-related public outreach efforts throughout the County as population, tourism, and development continue to grow as projected.	MEDIUM
FL-7: Prioritize and support flood mitigation structure and infrastructure projects in Shady Side Peninsula.	MEDIUM
DF-2: Prioritize the 16 critical facilities and community lifelines that have been identified as within the inundation areas of two high hazard potential dams, Liberty Dam and Duckett Dam.	MEDIUM
FL-2: Conduct targeted public outreach (including mailers) to the current Repetitive Loss Property listing. Also consider outreach to adjacent properties in these areas and other highly impacted areas including Spit Neck along Back Creek and Main Creek, Selby on the Bay, and Shadyside-Deale Peninsula.	MEDIUM
D-2: Encourage the use of drought resistant landscaping in public and private properties.	MEDIUM
WF-1: Encourage principals of "defensible space" in the WUI for new and existing development to help reduce the potential for wildfires to spread to structures.	LOW
ER-2: Implement recommendations of the South County Coastal Resilience Beneficial Reuse Study.	LOW
PDAA-2: Evaluate public buildings and facilities for emergency response protocols. Future designs could incorporate the following: more lighting systems in public places, increased pedestrian and bicycle traffic, utilization of vacant land, increased video imaging for public safety, increased red light traffic cameras, increased security of homes and commercial space.	LOW
ER-3: Assessment, protection, and/or documentation of historic, cultural resources at risk to erosion.	LOW

5.6 Integrating Mitigation into Existing Plans & Procedures

Through effective communication of the hazard mitigation opportunities and benefits that exist in communities, local leaders and elected officials can achieve agreement on efforts to integrate hazard mitigation into local planning. Educating jurisdictional leadership, staff, and community members about the benefits of mitigation actions is the best way to ensure seamless integration between mitigation planning and other local planning efforts.

Anne Arundel County will continue to work on developing strategies and opportunities to better incorporate mitigation actions from the 2025 HMP update into ongoing local planning activities. Additionally, the County has identified approaches to promote the integration of action items included in the 2025 HMP update into local planning mechanisms.

The primary means for integrating mitigation strategies into other local planning mechanisms will be the revision, updating, and implementation of plans that require specific planning and administrative tasks (for example, plan amendments, ordinance revisions, and capital improvement projects).

The HMPC will be responsible for ensuring that the goals and strategies of new and updated local planning documents are consistent with the goals and actions of the 2025 HMP update and will not contribute to increased hazard vulnerability in the County.

A best practice while updating other community plans, such as a comprehensive plan, capital improvement plan, or emergency management plan, is for OEM to provide a copy of the 2025 HMP update to the appropriate parties. This will ensure that plans are integrated, and all goals and strategies of new and updated local planning documents are consistent with and support the goals of the 2025 HMP update.

5.7 Action Plan for Implementation and Integration

Several notable challenges and missed opportunities to incorporate hazard mitigation into local planning efforts have been identified by FEMA, including the following:

- Hazard mitigation plans are often developed or updated without the active participation or leadership of local planning and community development staff.
- Local land use planners are less willing to embrace hazard mitigation planning as falling within their professional purview.
- Hazard mitigation plans often include mitigation strategies or actions that are focused on a disconnected series of emergency services, structure or infrastructure protection projects, and public outreach initiatives, with less emphasis on non-structural measures available through local land use planning or policy alternatives.
- Hazard mitigation plans are typically completed as stand-alone documents that cover multiple jurisdictions, and it is relatively uncommon for them to be directly linked or integrated with other community-specific planning tools such as comprehensive land use plans and development regulations.

To combat these challenges, increase accountability, and more clearly identify how Anne Arundel County and the Town of Highland Beach will incorporate the hazard mitigation risk assessment and goals into existing plans and procedures, participants completed an Action Plan for Hazard Mitigation Implementation and Integration assessment during the planning process (refer to *Section 6 Plan Maintenance*). Participants identified which existing plans and procedures they would work to incorporate mitigation into and provided a brief action plan for how this will be achieved.

5.8 Implementation Resources & Funding Opportunities

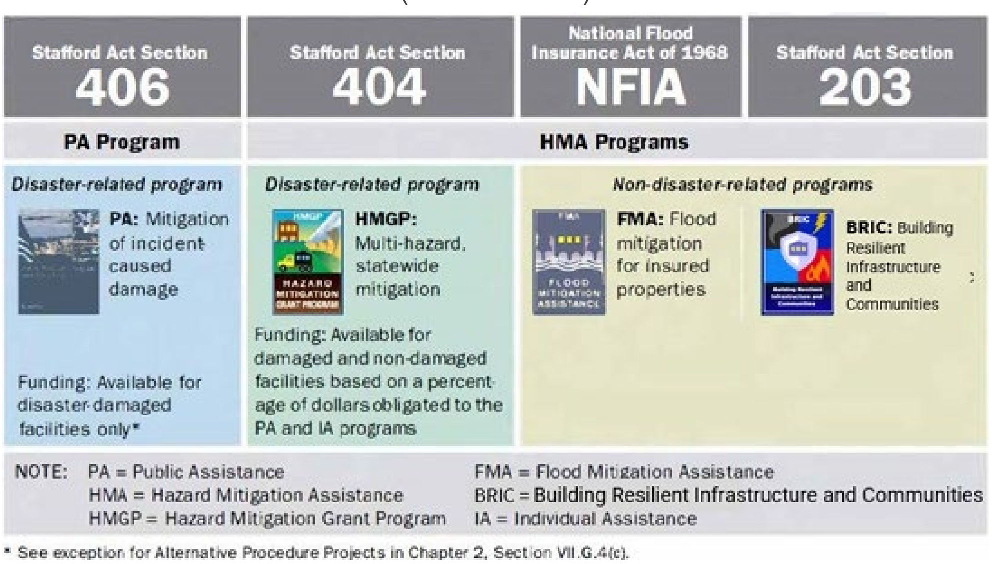
Determining current and/or potential implementation resources and funding opportunities for each identified action item is a vital part of the mitigation strategy planning process. By exploring, identifying, and designating funding sources now, the County will be poised to complete identified action items as implementation and funding opportunities arise.

Under 44 CFR §201.6, local governments must have a FEMA-approved local mitigation plan in order to apply for and/or receive hazard mitigation project grant funds for the following federal Hazard Mitigation Assistance (HMA) programs:

- Hazard Mitigation Grant Program (HMGP)
- Building Resilient Infrastructure and Communities (BRIC)
- Flood Mitigation Assistance (FMA)
- Repetitive Flood Claims (RFC)
- Severe Repetitive Loss (SRL)

FEMA funding programs for cost-effective hazard mitigation for facilities damaged by natural disasters which are eligible under the Stafford Act, HMA and National Flood Insurance Act of 1968 are illustrated in Figure 5.1.8-1

Figure 5.1.8-1 Federal Policies That Provide Funding for Local Hazard Mitigation
(Source: FEMA)



Mitigation activities can and should be implemented through a variety of funding streams. FEMA funding sources, including the Hazard Mitigation Grant Program (HMGP), the Building Resilient Infrastructure and Communities (BRIC) program, the Flood Mitigation Assistance (FMA) program, and Sections 404 and 406 of Hazard Mitigation Funding tend to be relied on heavily for mitigation action completion. However, it is important to research and leverage other available funding opportunities and not to limit funding sources to FEMA assistance programs. Funding opportunities may include other federal agencies, as applicable, or private funding. In addition to funding, mitigation implementation resources such as regulatory and technical assistance are available to assist jurisdictions in completing action items and integrating mitigation into planning and resilience efforts.

Coronavirus (COVID-19) relief funds were distributed by the United States Congress to federal, state, and local government agencies, nonprofit organizations, and individuals in 2020 and 2021. The main funding programs were the Coronavirus Aid, Relief, and Economic Security (CARES) Act (2020), the Coronavirus Response and Consolidated Appropriations Act (2021), and the American Rescue Plan Act (ARPA) (2021). These funds have a broad range of allowable expenses, including supporting public health expenditures, replacing lost public sector revenue, and investing in water, sewer, broadband, and cybersecurity infrastructure. Within these overall categories, recipients have broad flexibility to decide how best to use this funding to meet the needs of their communities. As of December 2021, $350 billion has been allocated to states, counties, cities, tribal governments, territories, and non-entitlement units of local government.

Another recent influx in federal funds that can be used for mitigation actions is the Infrastructure Investment and Jobs Act which was passed by Congress on November 6, 2021. This once-in-a- generation investment in infrastructure includes legislation that addresses repairing and rebuilding roads and bridges with a focus on climate change, mitigation, and resilience, and making the nation's infrastructure resilient against the impacts of climate change, cyberattacks, and extreme weather events. The methods by which this legislation will be implemented were still being determined at the time this Plan was written.

Hazard Mitigation Grant Program (HMGP) is authorized under section 404 of the Robert T. Stafford Act and 44 C.F.R. part 206. The purpose of HMGP is to provide funds to states, territories, Indian tribal governments, and communities to significantly reduce or permanently eliminate future risks to lives and property from natural hazards. Entities pursuant of HMGP funding must have fully participated in a FEMA-approved hazard mitigation plan.

HMGP funds are 15% of the federal share of a federally declared presidential disaster and are broken down into three categories:

- 5% initiative projects
- 7% plan development and revision
- 88% regular projects

The grant application period is open for 12 months after the declaration date. All applications are made through, reviewed by the State, and approved by FEMA.

Flood Mitigation Assistance Program (FMA) is a competitive grant program that provides funding to states, territories, and Indian tribal governments. FMA funds can be used for projects that reduce and/or eliminate the risk of repetitive flood damage to buildings insured by the National Flood Insurance Program (NFIP).

Its purpose is to implement cost-effective measures that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insured under the NFIP. The FMA funds planning activities that assess a community's flood risk and identify actions to reduce risk. Additionally, FMA funds property acquisitions, structure demolitions, and structure relocations, along with other flood mitigation activities.

Building Resilient Infrastructure and Communities (BRIC) is the newest FEMA pre-disaster hazard mitigation program that replaced the Pre-Disaster Mitigation (PDM) program. FEMA opened the first application period for the FY2020 Notices of Funding Opportunities that included BRIC.

BRIC supports communities through capability- and capacity-building, encouraging and enabling innovation, promoting partnerships, enabling large projects, maintaining flexibility, and providing consistency.

Priorities are to incentivize public infrastructure projects and projects that mitigate risk to one or more community lifelines, incentivize projects that incorporate nature-based solutions, and increase funding to applicants that facilitate the adoption and enforcement of the latest published editions of building codes.

Primary Hazard: Flood								
Goal(s): 3, 4, 5 **Objective(s): 3.1, 3.2, 3.3, 4.1, 4.2, 5.2**								
Project FL-1	**Action Type**	**Implementation Schedule**	**Estimated Cost**	**Potential Funding**	**Lead**	**Community Lifeline**	**Social Vulnerability**	**Jurisdiction(s)**
	Planning and Regulation	Short-term (1 to 3 years) FY' 2026	$75,000 plus fringe	HMA grants (incl. HMGP, BRIC, FMA)	OEM	Safety and Security	Those within the floodplain or in repetitive loss areas.	County, Highland Beach
	Action: Determine the feasibility of hiring a dedicated member of staff to administer the Community Rating System in order to advance the County's CRS status.							
	Background and/or Plan Reference: The National Flood Insurance Program (NFIP) Community Rating System (CRS) was implemented in 1990 as a voluntary program for recognizing and encouraging community floodplain management activities that exceed minimum NFIP standards. Any community fully compliant with NFIP floodplain management requirements may apply to join the CRS. Under the CRS, flood insurance premium rates are discounted to reward community actions that meet the three goals of the CRS: 1. Reduce flood damage to insurable property 2. Strengthen and support the insurance aspects of the NFIP 3. Encourage a comprehensive approach to floodplain management A community accrues points to improve its CRS Class rating and receive increasingly higher discounts. Points are awarded for engaging in any of 19 creditable activities, organized under four categories: 1. Public Information 2. Mapping and Regulations 3. Flood Damage Reduction 4. Warning and Response Community actions as listed above require time and effort that is best suited for a dedicated staff position that can manage said activities. Additionally, applying for the CRS is time consuming and may require a dedicated position.							

Primary Hazard: Flood								
Goal(s): 1, 2 Objective(s): 1.1, 1.3, 2.1, 2.2, 2.3								
Project FL-2	Action Type	Implementation Schedule	Estimated Cost	Potential Funding	Lead	Community Lifeline	Social Vulnerability	Jurisdiction(s)
	Education and Awareness	Short-term (1 to 3 years)	Staff time, printing costs for physical material	BRIC, HMGP, FMA grant	OEM	Safety and Security	N/A	Repetitive Loss Property Owners
	Action: Conduct targeted public outreach (including mailers) to the current Repetitive Loss Property listing. Also consider outreach to adjacent properties in these areas. Highly impacted areas include Spit Neck along Back Creek and Main Creek, Selby on the Bay, and Shadyside-Deale Peninsula.							
	Background and/or Plan Reference: The County can use a combination of direct mailings, neighborhood meetings, public information campaigns, and personalized consultations to notify property owners about their flood risk, potential mitigation solutions, and available grant programs, while respecting privacy concerns by avoiding specific identification of individual properties as "repetitive loss" due to privacy laws; this can include utilizing FEMA data to identify these areas without disclosing individual property details. This effort should also educate people on why they need flood insurance even if their residence is already paid. As of July 30, 2024, Anne Arundel County has 100 residential repetitive loss properties in the NFIP database. **Table 3.3.1-7 (refer to section 3.3.1)** provides basic NFIP residential repetitive loss statistics, sorted by the total number of residential repetitive loss properties in each community. Table 3.3.1-7 indicates that Pasadena has the highest number of repetitive loss properties in Anne Arundel County. As of July 2024, Pasadena had a total of 36 repetitive loss properties (up from 29 in the 2018 plan). The table shows that Pasadena is followed by Edgewater and Shady Side with 19 and 11 repetitive loss properties, respectively. Edgewater has less total RLP than Pasadena but has higher building values and average claim values than Pasadena. Total repetitive loss properties for all three top communities have increased, in some cases doubled, in the last 5-year planning period. Note: RLP are eligible for BRIC, HMGP, FMA grant programs – FMA specifically geared towards these types of properties. **See Section 3.3.16 page 3-9 for more information about RLP in the County and included Map 3.3.1-2 for general locations of RLP. Additionally, Table 3.3.1-7 summarizes RLP by community, building value, claims, and more.**							

Primary Hazard: Flood								
Goal(s): 2, 3, 4 **Objective(s): 2.1, 2.2, 3.3, 4.2, 4.7**								
Project FL-3	**Action Type**	**Implementation Schedule**	**Estimated Cost**	**Potential Funding**	**Lead**	**Community Lifeline**	**Social Vulnerability**	**Jurisdiction(s)**
	Planning and Regulations	Short-term (1 to 3 years)	Staff time	County budget	OEM	Safety and Security	N/A	County
	Action: Expand flood-related information on the County's website to include more floodplain management and permitting information. E.g., Permit application, links to state and federal floodplain mapping, insurance programs.							
	Background and/or Plan Reference: The County has a wealth of flood-related information throughout its website, but it would be beneficial to have this information in a central location (i.e., on the same landing page) for ease of access. A good source of information that the County could cross-reference for new topics to add to its flood webpage would be capabilities as identified in the FEMA "Checking In On the NFIP" worksheets completed for this plan update. Topics include Floodplain Identification and Mapping, Floodplain Management, and Flood Insurance. Generally, the floodplain management webpage should include information on: floodplain maps, regulations governing development within floodplains, permit applications for construction in flood zones, flood insurance information, educational materials about flood risks, mitigation strategies, contact details for floodplain management staff, and details about local flood hazards and historical flood events; essentially providing residents and developers with a comprehensive understanding of their flood risk and how to manage it within their property. **FEMA "Checking In On The NFIP" worksheets are included in the capabilities section of this plan.**							

Primary Hazard: Flood								
Goal(s): 1, 3, 4 Objective(s): 1.2, 3.2, 3.4, 4.2, 4.3								
Project FL-4	Action Type	Implementation Schedule	Estimated Cost	Potential Funding	Lead	Community Lifeline	Social Vulnerability	Jurisdiction(s)
	Planning and Regulations	Within next 5 year planning period	$250,000	FEMA HMGP	OEM	Safety and Security	N/A	County
	Action: Implement a flood drill within the next five years that internally tests and evaluates response procedures based on Homeland Security Exercise and Evaluation Program (HSEEP) and include an After-Action Report/Improvement Plan (AR/IP).							
	Background and/or Plan Reference: To conduct an HSEEP compliant flood drill, the County will follow the Homeland Security Exercise and Evaluation Program guidelines by planning the exercise with clear objectives, designing a realistic flood scenario, assigning roles and responsibilities, evaluating internal response actions, and creating a detailed After-Action Report/Improvement Plan (AAR/IP) to identify areas for improvement and implement corrective actions. The goals of an HSEEP compliant flood drill are to test and evaluate the effectiveness of the County's flood response plans, procedures, and capabilities by simulating a flood scenario, identifying potential gaps in preparedness, and highlighting areas for improvement in personnel response, resource allocation, communication, and coordination; all while adhering to the standardized exercise design and evaluation framework outlined by the HSEEP) FEMA has readily available materials for conducting HSEEP compliant flood drills including a Preparedness Toolkit (https://preptoolkit.fema.gov/), Exercise Best Practice Guides (including virtual exercises), HSEEP Video Series, and more, **Review the FEMA HSEEP Information Sheet (2020) for more information about compliance.**							

Primary Hazard: Flood

Goal(s): 3, 5, 8

Objective(s): 3.2, 3.4, 5.2, 5.5, 8.1, 8.2, 8.3

Project FL-5

Action Type	Implementation Schedule	Estimated Cost	Potential Funding	Lead	Community Lifeline	Social Vulnerability	Jurisdiction(s)
Structure and Infrastructure	Short-term (1 to 3 years)	At least $1 million	US Eco Devo Administration Public Works program, FEMA HMA program	Public Works	Water Systems, Hazardous Materials	N/A	County

Action: Fixed hazmat storage sites and sewer pump stations within the 100 year floodplain have been identified by their depth of flooding. Facilities with high depth of flooding (identified in Table 3.3.1-8) should be prioritized for investigation.

Background and/or Plan Reference: Critical facilities and community lifelines within the riverine 1 percent annual chance floodplain have been determined for this plan update. These facilities and detailed information have been included in **Table 3.3.1-8 (refer to handout)**.

The County has an extensive critical facility and community lifeline database, of which little is within the special flood hazard area. The facilities that are within the floodplain include fixed hazmat storage sites and sewer pump stations. Facilities with the highest flood depths are highlighted in yellow on Table 3.3.1-8. These facilities should be prioritized for determination of their current mitigation status and to decide if additional action is necessary. These facilities and their depth of flooding are mapped on **Map 3.3.1-4 (refer to handout).** Darker blue areas indicate higher depth of flooding.

Sewer pump stations that have the highest depth of flooding should be prioritized first, which include the following two stations:

Facility Name	Address	City	SFHA	Flood Depth
Patapsco Park SPS	200 Shenandoah Ave	Linthicum Heights	Zone AE	9.3 ft
Patapsco SPS	6816 Baltimore Annapolis Blvd	Linthicum Heights	Zone AE	7.9 ft

Primary Hazard: Flood								
Goal(s): 7, 8, 9 **Objective(s): 7.1, 7.2, 8.1, 8.2, 9.1, 9.2**								
Project FL-6	**Action Type**	**Implementation Schedule**	**Estimated Cost**	**Potential Funding**	**Lead**	**Community Lifeline**	**Social Vulnerability**	**Jurisdiction(s)**
	Planning and Regulation	Short-term (1 to 3 years) Integration should coincide with next LPPRP ~ 2027	Staff time	County budget	Recreation and Parks, OEM	Planning and Regulations	N/A	County
	Action: Integrate flood hazard mitigation into future Land Preservation Parks and Recreation Plan							
	Background and/or Plan Reference: • During the annual review and reporting of the Anne Arundel County Green Infrastructure Master Plan, update existing actions or add new actions that mitigate flood risk by slowing and reducing stormwater discharges and highlight water quality improvements. The most recent plan was adopted on April 4, 2022. • Overlay the Greenway Master Plan with the 1-percent-annual chance floodplain and parcel data to generate a list of flood prone properties. OEM will facilitate the request. Any new structures would have to meet FEMA requirements. • Ensure access to boat ramps for emergencies or to pull boats.							

Primary Hazard: Flood								
Goal(s): 3, 5, 7, 8 Objective(s): 3.2, 5.2, 5.5, 7.1, 8.1, 8.2, 8.3								
Project FL-7	**Action Type**	**Implementation Schedule**	**Estimated Cost**	**Potential Funding**	**Lead**	**Community Lifeline**	**Social Vulnerability**	**Jurisdiction(s)**
	Structure and Infrastructure	Next 5 year planning period (schedule is different for each identified project)	Cost is project dependent (based on size and location(s))	MD CoastSmart Communities Initiative	Public Works	Safety and Security, Transportation	N/A	County, specifically Deale-Shady Side Peninsula
	Action: Prioritize and support flood mitigation structure and infrastructure projects in Shady Side Peninsula.							
	Background and/or Plan Reference: Projects: • Shady Side Peninsula Improvements: Tide Gates • Shady Side Peninsula Improvements: Stormwater Conveyance • Shady Side Peninsula Improvements: Compound Flood Mitigation Project • Shady Side Peninsula Improvements: Road Raising • Shady Side Peninsula Improvements: Cedarhurst and Franklin Manor Chesapeake Dr Resiliency Plans Additionally, recommendations from the **Deale-Shady Side Peninsula Climate Adaptation Study** should be integrated into future annual updates of this Hazard Mitigation Plan. The Sea Level Rise on the Deale-Shady Side Peninsula Feasibility Study will determine cost-effective, feasible mitigation strategies that enhance resilience of the Peninsula in the face of increasing flood inundation levels and storm event intensities/frequencies associated with a changing climate.							

Primary Hazard: Flood

Goal(s): 3, 5, 8

Objective(s): 3.2, 3.4, 5.2, 5.5, 8.1, 8.2

	Action Type	Implementation Schedule	Estimated Cost	Potential Funding	Lead	Community Lifeline	Social Vulnerability	Jurisdiction(s)
Project FL-8	Structure and Infrastructure	Medium-term (3 to 5 years)	$15,000 to $400,000 depending site and scale of retrofits	HMA grants (incl. HMGP, BRIC, FMA)	Public Works	Safety and Security, Transportation	N/A	County

Action: Prioritize at-risk pumping station identified in the State of Maryland Flood Risk Report (12/31/2019) for retrofits.

Background and/or Plan Reference: Pumping station retrofits involves upgrading an existing water or sewer pumping station by replacing outdated components like pumps, controls, piping, or structural elements to improve efficiency, reliability, and overall performance, often including updates to address issues like increased flow capacity, energy consumption, or aging infrastructure, while minimizing the need for complete demolition and reconstruction of the station itself.

Identified locations:

- **Deale Pumping Station retrofits:** At-risk facility to a 1% annual-chance flood event.
  - Projection of a 2.3 ft inundation level.
- **Crofton Freshwater Pumping Station retrofits:** At risk facility to a 1% annual-chance flood event.
  - Projection of a 5.7 ft inundation level.
- **Severn Run State Park Freshwater Pumping Station retrofits:** At risk facility to a 1% annual-chance flood event.
  - Projection of a 1.0 ft inundation level.

<table>
<tr><td colspan="9">Primary Hazard: Flood</td></tr>
<tr><td colspan="9">Goal(s): 3, 5, 8
Objective(s): 3.2, 3.4, 5.2, 5.5, 8.2, 8.3</td></tr>
<tr><td rowspan="4">Project
FL-9</td><td>Action Type</td><td>Implementation Schedule</td><td>Estimated Cost</td><td>Potential Funding</td><td>Lead</td><td>Community Lifeline</td><td>Social Vulnerability</td><td>Jurisdiction(s)</td></tr>
<tr><td>Structure and Infrastructure</td><td>Steps can be achieved in the next 1-5 years and projects can continue into the long-term (5+ years)</td><td>Highly dependent on location of project and extent of retrofits</td><td>HMA grants (incl. HMGP, BRIC, FMA), NFIP</td><td>Public Works</td><td>Safety and Security, Transportation</td><td>Aged 65 and older in Bayside Beach community</td><td>County, Bayside Beach (community)</td></tr>
<tr><td colspan="8">Action: Prioritize at-risk facilities for retrofits identified in the State of Maryland Flood Risk Report (12/31/2019).</td></tr>
<tr><td colspan="8">Background and/or Plan Reference: Facility retrofits include measures like elevating the building structure, relocating critical equipment to higher levels, installing floodwalls or barriers, waterproofing lower levels, sealing utility lines, and considering site modifications like drainage improvements, all while consulting with a professional engineer to assess the specific flood risk and design the most appropriate mitigation strategies based on your location and building characteristics.

Identified locations:

Shadyside-Holly Avenue retrofits: At risk facility to a 1% annual-chance flood event.
Projection of a 0.5 ft inundation level.
Severn-Clark Station-Burns Crossing Road retrofits: At risk facility to a 1% annual-chance flood event.
Projection of a 0.7 ft inundation level.
Bayside Beach High Risk Area project scoping and retrofits: Community at risk to a 1% annual-chance flood event.
Projection of a 1.0 ft inundation level.
Hanover-Dorsey Road Recreation Area retrofits: At-risk facility to a 1% annual-chance flood event.
Projection of a 2.3 ft inundation level.
Harwood-Sands Road Recreation Area retrofits: At-risk facility to a 1% annual-chance flood event.
Projection of an 8.1ft inundation level.
Tipton Airport retrofits: At-risk facility to a 1% annual-chance flood event.
Projection of a 4.0 ft inundation level.

FEMA has programs and guidelines to help communities and facilities reduce flood damage: FEMA P-312: Provides information on financial assistance for retrofitting projects, including grants, loans, and insurance, Hazard Mitigation Assistance: Provides financial assistance for retrofitting projects, National Flood Insurance Program (NFIP): Offers Increased Cost of Compliance (ICC) coverage to help pay for some retrofitting.</td></tr>
</table>

Primary Hazard: Flood								
Goal(s): 3, 5, 7, 8 **Objective(s): 3.2, 5.2, 7.1, 7.2, 8.1, 8.2**								
Project FL-10	**Action Type**	**Implementation Schedule**	**Estimated Cost**	**Potential Funding**	**Lead**	**Community Lifeline**	**Social Vulnerability**	**Jurisdiction(s)**
	Structure and Infrastructure	Medium-term (3 to 5 years)	$1.5 million	NFWF Chesapeake Small Watershed Grants, National Coastal Resilience Fund	Resilience Authority	Water Systems, Transportation	Historic African American beach	County - Columbia Beach (Community)
	Action: Implement community-wide stormwater infrastructure improvements in Columbia Beach community.							
	Background and/or Plan Reference: This project implements a comprehensive, sustainable, and environmentally resilient upgrade of the stormwater conveyance system in the historically Black community of Columbia Beach, Maryland, and provides a mitigation model suitable for similar communities. The project prioritizes efficient mechanisms to remove stormwater from roads and community property, transfer stormwater and runoff to new or existing holding/infiltration devices and improve water quality before discharge into the Chesapeake Bay. A grant for design, permitting, and construction from NFWF's Chesapeake Small Watershed Grants was awarded for $996,200 and an application with the National Coastal Resilience Fund for the remainder of this $1,566,049.31 project is under development. An application for gap funding is also pending before MD DNR to mitigate flooding exacerbated by climate change and community growth in this diverse community of over 140 homes. Contracting is nearly complete, and the project is under way.							

<table>
<tr><th colspan="9">Primary Hazard: Flood</th></tr>
<tr><td colspan="9">Goal(s): 1, 8, 9
Objective(s): 1.2, 1.3, 1.4, 1.5, 8.1, 8.2, 8.3, 9.1, 9.2</td></tr>
<tr><td rowspan="4">Project
FL-11</td><td>Action Type</td><td>Implementation Schedule</td><td>Estimated Cost</td><td>Potential Funding</td><td>Lead</td><td>Community Lifeline</td><td>Social Vulnerability</td><td>Jurisdiction(s)</td></tr>
<tr><td>Structure and Infrastructure</td><td>Short-term (1 to 3 years)</td><td>There are 4 identified project sites – cost is site dependent.</td><td>HMA grants (incl. HMGP, BRIC, FMA), PROTECT grant, Safe Streets for All grant</td><td>Resilience Authority</td><td>Transportation, Water Systems</td><td>N/A</td><td>County</td></tr>
<tr><td colspan="8">Action: Support, to the extent possible, additional exploration for projects related to the following roadways with repetitive flooding issues: MD 450, MD 468 (Shady Side Peninsula), 695/295 Interchange, and H586800 Conway Road.</td></tr>
<tr><td colspan="8">Background and/or Plan Reference:
<u>MD 450:</u> SHA completed a flood study for this segment of MD 450 with long term needs. Looked at non-NBI culverts looking at what the culvert was designed to convey. Identified 3 sites along MD 450 study area. Identified site 1 at mile post 3.21 on 450 and has annual total risk of $84k. Site 2 is a concrete pipe located in a FEMA floodplain. Site 3 in a FEMA floodplain and noted for flooding ~ 23 days per year. Roadway has been problematic for a long time.
<u>MD 468 (on Shady Side peninsula)</u>: This section of MD 468 is a critical piece of public infrastructure serving over 6,000 residents as the only route connecting communities, businesses and public facilities in the northern portion of the Shady Side peninsula to all points south and west. The roadway crosses a tidal tributary and wetland of the West River with very little vertical distance between the roadway surface and mean sea level. Problems at this crossing are further compounded by the presence of gradually sloping land on either side of the tributary that enable high tides to easily inundate a long stretch of roadway. These facts were also highlighted by MDOT SHA in a 2016 roadway vulnerability assessment that found this stretch of roadway was already vulnerable to so-called 100-year flooding events and would only become more vulnerable over the remainder of the century as sea levels rise.
<u>695/295 Interchange:</u> Improve drainage at 695/295 interchange affecting the Linthicum Hills community. Community experiences flooding that has closed Nursery Road in the past, which is the only local route in or out of the community. As an example, the community experienced road closure and pavement crumbling during the big Ellicott City flooding. In the past, the County has put rock in to stabilize and slow the flow of runoff into the community, but it is not effective. The community also reports trees becoming uprooted because of the runoff. The state has provided funding to the County to begin studying a sound barrier at this same location, and the County is working with SHA to do that study which will include a study of the drainage issues. This issue affects an estimated 200+ homes.
<u>Conway Road (H586800):</u> Study looked at inland peninsula with one way in/out, and flooding on Patuxent Rd. First phase is improving Conway Rd to serve community and school (one way in/out) and 2nd phase is a second access.</td></tr>
</table>

<table>
<tr><th colspan="9">Primary Hazard: Coastal Hazards</th></tr>
<tr><td colspan="9">Goal(s): 1, 3, 4, 5
Objective(s): 1.1, 1.2, 1.4, 3.1, 3.2, 3.3, 4.1, 4.2, 5.1, 5.2</td></tr>
<tr><td rowspan="4">Project
CH-1</td><td>Action Type</td><td>Implementation Schedule</td><td>Estimated Cost</td><td>Potential Funding</td><td>Lead</td><td>Community Lifeline</td><td>Social Vulnerability</td><td>Jurisdiction(s)</td></tr>
<tr><td>Structure and Infrastructure</td><td>Short-term (1 to 3 years)</td><td>Cost has to be determined for each project site.</td><td>HMA grants (incl. HMGP, BRIC, FMA)</td><td>Public Works</td><td>Water Systems</td><td>N/A</td><td>County</td></tr>
<tr><td colspan="8">Action: Review listing of community lifelines identified within hurricane storm surge inundation areas and determine which facilities, if any, require additional structural mitigation to protect against storm surge and other coastal hazards.</td></tr>
<tr><td colspan="8">Background and/or Plan Reference: Community lifelines within the hurricane storm surge inundation area (category 1- 5) are identified. Table 3.3.2-13 (section 3.3.2) includes information for these lifelines within storm surge inundation area, including facility type, number of facilities, and estimated improvement value. 214 community lifelines are within storm surge inundation areas.

• 41 are within the category 1 storm surge inundation area (all of these facilities are also within the Special Flood Hazard Area and the 2050 and/or 2100 Sea Level Rise scenarios)
• 69 are within category 2 storm surge inundation area
• 47 are within category 3 storm surge inundation area
• 57 are within the category 4 storm surge inundation area

Note: Of these community lifelines, just three are considered critical facilities by the County. These facilities are Fire & EMS and include Deale Fire Co. 42 (Category 3), USNA Fire Co. 46 (Category 3), and Avalon Shores Fire Co. 41 (Category 2).

Those community lifelines within the category 1 and 2 storm surge inundation area are likely to be impacted by storm surge more frequently than other lifelines. However, due to the changing climate and sea level rise, it is likely that more severe storms will create greater storm surge inundation, which will impact those lifelines in Category 3 and higher.

The review should begin with lifelines within the Category 1 storm surge inundation area, then progress to Categories 2 through 4.

Refer to Table 3.3.2-13 Community Lifelines Within Hurricane Storm Surge Inundation Areas and Table 3.3.4-6 Community Lifelines Within Major (Cat 3+) Hurricane Storm Surge Inundation Areas.</td></tr>
</table>

Primary Hazard: Coastal Hazards								
Goal(s): 1, 3, 4, 5, 6 Objective(s): 1.1, 1.4, 3.1, 3.2, 3.3, 4.1, 4.2, 5.1, 5.2, 6.1								
Project CH-2	Action Type	Implementation Schedule	Estimated Cost	Potential Funding	Lead	Community Lifeline	Social Vulnerability	Jurisdiction(s)
	Structure and Infrastructure	Short-term (1 to 3 years)	Cost has to be determined for each project site.	HMA grants (incl. HMGP, BRIC, FMA)	Public Works	Water Systems	N/A	County
	Action: Review listing of eleven (11) County-owned sewer pump stations that are within multiple coastal hazard zones, including: storm surge inundation, sea level rise, and the coastal Special Flood Hazard Area. These pump stations should be assessed for mitigation action, with priority to those stations with a higher potential depth of flooding.							
	Background and/or Plan Reference: Sewer Pump Stations are listed below, sorted by anticipated depth of flooding caused by a 1% annual chance flood event.							

Station	Location	1% Flood Depth (feet)	Storm Surge Category
Bay Ridge #08	17 River Dr	6.4	Cat 1
River View	3085 Riverview Rd	4.3	Cat 2
Colchester	506 Lymington Rd	4	Cat 1
Krapish	3030 Old Riva Rd	3.9	Cat 1
Round Bay #02	106 Severn River Rd	2.7	Cat 2
Cape Anne	5636 Battee Dr	2.4	Cat 1
Bay Ridge #07	42 E Lake Dr	1.9	Cat 1
Whitehurst	480 White Cedar Ln	1.6	Cat 2
Selby #04	924 Holly Ave	1.1	Cat 1
Cedarhurst	1187 Holly Ave	0.5	Cat 1
Holly Hills #1	3824 Twin Oak Dr	0.5	Cat 1

<table>
<tr><th colspan="9">Primary Hazard: Coastal Hazards</th></tr>
<tr><td colspan="9">Goal(s): 7, 8, 9
Objective(s): 7.1, 7.2, 8.1, 8.2, 8.3, 9.1, 9.2</td></tr>
<tr><td rowspan="4">Project
CH-3</td><td>Action Type</td><td>Implementation Schedule</td><td>Estimated Cost</td><td>Potential Funding</td><td>Lead</td><td>Community Lifeline</td><td>Social Vulnerability</td><td>Jurisdiction(s)</td></tr>
<tr><td>Structure and Infrastructure, Education and Awareness</td><td>Ongoing</td><td>Staff time</td><td>County budget</td><td>Department of Health</td><td>Water Systems</td><td>N/A</td><td>County, Highland Beach</td></tr>
<tr><td colspan="8">Action:
CH-3a: Continue to implement construction standards that protect private wells from the hazards and impacts from saltwater intrusion and flooding.
Ch-3b: Implement outreach and planning to connect households and businesses to public sewer in communities identified as an on-site wastewater problem area.
CH-3c: Implement outreach and planning to connect households and businesses to public water in communities identified as a water quality problem area.</td></tr>
<tr><td colspan="8">Background and/or Plan Reference: To prevent saltwater intrusion in private wells, construction standards should prioritize proper well placement away from saltwater bodies, deep drilling into the freshwater aquifer, using a well casing that extends below the saltwater interface, installing a properly sealed well head, and regularly monitoring water quality for salinity levels; with specific regulations matching Maryland and Anne Arundel County guidelines.

According to the Department of Health, the five groundwater problem areas in the County are Annapolis Neck, Gambrills Area, Northern Anne Arundel County (generally all areas north of U.S. Route 50), Fort Meade/Odenton Area and the Annapolis/Edgewater Peninsula. The problems in these areas are due to saltwater intrusion.</td></tr>
</table>

Primary Hazard: Coastal Hazards

Goal(s): 1, 7, 8, 9

Objective(s): 1.1, 1.3, 1.4, 7.1, 7.2, 8.1, 8.2, 8.3, 9.1, 9.2

	Action Type	Implementation Schedule	Estimated Cost	Potential Funding	Lead	Community Lifeline	Social Vulnerability	Jurisdiction(s)
Project CH-4	Education and Awareness. Structure and Infrastructure	Ongoing	$60,000 to $250,000	Staff time, and HMA grants for additional costs (incl. HMGP, BRIC, FMA)	OEM (Lead), All Departments participate	Safety and Security	N/A	County and Municipality

Action: Continue outreach to coastal flood prone communities.

Background and/or Plan Reference: The hazard mitigation plan has identified the following high-risk areas and infrastructure. These areas should be prioritized for outreach efforts. *Note: these are not the only coastal flood prone areas.*

- **Region 9 (Most Critical)**: Mayo Peninsula, Deale - Shady Side Peninsula, Woodland Beach, Oak Bluff, Selby-on-the-Bay, and Pine Whiff Beach.
- **Other High-Risk Regions**: Pasadena (Region 4), Broadneck (Region 4), Annapolis Neck (Region 7), Crownsville (Region 6), Glen Burnie, Ferndale, and Curtis Bay.
- **Critical Infrastructure at Risk**: Sewer pump stations, telecommunication towers, and major roadways.

Community engagement and planning efforts should include:

- Develop a **public education campaign** on coastal hazards and coastal flood preparedness and insurance.
- Establish **neighborhood emergency response teams** in vulnerable communities, learning from police and community-led efforts.

To protect at-risk infrastructure:

- Elevate critical infrastructure, such as **sewer pump stations** and **electrical substations**, to withstand flooding. *Note: at-risk sewer pump stations are identified in Project CH-2.*
- Upgrade drainage systems in flood-prone areas to prevent road inundation.
- Enhance stormwater management through permeable pavements and rain gardens.

Primary Hazard: Coastal Hazards

Goal(s): 1, 8, 9

Objective(s): 1.1, 1.3, 1.4, 8.2, 9.1, 9.2

Project CH-5

Action Type	Implementation Schedule	Estimated Cost	Potential Funding	Lead	Community Lifeline	Social Vulnerability	Jurisdiction(s)
Education and Awareness	Ongoing	$60,000 to $250,000	County budget	Department of Public Works	Communications	N/A	County, Highland Beach

Action: Additional placement of signage and activation of flood warning devices on roadways where coastal flooding has occurred.

Background and/or Plan Reference: Flood warning devices and signs help keep drivers safe by warning them of flooded roadways and directing them away from danger. These systems can also help reduce emergency calls and save lives.

Flood warning devices can include flashing beacons, message signs, flip signs, or automatic road barrier gates. They can also include sensors that detect rising water levels.

Recent flip signs/detour signs were installed on Pure Water Way. Example above.

Benefits of flood warning signs and devices:

- Improve public safety: Warn drivers of flooded roadways and keep them away from danger
- Reduce emergency calls: Divert drivers away from flooded areas
- Conserve resources: Help regions conserve resources for emergency management, rescue, and road departments
- Save lives: Help save lives by keeping drivers off flooded roadways
- Help first responders: Save first responders by reducing the number of calls to emergency services
- Educate drivers: Increase knowledge and preparedness among drivers
- Help make informed decisions: Help authorities, communities, and organizations make informed decisions
- Help model flood zones: Help prevent or mitigate major flooding events

* Existing resources to help identify these roadways include: 2025 Hazard Mitigation Plan, 2025 Nuisance Flooding Plan, and the 2023 Sea Level Rise Strategic Plan Update.

	Refer to the County Nuisance Flood Plan for locations of Pure Water Way Detour flip signs.

Primary Hazard: Coastal Hazards

Goal(s): 1, 3, 8, 9

Objective(s): 1.2, 1.3, 1.5, 3.2, 3.3, 3.4, 8.1, 8.2, 8.3, 9.1, 9.2

	Action Type	Implementation Schedule	Estimated Cost	Potential Funding	Lead	Community Lifeline	Social Vulnerability	Jurisdiction(s)
Project CH-6	Structure and Infrastructure	Ongoing	*Estimated Cost will vary based on department, with some having more facility infrastructure than others.	County budget/staff time	Department of Public Works	Safety and Security	N/A	County

Action: Conduct assessments of County Department facilities with the goal of identifying facilities vulnerable to flooding and coastal hazards such as storm surge, sea level rise, and/or climate change forecasts and projections.

Background and/or Plan Reference:

Departments to assess include, but are not necessarily limited to:

- Central Services
- Public Works
- Recreation and Parks
- Fire Department
- Police Department
- Department of Health

During this plan update, GIS spatial analysis of Anne Arundel County's critical facilities and community lifelines was conducted to determine if facilities are within well-defined hazards zones including: Special Flood Hazard Area, Hurricane Storm Surge Inundation, Project Sea Level Rise Inundation Areas, Erosion, and more. In terms of coastal hazards as defined in this plan, the preliminary analysis determined that 113 County-owned community lifelines are impacted by one or more coastal hazards. Primarily facilities are within storm surge inundation areas. The majority, 101, are sewer pump stations. These stations are addressed in Project CH-2.

	Additional ground-level assessments should be conducted for these facilities to validate GIS analysis and determine the potential extent of coastal hazard impacts.

<table>
<tr><th colspan="9">Primary Hazard: Dam Failure and Inundation</th></tr>
<tr><td colspan="9">Goal(s): 1, 4, 5, 9
Objective(s): 1.1, 1.4, 1.5, 4.3, 4.7, 5.4, 9.2</td></tr>
<tr><td rowspan="4">Project
DF-1</td><td>Action Type</td><td>Implementation Schedule</td><td>Estimated Cost</td><td>Potential Funding</td><td>Lead</td><td>Community Lifeline</td><td>Social Vulnerability</td><td>Jurisdiction(s)</td></tr>
<tr><td>Local Planning and Regulations</td><td>Short-term (1 to 3 years), ASAP</td><td>Minimal, staff time</td><td>County budget</td><td>Anne Arundel County OEM, Dam Owners</td><td>Safety and Security</td><td>Socially vulnerable groups to dam failure are identified in section 3.3.3.</td><td>Anne Arundel County, Baltimore City, Prince George's County.</td></tr>
<tr><td colspan="8">Action: Coordinate dam safety procedures and response with the owners and operators of the two adjacent high hazard potential dams that have inundation areas in Anne Arundel County: Liberty Dam and Duckett Dam.</td></tr>
<tr><td colspan="8">Background and/or Plan Reference: There are no dams with a high hazard potential classification within or owned/operated by Anne Arundel County. However, the County is in the inundation areas of two adjacent High Hazard Potential Dams. These dams, should they fail, have the potential to negatively impact Anne Arundel County due to flooding. The owner of Duckett Dam is Howard County, and the owner of Liberty Dam is Baltimore City.

Duckett Dam was completed in 1953. As of the dam's most recent inspection (5/10/2023), the dam is in "fair" condition. Liberty Dam was completed in 1953. As of the dam's most recent inspection (6/13/2023), the dam is in "unsatisfactory" condition.

Fair: No existing dam safety deficiencies are recognized for normal operating conditions. Rare or extreme hydrologic and/or seismic events may result in a dam safety deficiency. Risk may be in the range to take further action. Note: Rare or extreme event is defined by the regulatory agency based on their minimum.

Unsatisfactory: A dam safety deficiency is recognized that requires immediate or emergency remedial action for problem resolution.

Refer to Map 3.3.3-1 in reference material to view locations of these dam inundation areas.</td></tr>
</table>

<table>
<tr><th colspan="9">Primary Hazard: Dam Failure and Inundation</th></tr>
<tr><td colspan="9">Goal(s): 1, 3, 5, 8, 9
Objective(s): 1.4, 1.5, 3.2, 3.3, 5.2, 5.3, 8.2, 8.3, 9.1, 9.2</td></tr>
<tr><td rowspan="5">Project
DF-2</td><td>Action Type</td><td>Implementation Schedule</td><td>Estimated Cost</td><td>Potential Funding</td><td>Lead</td><td>Community Lifeline</td><td>Social Vulnerability</td><td>Jurisdiction(s)</td></tr>
<tr><td>Local Planning and Regulations</td><td>Short-term (1 to 3 years), ASAP</td><td>Staff time</td><td>County budget</td><td>Office of Central Services</td><td>Safety and Security</td><td>N/A</td><td>County</td></tr>
<tr><td colspan="8">Action: Prioritize the 16 critical facilities and community lifelines that have been identified as within the inundation areas of the two adjacent high hazard potential dams, Liberty Dam and Duckett Dam.</td></tr>
<tr><td colspan="8">Background and/or Plan Reference: Anne Arundel County has no high hazard potential dams within its boundary. However, critical structures within the County could be impacted by the failure of two high hazard dams in adjacent jurisdictions; these dams' inundation areas overlap with areas within the County.

Critical structures within the inundation areas of Liberty Dam or Duckett Dam would be impacted by a dam failure event. Potentially impacted facility types include: Communications (telecommunication tower) Transportation (County roads and bridges), Water Systems (sewer pump stations, water pump stations), and County owned fixed hazmat storage sites. These facilities are listed in more detail in Tables 3.3.3-2 and 3.3.3-3 (see section 3.3.3).

Refer to Tables 3.3.3-2 and 3.3.3-3 for a list of critical facilities and community lifelines identified within the dam inundation areas for these two high hazard dams. Map 3.3.3-1 to see locations of critical facilities within these dam's inundation area.</td></tr>
</table>

Primary Hazards: Hurricane, Tropical Storm, and Nor'easter & Tornado								
Goal(s): 1, 2, 3, 4, 7, 9 Objective(s): 1.1, 1.4, 1.5, 2.1, 2.2, 3.2, 3.4, 4.1, 4.6, 7.1, 9.1								
Project HTN-1	Action Type	Implementation Schedule	Estimated Cost	Potential Funding	Lead	Community Lifeline	Social Vulnerability	Jurisdiction(s)
	Education and Awareness	Short-term (1 year)	Staff time	County budget	BGE and Public Safety	Safety and Security	Residents that rely on Durable Medical Equipment	County and Municipalities
	Action: Collaborate with BGE to educate property owners on tree removal and trimming to prevent power outages during a high wind event resulting from hurricane, tropical storm, and nor'easter. Educate the public about securing debris, propane tanks, yard items, or stored objects that may otherwise be swept away, damage, or pose a hazard to people and property during high wind event.							
	Background and/or Plan Reference: Hurricane wind can uproot trees and cause significant damage to trees and other infrastructure. Downed trees or weak/dead trees located near power lines and transformers can take out power to entire communities. Ensuring that trees are trimmed properly, and new trees are planted away from electric lines are key to minimizes power outages from high wind events, like tornados. For the last 30 years, research on multiple storms across the Northeastern U.S. has pointed to trees "as the leading cause of outages." There is ample evidence that Utility Vegetation Management programs improve reliability and cut the system average interruption frequency index (SAIFI). For example, a University of Connecticut statewide study comparing 13 years of pruning using an enhanced tree pruning program versus nearby untreated rights-of-way found "ETT-treated conductors had storm outage rates that were 0.07 to 0.36 outages/km/year lower than untreated conductors or 35% to 180% lower than the service area's average annual outage rate for untreated conductors." Vulnerable populations, particularly those reliant on medical equipment, are at risk during power outages. Power outages caused by widespread disasters, like high wind from a hurricane, often have longer restoration times than those caused by equipment failure or an incident at one specific location. Over 3 million Medicare beneficiaries rely on electricity-dependent durable medical and assistive equipment (DME) and devices to live independently in their homes, and some of those individuals also have health care service dependencies. Severe weather and other emergencies, especially those with prolonged power outages, can be life-threatening for these individuals. The HHS emPOWER Map is regularly updated and displays the total number of Medicare beneficiaries who have had an administrative claim for one or more types of electricity-dependent durable medical and assistive equipment (DME) and devices, as well as at-risk combinations data for those who rely on a certain essential health care service(s) and any electricity-dependent DME and devices. Data collected in February 2025 by zip code indicates that there are 103,541 beneficiaries for all zip codes in Anne Arundel County, and a							

	total of 3,318 at-risk beneficiaries for all zip codes. The zip codes with the highest at-risk beneficiaries include 21122 – Lake Shore (470 total) and 21061 – Glen Burnie (395 total).

Primary Hazard: Hurricane, Tropical Storm, and Nor'easter

Goal(s): 1, 2, 4, 5, 9
Objective(s): 1.1, 1.3, 1.4, 2.1, 2.2, 4.1, 4.3, 5.1, 5.2, 9.2

Project HTN-2

Action Type	Implementation Schedule	Estimated Cost	Potential Funding	Lead	Community Lifeline	Social Vulnerability	Jurisdiction(s)
Education and Awareness	Ongoing	\$61,000 to \$250,000	County budget	OEM	Safety and Security	N/A	County and Municipalities

Action: Continue pre-and post-disaster public information campaigns related to hurricanes and tropical systems, particularly prior to hurricane season. Utilize "Anne Arundel Hurricane Preparedness Week" for seasons that are predicted to be extremely active. Outreach efforts to include information on emergency preparedness, public assistance, damage assessments, response, recovery efforts and future mitigation actions.

Background and/or Plan Reference: The Atlantic **Hurricane season** lasts from approximately June to November, with peak season occurring between mid-August and late October. For Anne Arundel County, later October is historically the peak of hurricane season. National Hurricane Preparedness Week is held in May, and in the past (August 16 – 22, 2020) Anne Arundel County has conducted "Anne Arundel County Hurricane Preparedness Week." Each day of Hurricane Preparedness Week focused on a different topic and associated tips, which can be used as a template for future weeks:

August 16 – Start of Anne Arundel County Hurricane Preparedness Week
August 17 – Hurricane Season Update
August 18 – Make a Plan and Stay Informed
August 19 – Personal Safety
August 20 – Be Financially Prepared
August 202 – Build a Hurricane Go-Kit
August 22 – Have a Plan for Pets

Additionally, Anne Arundel County maintains year-round information related to hurricanes and tropical storms under the "Hazard' section of OEM's website. Informational material includes how to plan for a hurricane, building a kit, staying informed, and ways to get involved in the community.

Outreach materials including flyers, social media messaging, videos, toolkits and more are available for use from FEMA and Ready.gov.

<table>
<tr><th colspan="9">Primary Hazard: Drought</th></tr>
<tr><td colspan="9">Goal(s): 7, 8, 9
Objective(s): 7.1, 7.2, 8.1, 9.1</td></tr>
<tr><td rowspan="4">Project
D-1</td><td>Action Type</td><td>Implementation Schedule</td><td>Estimated Cost</td><td>Potential Funding</td><td>Lead</td><td>Community Lifeline</td><td>Social Vulnerability</td><td>Jurisdiction(s)</td></tr>
<tr><td>Education and Awareness</td><td>Short-term (1 to 3 years)</td><td>Staff time</td><td>County budget, and USDA Natural Resource Conservation Service for larger outreach activities</td><td>County Executive, Agriculture Commission</td><td>Water Systems & Food, Hydration, Shelter</td><td>N/A</td><td>County, Highland Beach</td></tr>
<tr><td colspan="8">Action: Promote drought resistant crops and precision irrigation techniques for the County’s agricultural land uses.</td></tr>
<tr><td colspan="8">Background and/or Plan Reference: Per the 2022 Census of Agriculture, Anne Arundel County has 454 farms, which comprise 17.2% of the County’s total land area. Total farms have increased by 33 since the previous Census of Agriculture was conducted in 2017. Droughts are projected to become more frequent and intense due to climate change, therefore expanding agricultural land uses in the County will have to take into consideration the negative consequences of a drought event. Drought resistant agricultural practices include prescribed grazing, mulching, no-till or reduced tillage, cover crops, and micro irrigation. The following practices are utilized by farms in Anne Arundel County:

• No till (24% of farm)
• Reduced till (11% of farms)
• Intensive Till (8% of farms)
• Cover crop (20% of farms)

Drought resistant crops currently farmed in Anne Arundel County include: soybeans (8,099 acres total), corn (5,405 acres), wheat (1,446 acres), and sorghum (574 acres). The long term goal of promoting drought resistant crops and precision irrigation techniques would be to decrease the percentage of intensive till land use, while increasing the percentage of farmland that utilizes no till, reduced till, and cover crop.

This action is consistent with Plan 2040, Policy HC 10.4: “Increase preparedness for weather-related emergencies including extended heat waves, urban and coastal flooding, and drought.”</td></tr>
</table>

<table>
<tr><td colspan="9">Primary Hazard: Drought</td></tr>
<tr><td colspan="9">Goal(s): 7, 8, 9
Objective(s): 7.1, 7.2, 8.1, 8.3, 9.1</td></tr>
<tr><td rowspan="4">Project
D-2</td><td>Action Type</td><td>Implementation Schedule</td><td>Estimated Cost</td><td>Potential Funding</td><td>Lead</td><td>Community Lifeline</td><td>Social Vulnerability</td><td>Jurisdiction(s)</td></tr>
<tr><td>Education and Awareness</td><td>Short-term (1 to 3 years)</td><td>Staff time, printing costs, $50,000 to $100,000</td><td>County budget</td><td>Inspections and Permits</td><td>Water Systems & Food, Hydration, Shelter</td><td>N/A</td><td>County</td></tr>
<tr><td colspan="8">Action: Encourage the use of drought resistant landscaping in public and private properties.</td></tr>
<tr><td colspan="8">Background and/or Plan Reference:

Xeriscaping is the practice of landscaping with minimal use of water. Incorporating drought tolerant or xeriscape practices into landscape reduces dependence on irrigation. This information can be included on OEM’s existing drought information webpage, as well as through social media campaigns. Also, promote the use of permeable driveways and surfaces that reduce runoff and promote groundwater recharge.

This action is consistent with Plan 2040, Policy HC 10.4: “Increase preparedness for weather-related emergencies including extended heat waves, urban and coastal flooding, and drought.”</td></tr>
</table>

<table>
<tr><th colspan="9">Primary Hazard: Earthquake</th></tr>
<tr><td colspan="9">Goal(s): 1, 2, 4, 9
Objective(s): 1.1, 1.3, 1.5, 2.1, 2.2, 4.1, 4.3, 9.2</td></tr>
<tr><td rowspan="4">Project
EQ-1</td><td>Action Type</td><td>Implementation Schedule</td><td>Estimated Cost</td><td>Potential Funding</td><td>Lead</td><td>Community Lifeline</td><td>Social Vulnerability</td><td>Jurisdiction(s)</td></tr>
<tr><td>Education and Awareness</td><td>Annually (ongoing)</td><td>Staff time, advertising costs (variable)</td><td>NEHRP</td><td>OEM</td><td>Safety and Security</td><td>Older neighborhood, multiple languages and formats needed</td><td>County & Highland Beach</td></tr>
<tr><td colspan="8">Action: Participate in the Great ShakeOut earthquake event to promote education and community awareness about seismic hazards. Consider utilizing NEHRP assistance to help plan this event.</td></tr>
<tr><td colspan="8">Background and/or Plan Reference: The Great Southeast ShakeOut is a multi-state earthquake drill spanning much of the southeastern United States. ShakeOut activities for Maryland are supported by the Maryland Department of Emergency Management. Earthquake information for Maryland is provided below. Target oldest neighborhoods for age of housing stock, such as Brooklyn Park. Provide information in multiple formats (online, print, radio, etc.) and multiple languages.

The National Earthquake Hazards Reduction Program (NEHRP) spearheads federal efforts to reduce the fatalities, injuries, and property losses caused by earthquakes. NERHP was established by Congress in 1977 and directs four federal agencies to coordinate their complementary activities to implement and maintain the program: FEMA, the National Institute of Standards and Technology (NIST); the National Science Foundation (NSF); and the USGS. NEHRP also partners with state and local governments, universities, research centers, professional societies, trade associations, and businesses to mitigate earthquake risks. (National Earthquake Hazards Reduction Program, 2021).</td></tr>
</table>

Primary Hazard: Earthquake								
Goal(s): 1, 3, 4, 9 **Objective(s): 1.1, 1.3, 1.4, 3.3, 3.4, 3.5, 4.3, 4.7, 9.2**								
Project EQ-2	**Action Type**	**Implementation Schedule**	**Estimated Cost**	**Potential Funding**	**Lead**	**Community Lifeline**	**Social Vulnerability**	**Jurisdiction(s)**
	Structure and Infrastructure	Annually (ongoing)	Staff time	County budget	Central Services, I&P building inspectors	Safety and Security	N/A	County & Highland Beach
	Action: Conduct Earthquake Safety Inspections of County critical facilities, beginning with those facilities built prior to the 1970s and/or greater than 3 stories. Utilize rapid visual screening (RVS) to quickly inspect facilities and identify disaster damage or potential seismic structural and non-structural weakness to prioritize retrofit efforts, inventory high-risk structures/facilities, or assess post-disaster risk to determine if buildings are safe to re-occupy. Training for rapid visual screening is available (FEMA course P-154).							
	Background and/or Plan Reference: FEMA's P-154 "Rapid Visual Screening of Building for Potential Seismic Hazards: A Handbook" can be referenced to complete the safety inspections of critical facilities. In general, an RVS program will offer an opportunity to collect valuable information about nonstructural features of buildings. Although deemed very important in high seismic regions, in areas of low seismicity such as Anne Arundel County, nonstructural hazards are typically less significant, but they can be important for life-safety considerations in a large, rare earthquake.							

<table>
<tr><th colspan="9">Primary Hazard: Extreme Temperatures</th></tr>
<tr><td colspan="9">Goal(s): 7, 8, 9
Objective(s): 7.1, 7.2, 8.1, 8.2, 9.1</td></tr>
<tr><td rowspan="5">Project
ET-1</td><td>Action Type</td><td>Implementation Schedule</td><td>Estimated Cost</td><td>Potential Funding</td><td>Lead</td><td>Community Lifeline</td><td>Social Vulnerability</td><td>Jurisdiction(s)</td></tr>
<tr><td>Education and Awareness</td><td>Ongoing, and Long term (5+ years)</td><td>Staff time, printing costs, $50,000 to $100,000</td><td>County budget</td><td>County Inspections and Permits, County Recreation and Parks</td><td>Energy</td><td>Pops aged 65 and older</td><td>County (e.g. North County), City of Annapolis, Highland Beach</td></tr>
<tr><td colspan="8">Action: Promote tree planting at the neighborhood level. Distribute information on Maryland's 5 Million Trees Initiative (5MT). Consider social equity when prioritizing neighborhood outreach. Prioritize those properties within socially vulnerable Census Tracts.</td></tr>
<tr><td colspan="8">Background and/or Plan Reference: Urban heat islands form as cities replace natural land cover with dense concentrations of pavement, buildings, and other surfaces that absorb and retain heat. Trees, green roofs, and other green infrastructure features can cool urban areas by shading building surfaces, deflecting radiation from the sun, and releasing moisture into the atmosphere. Evaluate current actions or add new that integrate social equity, as applicable.

According to Plan 2040, the County has identified areas where the tree canopy is lacking – particularly in North County. Poor tree canopy contributes to poor air quality, poor water quality, and heat islands in the summer. Sub watersheds in North County and around Parole have been identified for restoration, including increasing the tree canopy. Many of these areas were developed prior to modern environmental regulations that require measures to protect trees and water quality. Redevelopment and restoration projects both have the potential to improve environmental conditions for residents in these areas. Areas with the most degraded environmental conditions have lower median incomes and disproportionately higher concentrations of minorities than the rest of the County.

This action item is in line with the following strategy included in Plan2040:
- Fund a robust community-based urban tree planting effort so planting trees becomes standard practice by communities and residents across the County. Ensure the program actively addresses a lack of tree canopy in underserved communities and results in a more equitable distribution of tree canopy throughout the County.</td></tr>
</table>

Primary Hazard: Extreme Temperature								
Goal(s): 1, 2, 4, 9 Objective(s): 1.1, 1.4, 1.5, 2.1, 2.2, 4.1, 4.3, 9.1								
Project ET-2	Action Type	Implementation Schedule	Estimated Cost	Potential Funding	Lead	Community Lifeline	Social Vulnerability	Jurisdiction(s)
	Education and Awareness	Ongoing	Minor ($0 to $60,000)	County budget	OEM	Safety and Security & Food, Hydration, Shelter	Populations aged 65+ and 5 years or younger, homeless population	County and Municipalities
	Action: Minimize the impact of extreme temperatures on vulnerable populations by notifying the public of the opening of warming and cooling centers and promoting their use with Dept of Aging, Dept of Social Services, Dept of Health, and other agencies that provide services to socially vulnerable groups.							
	Background and/or Plan Reference: Those hardest hit by extreme temperatures are adults 65 years of age or older, many who are already physically vulnerable. Excessive heat exposure also affects people with certain pre-existing medical conditions, including cardiovascular disease, respiratory illnesses, and obesity. Small children are also more susceptible to temperature extremes. For an extreme temperature event, as with all disaster events, responders face the risk of personal injury while performing necessary job functions. Steps to consider: a.) Ensure that vulnerable populations are aware of warming and cooling centers by targeting outreach efforts. b.) Coordinate with County and municipal departments and partners who already work with vulnerable populations in the realm of health. c.) Educate on personal preparedness and safety measures taken during a hazard event. d.) Determine the need for additional warming and/or cooling centers. Extreme heat conditions are expected to become more frequent and intense due to changing climate conditions. The need for more cooling centers is one major consideration in terms of future development to meet the needs of vulnerable populations.							

<table>
<tr><td colspan="9">Primary Hazard: Thunderstorm (Lightning, Hail, Straight-line Winds)</td></tr>
<tr><td colspan="9">Goal(s): 3, 5, 8
Objective(s): 3.2, 3.5, 5.2, 5.3, 8.1, 8.2</td></tr>
<tr><td rowspan="4">Project
TH-1</td><td>Action Type</td><td>Implementation Schedule</td><td>Estimated Cost</td><td>Potential Funding</td><td>Lead</td><td>Community Lifeline</td><td>Social Vulnerability</td><td>Jurisdiction(s)</td></tr>
<tr><td>Structure and Infrastructure</td><td>Short-term (1 to 3 years)</td><td>Staff time</td><td>County budget, grant funding could come from FEMA HMGP and DOE CiFER</td><td>Office of Central Services</td><td>All Lifelines</td><td>N/A</td><td>County, City of Annapolis, Highland Beach</td></tr>
<tr><td colspan="8">Action: Survey prioritized critical facilities to determine the status of grounding and surge protection capabilities for each facility.
a. Identify which critical facilities are lacking and/or need additional grounding protection.
b. Survey outside grounding and inside surge protection capabilities simultaneously.
c. Prioritize critical facilities from highest to lowest for upgrades.</td></tr>
<tr><td colspan="8">Background and/or Plan Reference:

Prioritization can start with essential facilities: fire/EMS, police, medical (hospitals and emergency health centers), schools, and EOC. Then following essential facilities, the County’s government buildings can be assessed. According to the 2025 community lifeline database, there are 29 County government buildings.

Refer to Appendix for database of community lifelines.</td></tr>
</table>

Primary Hazard: Thunderstorm (Lightning, Hail, Straight-line Winds)								
Goal(s): 1, 2, 4, 9 Objective(s): 1.3, 1.5, 2.1, 2.3, 4.7, 9.1								
Project TH-2	Action Type	Implementation Schedule	Estimated Cost	Potential Funding	Lead	Community Lifeline	Social Vulnerability	Jurisdiction(s)
	Structure and Infrastructure	1-2 years	$5,000	CSW-Facility and Community Improvements Details, FEMA Hazard Mitigation Grant Program	OEM, Public Works	Communications	N/A	County, Municipalities
	Action: Work with MDEM to determine potential location(s) for Mesonet in Anne Arundel County.							
	Background and/or Plan Reference: The Maryland Mesonet's mission is to design, build, and operate a network of high-quality, closely spaced, rapid-sampling weather monitoring and data collection systems across the state to advance emergency preparedness, the accuracy of regional weather forecasts, and expedite disaster assessment and recovery. Each Mesonet site will measure air temperature, atmospheric pressure, relative humidity, wind speed and direction, solar radiation, rainfall, snow depth, and soil moisture and temperature at five depths, most at 1-minute intervals. The measurements are sent to data servers at the University of Maryland using cellular transmission. The automatic quality-controlled observations are transmitted in near real-time to the National Weather Service and simultaneously available to emergency management personnel and Maryland citizens from the Mesonet website. Mesonet data will advance community risk assessment and emergency preparedness for impending extreme weather, improve regional weather forecasts by providing more accurate initial states for prediction models, and expedite post-event analysis for disaster declaration and recovery. It is the goal of Mesonet to have at least 3 sites in all Maryland Counties.							

<table>
<tr><th colspan="9">Primary Hazard: Severe Winter Storm</th></tr>
<tr><td colspan="9">Goal(s): 1, 2, 4, 5
Objective(s): 1.1, 1.4, 1.5, 2.1, 2.2, 4.1, 4.3, 5.1</td></tr>
<tr><td rowspan="4">Project
SWS-1</td><th>Action Type</th><th>Implementation Schedule</th><th>Estimated Cost</th><th>Potential Funding</th><th>Lead</th><th>Community Lifeline</th><th>Social Vulnerability</th><th>Jurisdiction(s)</th></tr>
<tr><td>Education and Awareness</td><td>Ongoing</td><td>$61,000 to $250,000</td><td>County budget</td><td>OEM, Department of Health</td><td>Safety and Security</td><td>See below.</td><td>County, City of Annapolis, Highland Beach</td></tr>
<tr><td colspan="8">Action: Partner with the Department of Health, Dept of Aging and Disabilities and other health equity groups to provide severe winter storm emergency preparedness information to vulnerable groups and populations.</td></tr>
<tr><td colspan="8">Background and/or Plan Reference: To reach vulnerable populations before or during severe winter weather, focus on actively checking in on the elderly, individuals with chronic illnesses, the homeless, young children, and outdoor workers, ensuring they have access to shelter, warm clothing, food, and necessary medical support, while also providing information about staying safe during extreme cold conditions.

Extreme cold associated with winter storms can cause older pipes to freeze and burst, leaving residents without access to water. Large amounts of snow or ice can damage power lines, leading to power outages. Power outages, if lengthy, can lead to dropping temperatures within homes and businesses, and are especially dangerous to those who rely on at-home medical equipment for support needs. Back-up heat and generators can mitigate these issues, but residents should take the proper precautions when using these.

While blanket outreach via traditional media and social media is beneficial, partnering with local health departments and social equity groups provides the necessary information to identify and locate vulnerable populations to conduct targeted outreach efforts.

Once vulnerable populations are identified, outreach strategy may include:
Utilization of community centers, shelters, and religious institutions as gathering points for outreach efforts.
Conducting door-to-door checks, especially in high-risk neighborhoods.
Distribution of winter survival kits containing essential items like blankets, hand warmers, and non-perishable food.
Ready.gov has ready-made materials for winter weather outreach, including Winter Safety Social Media Toolkit, Winter Storm Information Sheet, and informational “what to do” videos. Refer to handouts.</td></tr>
</table>

<table>
<tr><th colspan="9">Primary Hazard: Severe Winter Storm</th></tr>
<tr><td colspan="9">Goal(s): 3, 5, 8, 9
Objective(s): 3.2, 5.2, 5.3, 8.2, 9.1</td></tr>
<tr><td rowspan="4">Project
SWS-2</td><td>Action Type</td><td>Implementation Schedule</td><td>Estimated Cost</td><td>Potential Funding</td><td>Lead</td><td>Community Lifeline</td><td>Social Vulnerability</td><td>Jurisdiction(s)</td></tr>
<tr><td>Structure and Infrastructure</td><td>Short-term (1 to 3 years)</td><td>$300 to $450 per kilowatt of power generated</td><td>HMGP</td><td>Central Services, DPW</td><td>Energy</td><td>N/A</td><td>County, Municipalities</td></tr>
<tr><td colspan="8">Action: Review listing of essential facilities and determine the status of backup generators for each one. Prioritize facilities without generators or those with undersized generators for new generators or replacements.</td></tr>
<tr><td colspan="8">Background and/or Plan Reference: All essential facilities, a subset of critical facilities, should be assessed to determine their generator status. Facilities with no generator or an undersized generator should be prioritized for a potential upgrade. Essential facilities include fire/EMS, police, schools, hospital/medical, and EOC. According to FEMA guidelines, essential facilities like hospitals, police stations, and water treatment plants can be eligible for generator funding under the Hazard Mitigation Grant Program (HMGP) if the generator is deemed necessary to protect critical functions during power outages, and must meet requirements like demonstrating cost-effectiveness, providing a long-term solution, and being properly sized to power essential equipment within the facility; applicants need to provide documentation proving the need for the generator and its impact on public safety or health.

Critical Function Focus:
Generators must be sized to power essential functions within the facility, not just the entire building.
Benefit-Cost Analysis:
FEMA may require a benefit-cost analysis to justify the generator purchase, considering factors like the frequency and duration of power outages, the number of people affected, and the potential economic losses without backup power.
Documentation Needed:
Applicants must provide detailed information about the facility, power needs, generator specifications, and how the generator will be used to maintain critical functions.

Refer Appendix I for listing of critical facilities (including essential facilities) and community lifelines.</td></tr>
</table>

Primary Hazard: Severe Winter Storm								
Goal(s): 1, 4, 9 Objective(s): 1.1, 1.4, 1.5, 4.3, 4.6, 9.1								
Project SWS-3	Action Type	Implementation Schedule	Estimated Cost	Potential Funding	Lead	Community Lifeline	Social Vulnerability	Jurisdiction(s)
	Education and Awareness	Short-term (1 to 3 years)	$61,000 to $250,000	County budget	OEM	Safety and Security	Homeless populations, those aged 65 and older, and those under 5 years of age	County, City of Annapolis, Highland Beach
	Action: Conduct inventory of existing warming centers and shelters to ensure adequate stockpile of supplies related to severe winter weather events. If necessary, also consider additional warming centers to meet the needs of the community.							
	Background and/or Plan Reference: For a warming center or shelter during severe winter weather, essential supplies include blankets, warm clothing (hats, gloves, socks), sleeping bags, cots or mats, non-perishable food, water, hand warmers, personal hygiene items, first-aid kits, portable heaters, flashlights with extra batteries, a battery-powered radio, and sanitation supplies to maintain a clean and safe environment.							

Primary Hazard: Severe Winter Storm								
Goal(s): 3, 7, 9 Objective(s): 3.3, 3.5, 7.1, 9.1								
Project SWS-4	Action Type	Implementation Schedule	Estimated Cost	Potential Funding	Lead	Community Lifeline	Social Vulnerability	Jurisdiction(s)
	Local Planning And Regulation	Ongoing (public outreach)	Staff time	County budget	I&P	Food, Hydration, Shelter	N/A	County, Municipalities
	Action: In relation to future development, property owners and land developers should be encouraged to mitigate the impacts of winter storms by avoiding flat roofs and constructing to the most recent building code requirements for snow loading and insulation.							
	Background and/or Plan Reference: To mitigate the impacts of winter weather during building construction, key strategies include: using specialized materials like anti-freeze concrete mixtures, properly insulating exposed areas, employing temporary heating systems, scheduling work based on weather forecasts, protecting pipes from freezing, and designing roofs with proper snow load capacity; all while prioritizing worker safety in cold conditions. **Structural design considerations:** • Roof pitch: Design roofs with a steep pitch to facilitate snow slide-off, preventing excessive snow accumulation • Load-bearing capacity: Ensure structural elements are designed to withstand increased snow loads							

<table>
<tr><td colspan="9">Primary Hazard: Tornado</td></tr>
<tr><td colspan="9">Goal(s): 1, 2, 4, 9
Objective(s): 1.1, 1.3, 1.4, 2.1, 2.2, 4.1, 4.3, 9.1</td></tr>
<tr><td rowspan="4">Project
T-1</td><td>Action Type</td><td>Implementation Schedule</td><td>Estimated Cost</td><td>Potential Funding</td><td>Lead</td><td>Community Lifeline</td><td>Social Vulnerability</td><td>Jurisdiction(s)</td></tr>
<tr><td>Education and Awareness</td><td>Ongoing (public outreach)</td><td>Staff-time</td><td>Funding needs are minimal for outreach materials.</td><td>OEM</td><td>Communications</td><td>N/A</td><td>County, City of Annapolis, Highland Beach</td></tr>
<tr><td colspan="8">Action: Educate the public on what to do in the event of a tornado, where to seek shelter (indoors or outdoors), and how to plan for communication before and after the storm.</td></tr>
<tr><td colspan="8">Background and/or Plan Reference: Ready-made outreach materials are available from FEMA, the National Weather Service, Ready.gov, and more. More generally, FEMA has a guide that includes findings and recommendations for emergency managers related to Improving Public Messaging for Evacuation and Shelter-in-Place (April 2021).

Findings and recommendations from this report can be utilized for tornado messaging, but are broad enough to be multi-hazard, which means the takeaways are effective for different types of hazards. For example, based on peer reviewed findings, examples of some of these recommendations include:
Use websites and social media platforms and work with local media to provide authoritative, time-stamped, geo-tagged photos and videos of hazards such as rising waters and wildfires. Encourage individuals to share those visuals with friends and family, including via social media.
There is strong agreement across research studies that although both voluntary and mandatory evacuation orders increased the likelihood of evacuation, mandatory evacuation orders had a significantly greater effect than voluntary evacuation orders. This finding was consistent across different hazards.</td></tr>
</table>

Primary Hazard: Wildfire

Goal(s): 2, 3, 9

Objective(s): 2.1, 2.2, 3.3, 2.6, 9.1

	Action Type	Implementation Schedule	Estimated Cost	Potential Funding	Lead	Community Lifeline	Social Vulnerability	Jurisdiction(s)
Project WF-1	Education and Awareness	Long-term (5+ years)	\$50,000 to \$100,000	County budget	Inspections and Permits, with Fire supporting in commercial spaces	Safety and Security	N/A	County, Communities within the WUI

Action: Encourage principals of "defensible space" in the WUI for new and existing development to help reduce the potential for wildfires to spread to structures.

Background and/or Plan Reference: A defensible space is an area around a building in which vegetation, debris, and other types of combustible fuels have been treated, cleared, or reduced to slow the spread of fire to and from the building. Information about local vegetation, weather, and topography is used to determine the Fire Severity Zone of an area, which can help determine the most effective design of a defensible space. A defensible space is one of the most cost-effective ways to protect a building from a wildfire and can often be created by the property owner.

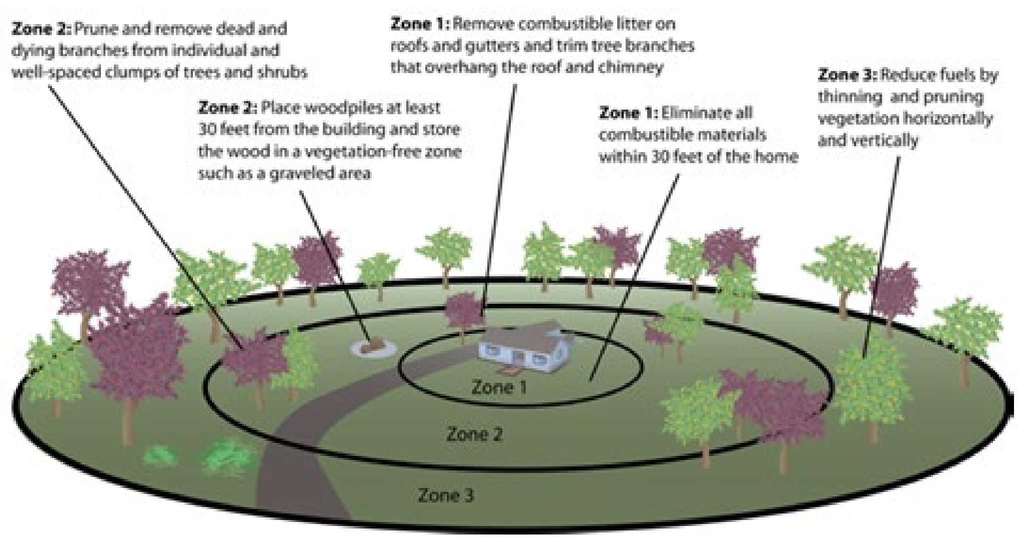


Figure 3. The three concentric zones of defensible space.

To educate the public about defensible space for wildfires, you can: use clear, accessible language to explain the concept of defensible space, highlight the importance of creating zones around homes with minimal flammable vegetation, emphasize regular maintenance practices like trimming trees and

	clearing debris, and provide specific guidelines for different vegetation types based on local fire risks, while also addressing common concerns and misconceptions about creating defensible space; this can be done through community workshops, online resources, brochures, social media campaigns, and partnerships with local fire departments and government agencies

Primary Hazard: Wildfire								
Goal(s): 3, 7, 9 Objective(s): 3.3, 3.5, 7.1, 7.2, 9.1								
Project WF-2	Action Type	Implementation Schedule	Estimated Cost	Potential Funding	Lead	Community Lifeline	Social Vulnerability	Jurisdiction(s)
	Local Planning and Regulations	Long-term (5+ years)	Staff time and site-dependent property costs.	County budget	Office of Planning and Zoning, Inspections and Permits, Central Services	Safety and Security	N/A	County, Highland Beach
	Action: Limit future development within Wildland Urban Interface (WUI) areas.							
	Background and/or Plan Reference: As human development continues to increase in Anne Arundel County, so will the number of WUIs and intermix areas. The potential for property damage and other wildfire impacts will increase each year as more properties are developed and more people move to these areas. **Remember: 97% of wildfires are started by humans**, therefore wildfire ignition are also more common in WUI zones. However, encouraging principles of defensible space in new and existing development in these areas could help reduce the potential for wildfires to spread to structures. New developments should be carefully placed near the WUI, if developed at all. In general, future development near or along large areas of contiguous forest should be avoided to reduce wildfire risk. Additionally, development in areas that lack public water and sewer service should be heavily considered as the lack of public water access may create difficulties in extinguishing large fires. These would include areas in Anne Arundel County that are in Growth Tiers II and IV, which are not planned for public sewer services. These growth areas are generally agriculture forest lands, or other natural lands. Therefore, the land adjacent to these growth areas, even should they have public sewer service, should be carefully considered for development. To limit development in the WUI, communities can implement land use planning strategies like zoning regulations that restrict building in high-risk fire areas, designate fire-resistant building codes, require ample defensible space around homes, prioritize development in less flammable locations, and purchase development rights in particularly hazardous areas, all while working with local fire agencies to assess risk and guide development decisions.							

Primary Hazard: Erosion								
Goal(s): 4, 7, 9 **Objective(s): 4.1, 4.7, 7.1, 7.2, 9.1**								
Project ER-1	**Action Type**	**Implementation Schedule**	**Estimated Cost**	**Potential Funding**	**Lead**	**Community Lifeline**	**Social Vulnerability**	**Jurisdiction(s)**
	Natural Resource Protection	Ongoing	$1.2 million annually for grant program	Watershed Restoration Grant Program	Public Works Bureau of Watershed Protection and Restoration	Safety and Security	Social vulnerability considerations are included in grant application & review.	County, Highland Beach
	Action: Continue working with partners (e.g., Chesapeake Bay Trust, City of Annapolis, Department of Natural Resources, and local watershed groups) to prioritize identified riparian and shoreline buffers in need of restoration. Identify potential new partners as needed.							
	Background and/or Plan Reference: There are several watershed groups and non-profit organizations and NGOs that are actively engaged in planning and implementing natural resource projects to address shoreline erosion and mitigate areas of drainage problems. The County's Restoration Program utilizes a watershed based approach to restoring degraded stream systems to improve stream and wetland function, water quality, aquatic and riparian habitat to ensure the resilience of the County's environment for its citizens, and to improve the health of local waterways. Watershed groups in Anne Arundel County include: • Anne Arundel Watershed Stewards Academy: A public-private partnership that trains residents to become Watershed Stewards • Arundel Rivers Federation: Works on projects such as living shorelines, wetland creation, and stormwater bioretention • Magothy River Association: Works to protect the Magothy River watershed • Patuxent Riverkeeper: Works to protect the Little Patuxent watershed • Severn River Association: Works with communities to implement stormwater management projects • Scenic Rivers Land Trust: Works to protect watersheds • Spa Creek Conservancy: Works on restoration and protection programs, as well as community educational programs Recent Projects: • Turnbull Estates Living Shoreline: A project completed in 2019 that restored the South River shoreline • Twin Harbors Living Shoreline: A project that restored the shoreline of Mill Creek and Dividing Creek • Wardour Stormwater Management and Living Shoreline: A project that aims to reduce erosion, flooding, and sedimentation							

Primary Hazard: Erosion								
Goal(s): 4, 7, 9 Objective(s): 4.1, 7.1, 7.2, 9.1								
Project ER-2	Action Type	Implementation Schedule	Estimated Cost	Potential Funding	Lead	Community Lifeline	Social Vulnerability	Jurisdiction(s)
	Natural Systems Protection	Mid-term (3 to 5 years)	Staff time, currently in the process of finding funding for implementation of recommendations	Chesapeake and Atlantic Coastal Bays Trust Fund, the Coastal Resiliency Program, the Waterway Improvement Fund, the National Oceanic and Atmospheric Administration (NOAA) and the Environmental Protection Agency's Chesapeake Bay Program.	DPW	Safety and Security	N/A	County
	Action: Implement recommendations of the South County Coastal Resilience Beneficial Reuse Study.							
	Background and/or Plan Reference: Beneficial re-use of material generated from maintenance dredging of multiple creeks to restore shoreline and coastal habitat that has been lost due to erosion. Study was completed by DPW, actively seeking funding for implementation.							

Primary Hazard: Erosion								
Goal(s): 3, 6, 7, 9 Objective(s): 3.2, 6.1, 7.1, 7.2, 9.1								
Project ER-3	Action Type	Implementation Schedule	Estimated Cost	Potential Funding	Lead	Community Lifeline	Social Vulnerability	Jurisdiction(s)
	Local Planning and Regulations	Ongoing	Staff time	County budget. Projects can utilize MHT, HMGP, Coastal Habitat and Resilience Grants for Tribes and Underserved Communities	OPZ – Cultural Resources	Safety and Security	Historic African American communities and resources	County
	Action: Identify strategies for integrating historic site preservation and other cultural resource considerations with natural resource conservation through County shoreline protection projects and other resiliency plans and actions, including environmental monitoring.							
	Background and/or Plan Reference: According to the Sea Level Rise Strategic Plan Update, Anne Arundel County contains thousands of historic properties, archaeological sites, and cemeteries, as well as scenic and historic roadways that are afforded some protection through the Anne Arundel County Code. Over the past decade, with the support of competitive grant funding when available, the Cultural Resources Section has provided vulnerability assessment studies for flooding and sea level rise hazards, as well as conducted a few instances of salvage archaeology. These studies focused on historic structures and archaeological sites, identifying endangered cultural resources and providing priority action lists based on their significance and level of threat. The Sea Level Rise Strategic Plan Update has identified potential actions to protect coastal historic structures and sites that are vulnerable to flooding and shoreline erosion: • Groins, jetties, seawall, and other structural barrier solutions. • Incorporate site preservation considerations into shoreline restoration methods (i.e., archaeological site capping/burial sensitive landscape plantings to increase site stability) • Salvage archaeology & historic site documentation • Site Monitoring Additional potential mitigation action include: • Develop guidelines and requirements for the potential displacement and destruction of vulnerable historic resources and archaeological sites when shoreline stabilization is not a feasible strategy for permanent protection.							

<table>
<tr><th colspan="9">Primary Hazard: Erosion</th></tr>
<tr><td colspan="9">Goal(s): 4, 7, 8, 9
Objective(s): 4.1, 4.3, 7.1, 7.2, 8.1, 8.2, 9.1</td></tr>
<tr><td rowspan="4">Project
ER-4</td><td>Action Type</td><td>Implementation Schedule</td><td>Estimated Cost</td><td>Potential Funding</td><td>Lead</td><td>Community Lifeline</td><td>Social Vulnerability</td><td>Jurisdiction(s)</td></tr>
<tr><td>Planning and Regulations</td><td>Short-term (1 to 3 years)</td><td>$500,000</td><td>Note: Potential grant sources listed below.</td><td>Resilience Authority</td><td>Safety and Security</td><td>N/A</td><td>County</td></tr>
<tr><td colspan="8">Action: Galesville Community Waterfront Resilience Project.</td></tr>
<tr><td colspan="8">Background and/or Plan Reference: Develop a master plan to enhance the Galesville peninsula community waterfront by protecting against shoreline damage and coastal erosion in a manner that improves public safety, community connectivity and water access. Opportunities to use a variety of natural shoreline/green infrastructure approaches to protect community assets and address stormwater issues.

Exploring grants with the Chesapeake Bay Trust's Capacity Building Initiative, Arundel Community Development Corporation's Community Development grants, US DOT's Safe Streets for All grant program, and the PROTECT grants administered by the FHA and SHA to enhance Galesville waterfront, by protecting against shoreline damage and coastal erosion in a manner that improves public safety, community connectivity and water access.</td></tr>
</table>

Primary Hazard: Soil Movement								
Goal(s): 3, 4, 7, 9 Objective(s): 3.2, 3.3, 4.3, 7.1, 7.2, 9.1								
Project SM-1	Action Type	Implementation Schedule	Estimated Cost	Potential Funding	Lead	Community Lifeline	Social Vulnerability	Jurisdiction(s)
	Natural Resources Protection & Structure and Infrastructure Project	Long-term (5+ years)	Staff time	County budget	Anne Arundel Soil Conservation District	Safety and Security	N/A	County, Highland Beach
	Action: Investigate locations in Anne Arundel County identified as potentially vulnerable to land slide or sinkholes and determine appropriate mitigation projects, if any.							
	Background and/or Plan Reference: Areas that are generally prone to landslide hazards include previous landslide areas, the bases of steep slopes, the bases of drainage channels, and developed hillsides where leach-field septic systems are used. Anne Arundel County has experienced few sinkholes in the past, most of which are along roadways. Areas that are typically considered safe from landslides include areas that have not moved in the past, relatively flat-lying areas away from sudden changes in slope, and areas at the top or along ridges, set back from the tops of slopes. Vulnerable locations and associated risks include: • South River & Severn River Areas: Steep slopes prone to erosion and landslides, especially after heavy rain. • Highland Beach: Identified as having slopes 25% or greater, increasing landslide susceptibility. • Riverine & Flood-Prone Areas: At risk due to soil erosion and human-induced factors such as deforestation and development. • Developed Hillsides with Leach-Field Septic Systems: Soil instability risks heightened by septic system leakage. • Central County Steep Slopes: Highly erodible soils in residential and rural zones requiring targeted mitigation.							

Primary Hazard: Soil Movement

Goal(s): 1, 2, 4, 9

Objective(s): 1.1, 1.3, 2.1, 2.2, 4.1, 4.7, 9.1

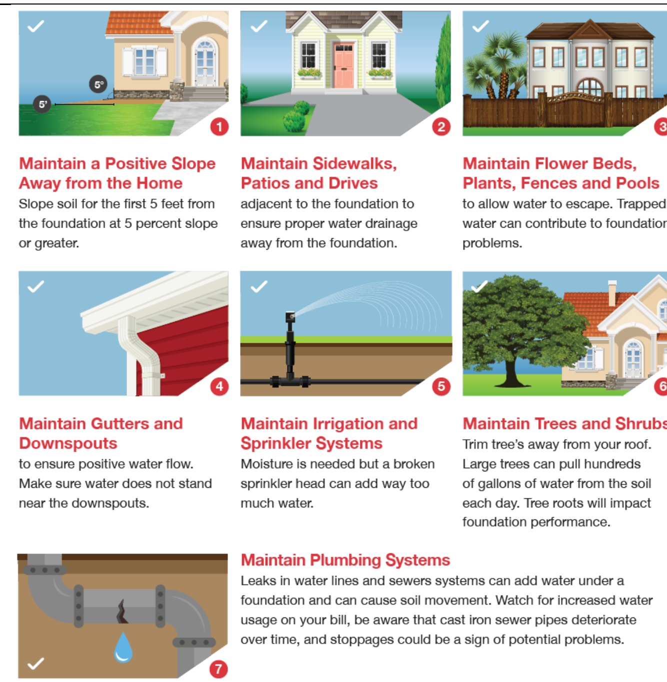
	Action Type	Implementation Schedule	Estimated Cost	Potential Funding	Lead	Community Lifeline	Social Vulnerability	Jurisdiction(s)
Project SM-2	Education and Awareness	Ongoing	Staff time	County budget	OEM, OPZ (as support as property owners apply for subdivision and dev. Permits)	Safety and Security	Information needs to be made available in multiple formats and languages.	County, Highland Beach

Action: Develop an outreach campaign that teaches the public to identify and recognize the signs of soil movement (landslide or sinkhole) before it becomes a hazard.

Background and/or Plan Reference: To detect a soil movement hazard, look for visual signs like cracks in the ground, leaning trees or utility poles, uneven or shifting fences, changes in drainage patterns, bulges in the soil, and visible movement of the ground surface, especially on slopes; further investigation can involve monitoring with specialized instruments like inclinometers or GPS to measure precise soil displacement.

Homeowners can protect their homes from soil movement by installing proper drainage systems like gutters and downspouts, grading the land around the foundation to direct water away, planting deep-rooted vegetation on slopes, and in cases of significant slope, constructing retaining walls to hold back soil and prevent erosion; regular monitoring of drainage and soil conditions is also crucial.

Outreach efforts can include through appropriate social media channels, utilizing ready-made public outreach material from FEMA and Ready.gov. Additionally, the County's website already has extensive webpages with information for various hazards included in the hazard mitigation plan. The website could be updated with information related to soil movement (landslides and sinkholes).



Primary Hazard: Emerging Infectious Diseases								
Goal(s): 1, 2, 4, 5 Objective(s): 1.1, 1.3, 2.1, 2.2, 4.1, 4.3, 5.1								
Project EID-1	Action Type	Implementation Schedule	Estimated Cost	Potential Funding	Lead	Community Lifeline	Social Vulnerability	Jurisdiction(s)
	Education and Awareness	Ongoing	Staff time	County budget	Department of Health	Health and Medical	Identified below.	County, Highland Beach, City of Annapolis
	Action: Partner with the Dept of Aging and Disabilities, OEM, and other health equity groups to provide public health information and outreach to vulnerable groups and populations on emerging infectious diseases. Ensure that all health-related announcements, information, and materials are accessible to all socially vulnerable groups, including but not limited to those: over the age of 65, under the age of 5, with limited English-speaking proficiency, with disability, and those at or below the poverty line. Coordinate with the City of Annapolis and Highland Beach on distribution.							
	Background and/or Plan Reference: Health outreach materials for vulnerable populations should be designed to be easily understood, culturally sensitive, and accessible, focusing on key health concerns relevant to the specific group, including information about available services, how to access them, and contact details, often utilizing simple language, visuals, and community-based distribution methods to reach the target audience effectively; examples include flyers promoting preventative screenings, brochures explaining chronic disease management, or community event posters highlighting mental health support services, all tailored to specific vulnerable populations like the homeless, elderly, or individuals with limited English proficiency. Anne Arundel County participated in the Maryland Department of Health Office of Preparedness and Response 2025 Jurisdictional Risk Assessment and health and preparedness workers in Anne Arundel County identified the following as vulnerable populations to emerging infectious diseases: • Elderly residents • Residents with disabilities • Individuals experiencing homelessness • Low-income residents • Essential workers (due to their inability to avoid work during hazardous conditions) • Non-English speaking residents							

<table>
<tr><th colspan="9">Primary Hazard: Emerging Infectious Diseases</th></tr>
<tr><td colspan="9">Goal(s): 1, 2, 4, 9
Objective(s): 1.1, 1.3, 2.1, 2.2, 4.1, 4.7, 9.1</td></tr>
<tr><td rowspan="5">Project
EID-2</td><td>Action Type</td><td>Implementation Schedule</td><td>Estimated Cost</td><td>Potential Funding</td><td>Lead</td><td>Community Lifeline</td><td>Social Vulnerability</td><td>Jurisdiction(s)</td></tr>
<tr><td>Education and Awareness</td><td>Ongoing</td><td>Staff time</td><td>County budget</td><td>Department of Health</td><td>Health and Medical</td><td>Identified in EID-1</td><td>County, Highland Beach</td></tr>
<tr><td colspan="8">Action: Increase ongoing and long-term health-related public outreach efforts throughout the County as population, tourism, and development continue to grow as projected.</td></tr>
<tr><td colspan="8">Background and/or Plan Reference: Population and tourism are projected to grow for Anne Arundel County. The new development accompanying this growth will increase the total vectors (i.e., people) of disease spread. More people mean more pathways for an infectious disease to spread. As the population of Anne Arundel County grows, residents and visitors will need to continue to take safety precautions and listen to trustworthy health sources when they warn of potential new infectious diseases. High-density areas are at risk for EIDs because of the increased contact and interaction between people. This can lead to the rapid spread of EIDs, especially in large urban centers with strong tourism. Guidelines and public health policies for preventing the spread of infectious diseases will have to be enforced in these high-density areas in the County; the best example of this type of development is in North County.

Increased development as projected in Anne Arundel County can affect EIDs in the following ways:
• Land use changes – Agricultural expansion and urbanization can lead to habitat conversion, which can cause humans to encounter animals and insects that may carry infectious agents. For example, deforestation and reforestation can influence the emergence of pathogens, such as Lyme disease.
• Population movement – As human populations grow and move into new areas; it increases the likelihood of humans encountering animals that may carry infectious agents.
• Overcrowding – In rapidly growing cities and urban areas, infrastructure strain can disrupt public health measures, which can allow newly introduced infections to establish themselves.
• Climate change – As the Earth's climate warms, diseases can spread into new areas, such as when mosquitoes and the diseases they carry expand their range.

Additionally, utilize results of the Social Vulnerability Index (SVI) mapping (or MD's environmental justice screening tool) to identify potentially under-served and/or underrepresented communities at the census tract level. Including emerging infectious diseases, these areas are likely to be impacted by multiple hazards. Targeted outreach efforts should be attempted to “bridge the gap” in access to information and services as it relates to natural hazards.</td></tr>
</table>

Primary Hazard: Public Disorder and Active Assailant								
Goal(s): 1, 2, 4, 9 Objective(s): 1.1, 1.3, 2.1, 2.2, 4.1, 4.3, 9.1								
Project PD/AA-1	Action Type	Implementation Schedule	Estimated Cost	Potential Funding	Lead	Community Lifeline	Social Vulnerability	Jurisdiction(s)
	Education and Awareness	Ongoing	Staff time	ARPA	Police Department	Safety and Security Communications	See below.	County & Highland Beach
	Action: Continue to work with the community to prepare better for future events. An example is C.R.A.S.E (Civilian Reaction Active Shooter Events) and "Stop the Bleed" training. These are courses offered by the Anne Arundel County Police Department and will help prepare residents to have a plan and to be prepared.							
	Background and/or Plan Reference: Community Police Academy provides Anne Arundel County residents, 21 years of age and older, an opportunity to learn about laws, police procedures, forensics, crime scene collections, resource management and more. The goal of this program is to build bridges between the communities and the police department. This is accomplished by offering an opportunity to gain a better understanding of the department and to develop a relationship with the community members through education and training. The Community Police Academy allows community members to learn what resources are available to them through the Police Department. It also allows the communities to bond with the department and form a "partnership." The Community Police Academy is 11 weeks (sessions) long. The sessions are held once a week for 3 hours on Thursdays during the course at various locations throughout the County. **Plan Reference – Section 3.3.15.** FBI Active Assailant Safety Resources: The FBI defines an "active shooter" as one or more individuals actively engaged in killing, attempting to kill people, or cause serious bodily injury to a group or group of persons in a populated area. Recent active assailant incidents have underscored the need for a coordinated response by law enforcement and other first responders to save lives. People in commercial areas, places of business, educational institutions, open spaces, and government facilities are most at risk during active assailant events. The FBI is committed to working with its partners to protect schools, workplaces, houses of worship, medical facilities, transportation centers, government facilities, other public gathering sites, and communities.							

<table>
<tr><th colspan="9">Primary Hazard: Public Disorder and Active Assailant</th></tr>
<tr><td colspan="9">Goal(s): 1, 3, 4, 9
Objective(s): 1.1, 1.3, 3.3, 3.6, 4.3, 9.1</td></tr>
<tr><td rowspan="4">Project PD/AA-2</td><td>Action Type</td><td>Implementation Schedule</td><td>Estimated Cost</td><td>Potential Funding</td><td>Lead</td><td>Community Lifeline</td><td>Social Vulnerability</td><td>Jurisdiction(s)</td></tr>
<tr><td>Structure and Infrastructure</td><td>Short-term (1 to 3 years)</td><td>Facility-dependent</td><td>Highway Safety Grants
MDOT's Complete Streets</td><td>Police Department</td><td>Safety and Security
Transportation</td><td>N/A</td><td>County & Highland Beach</td></tr>
<tr><td colspan="8">Action: Evaluate public buildings and facilities for emergency response protocols. Future designs could incorporate the following: more lighting systems in public places, increased pedestrian and bicycle traffic, utilization of vacant land, increased video imaging for public safety, increased red light traffic cameras, increased security of homes and commercial space.</td></tr>
<tr><td colspan="8">Background and/or Plan Reference: Creating safe environments planning refers to the process of proactively identifying potential hazards and developing strategies to mitigate risks in a specific setting, whether it be a workplace, school, community, or home, by implementing preventative measures, clear safety protocols, and consistent communication to ensure the well-being and safety of all individuals present.
Key aspects of creating safe environments planning:
Risk assessment: Conducting thorough evaluations to identify potential hazards, including physical hazards (slips, trips, falls), chemical exposure, electrical risks, and behavioral issues.
Policy development: Establishing clear safety guidelines, rules, and procedures that address identified risks, outlining responsibilities for staff and individuals.
Physical environment design: Modifying spaces to minimize hazards by ensuring proper lighting, clear pathways, well-maintained equipment, and appropriate signage.
Training and education: Providing regular safety training to all relevant personnel, including staff, volunteers, and community members, covering emergency response procedures, hazard recognition, and proper safety practices. Additionally, improve public understanding of video monitoring for public safety via outreach and education.
Communication and reporting: Establishing clear channels for reporting incidents, near-misses, and concerns, ensuring timely response and follow-up actions.
Emergency preparedness: Developing comprehensive emergency response plans with designated roles, evacuation procedures, and necessary equipment to handle potential emergencies.</td></tr>
</table>

Primary Hazard: Transportation Accidents								
Goal(s): 1, 4, 8, 9 Objective(s): 1.1, 1.4, 4.3, 8.2, 9.1								
Project TA-1	Action Type	Implementation Schedule	Estimated Cost	Potential Funding	Lead	Community Lifeline	Social Vulnerability	Jurisdiction(s)
	Local Planning and Regulations,	Ongoing	Project dependent. (Current highway safety grant recipients through 2030 total $13.3 million)	Federal Highway Safety Grants, State Highway Safety Grants	Bureau of Highways Police Depart	Transportation Safety and Security	N/A	County & Highland Beach
	Action: Reduce the number of highway transportation accidents through programs such as the Highway Safety Improvement Program and participation in the Maryland Zero Deaths Program.							
	Background and/or Plan Reference: Maintaining and enhancing transportation infrastructure will be necessary to meet the demands of future development. As the population grows, the number of housing units and other structures near major highways, active rail lines, and the airport will likely also rise and therefore increase vulnerability. The Highway Safety Improvement Program (HSIP) is a core Federal-aid program with the purpose to achieve a significant reduction in traffic fatalities and serious injuries on all public roads, including non-State-owned roads and roads on tribal land. The HSIP requires a data-driven, strategic approach to improving highway safety on all public roads with a focus on performance. The HSIP consists of three main components, the Strategic Highway Safety Plan (SHSP), State HSIP or program of highway safety improvement projects and the Railway-Highway Crossing Program (RHCP). In addition, some states also have a High Risk Rural Roads (HRRR) program if they had increasing fatality rate on rural roads. The Maryland Strategic Highway Safety Plan (SHSP) is a statewide, coordinated, comprehensive, traffic safety plan to reduce highway fatalities and serious injuries on all public streets and highways. It establishes overall goals and objectives, as well as strategies within each of six key areas. SHSP is a working document covering the years 2016 through 2020. The plan was formulated after years of improved highway safety. Despite increases in vehicle miles traveled, reported traffic crashes declined in Maryland, dropping to a historic low of 96,392 in 2009. Between 2005 and 2009, the number of fatalities decreased by 10.4 percent, overall injuries decreased by 14.4 percent, and serious injuries declined by 39.9 percent. To continue this positive trend, Maryland updated the plan in 2010 under the direction of the SHSP Management and Implementation Teams. Safety is a State priority. Maryland joined the American Association of State Highway and Transportation Officials (AASHTO), other national organizations and several other states in adopting a Toward Zero Deaths fatality goal to reduce motor vehicle-related fatalities and injuries by one-half by 2030. Each emphasis area also adopted measurable fatality and injury objectives in line with these goals. https://zerodeathsmd.gov/highway-safety-office/strategic-highway-safety-plan/ **Plan Reference – Section 3.3.16.** As of September 13, 2024, Anne Arundel County Police received a federal grant of $56,000 as part of this program. As of September 13, 2024 Anne Arundel County Police received a state grant of $8,000 as part of this program.							

Primary Hazard: Cyber Attack								
Goal(s): 3, 4, 8, 9 **Objective(s): 3.6, 4.3, 8.2, 9.1**								
Project CA-1	**Action Type**	**Implementation Schedule**	**Estimated Cost**	**Potential Funding**	**Lead**	**Community Lifeline**	**Social Vulnerability**	**Jurisdiction(s)**
	Structure and Infrastructure	Ongoing	Staff time	SLCGP, County budget	OIT	Safety and Security	N/A	County & Highland Beach
	Action: Ensure County records are secure. This includes resident personal and financial information, including tax filings, birth and death records, Social Security numbers, medical information, and more.							
	Background and/or Plan Reference: The Cybersecurity team is responsible for implementing an effective, County-wide information security program that involves the management of information and information system risks. Responsibilities include developing OIT security policies and standards, ensuring security requirements, including necessary security controls, are integrated into the County's enterprise architecture and system development life cycle processes, and aligning information system-related security risks with the County's mission objectives and overall risk strategy. Additionally, ensure the COOP is compliant with cyber security – example: workers need to be able to rely on technology in order to telework. Also refer to Action Item AH-5. **Plan Reference – Section 3.3.17.**							

Primary Hazard: All Hazards								
Goal(s): 1, 4, 9 Objective(s): 1.1, 1.3, 4.3, 9.1								
Project AH-1	**Action Type**	**Implementation Schedule**	**Estimated Cost**	**Potential Funding**	**Lead**	**Community Lifeline**	**Social Vulnerability**	**Jurisdiction(s)**
	Planning and Regulations	Ongoing	Staff time	County budget	OEM	All Lifelines	Need EOP in multiple formats and languages.	County
	Action: Update and adopt the local Emergency Operations Plan.							
	Background and/or Plan Reference: The Anne Arundel County Emergency Operations Plan (EOP) is a multi-discipline, all-hazards plan that establishes a single, comprehensive framework for the management of major emergencies and disasters within the County. The EOP provides guidelines on roles and responsibilities to prevent, mitigate, prepare for, respond to, and recover from the effects of natural, man-made, and technological disasters as well as other major incidents and hazards. The EOP was last updated in 2018.							

Primary Hazard: All Hazards								
Goal(s): 1, 3, 4, 8 Objective(s): 1.1, 1.4, 3.2, 3.6, 4.3, 8.3								
Project AH-2	**Action Type**	**Implementation Schedule**	**Estimated Cost**	**Potential Funding**	**Lead**	**Community Lifeline**	**Social Vulnerability**	**Jurisdiction(s)**
	Structure and Infrastructure	Short-term (1-3 years for analysis of generator needs) Long-term (5+ years for generator upgrades, as needed)	Based on needs of individual shelters, cost is primarily based on size needs.	HMA grants (incl. HMGP, BRIC)	OEM	Energy	N/A	County
	Action: Assure back-up power source at mass care shelters.							
	Background and/or Plan Reference: The Office of Emergency Management coordinates with Anne Arundel County Public Schools to utilize the following high schools as shelters: • Annapolis High School • Meade High School • Northeast High School • Severna Park High School • Southern High School • Crofton High School • Severn Run High School • Future: Old Mill High School A mass care shelter typically relies on portable or permanently installed generators as the primary backup power source, providing electricity during power outages when the main grid is unavailable; depending on the shelter's needs, additional options like Uninterruptible Power Supplies (UPS) might be used for sensitive electronics. The County owns three 350kW generators to serve as backup generators. Of the five approved shelters, only Annapolis and Severna Park have transfer switches and wiring complete to provide a backup generator if power fails. Currently, there are three elementary schools wired for emergency generators; however, they are not practical to utilize due to the smaller lavatory facilities. Once the electrical system is fixed, Northeast High School will be approved as a shelter.							

<table>
<tr><th colspan="9">Primary Hazard: All Hazards</th></tr>
<tr><td colspan="9">Goal(s): 1, 4, 9
Objective(s): 1.3, 1.5, 4.3, 9.1</td></tr>
<tr><td rowspan="4">Project
AH-3</td><td>Action Type</td><td>Implementation Schedule</td><td>Estimated Cost</td><td>Potential Funding</td><td>Lead</td><td>Community Lifeline</td><td>Social Vulnerability</td><td>Jurisdiction(s)</td></tr>
<tr><td>Local Planning and Regulation</td><td>Ongoing, every 3 years</td><td>Staff time</td><td>County budget</td><td>OEM</td><td>Communications</td><td>N/A</td><td>County</td></tr>
<tr><td colspan="8">Action: Maintain Integrated Public Alert and Warning System (IPAWS) Certification.</td></tr>
<tr><td colspan="8">Background and/or Plan Reference: Anne Arundel County uses IPAWS to send emergency alerts to residents. IPAWS messages are sent through the Emergency Alert System (EAS) and Wireless Emergency Alerts (WEA).

Benefits and uses of IPAWS:
Authorized users send alerts through IPAWS
Alerts are sent via radio, television, and other media
WEA are sent to cell phones
Alerts can be for emergencies like missing persons, hazardous chemical spills, and evacuations
Alerts can also be for non-emergencies like significant transportation problems or police activity
Residents can sign up for Alert Anne Arundel to receive alerts to their phone or email
According to FEMA, the IPAWS alerting certification, known as the Memorandum of Agreement, must be renewed every three years. The digital certification expires after three years.</td></tr>
</table>

Primary Hazard: All Hazards

Goal(s): 1, 3, 4, 9

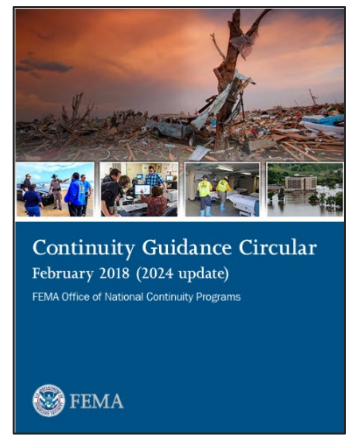
Objective(s): 1.3, 1.4, 3.6, 4.3, 9.1

Project	Action Type	Implementation Schedule	Estimated Cost	Potential Funding	Lead	Community Lifeline	Social Vulnerability	Jurisdiction(s)
Project AH-4	Local Planning and Regulation	Medium-term (3 to 5 years)	Consultant - $50,000, in addition to staff time	County budget, FEMA Preparedness Grants	OEM	All Lifelines	N/A	County

Action: Develop a Countywide Continuity of Operations Program.

Background and/or Plan Reference: A County-wide Continuity of Operations (COOP) program is a plan that ensures critical functions continue during emergencies. The plan includes procedures, resources, and information to respond to threats and hazards. The purpose of the COOP is to ensure the safety of people, protect assets and resources, resume services and processes as quickly as possible, and to minimize loss of vital records and data. The plan should also address the impacts to COOP caused by a cyber incident. Increase overall awareness of this type of planning process.

FEMA's Continuity Guidance Circular (CGC) provides a framework/template and instructions for developing a continuity of operations plan. The plan should include four phases: Readiness and preparedness, Activation and relocation, Continuity operations, and Reconstitution.



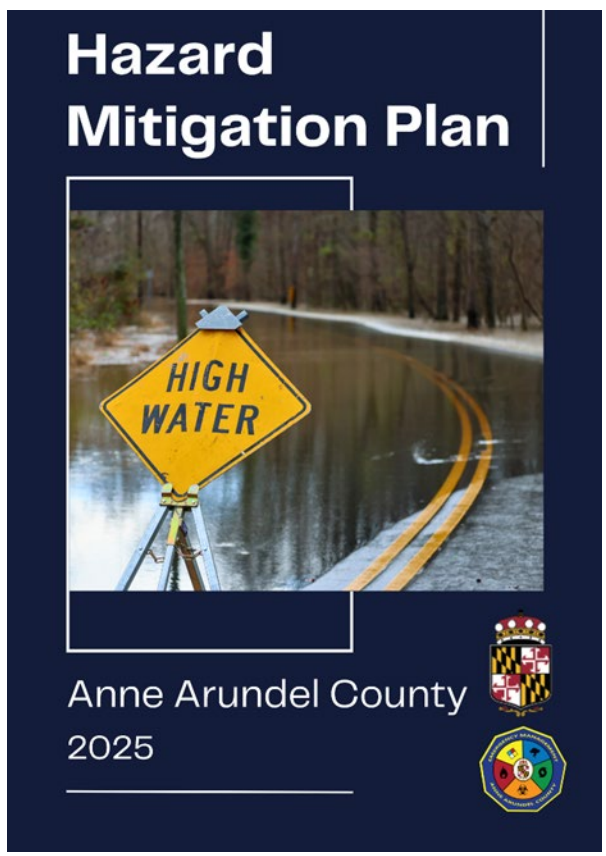
Steps for developing a continuity of operations plan:

1. Form a collaborative team
2. Understand the situation
3. Determine goals and objectives
4. Develop the plan
5. Prepare, review, and approve the plan
6. Implement and maintain the plan

Additionally, FEMA offers a Continuity of Operations Plan Template and Instructions guide that local jurisdictions can reference and utilize to develop their own local COOP. https://www.fema.gov/pdf/about/org/ncp/coop/continuity_plan_federal_d_a.pdf

Plan Maintenance

Contents of this Section



6.0 Plan Maintenance

The 2025 HMP update is a blueprint for reducing risk and protecting community investments. Having a process for maintaining the plan reflects the recognition that things change. Not only is there a need to track progress on implementing the mitigation strategy, but new information may become available, and disasters may happen. The plan needs to be revisited at regular intervals to keep it relevant, and the County needs to decide how that will be done. At a minimum, this must be done every five years, but it should also be done after major disaster events or if new conditions significantly change risk.

Plan maintenance means keeping the plan accurate, current, and relevant over the five-year approval period. It includes monitoring, evaluating and updating the plan – and generally keeping the planning process active.

D1. Is there discussion of how each community will continue public participation in the plan maintenance process? **(Requirement 44 CFR § 201.6(c)(4)(iii))**

D2. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a five-year cycle)? **(Requirement 44 CFR § 201.6(c)(4)(i))**

D3. Does the plan describe a process by which each community will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? **(Requirement 44 CFR § 201.6(c)(4)(ii))**

6.1 Monitoring, Evaluating, & Updating

Monitoring, evaluating, and updating the 2025 HMP update is critical to maintaining its value and success in Anne Arundel County's hazard mitigation efforts. Ensuring effective implementation of mitigation activities paves the way for continued momentum in the planning process and gives direction for the future. This section explains who will be responsible for maintenance activities and what those responsibilities entail. It also provides a methodology and schedule of maintenance activities including a description of how the public will be involved on a continued basis.

An adopted HMP faces the truest test of its worth: implementation. While this plan contains many worthwhile actions, the County will need to decide which action(s) to undertake first. Two factors will help with making that decision: the priority assigned the actions in the planning process and funding availability. Low or no-cost actions most easily demonstrate progress toward successful plan implementation.

An important implementation mechanism that is highly effective and low-cost is incorporation of the 2025 HMP update recommendations and their underlying principles into other plans and mechanisms. This plan builds upon the momentum developed through previous and related planning efforts and recommends implementing actions, where possible, through other mechanisms. HMPC members involved in these other planning mechanisms will be responsible for integrating the findings and recommendations of this plan with other plans, programs, as appropriate. Implementation, incorporation into existing planning mechanisms will be done through the routine actions of:

- Monitoring other planning/program agendas
- Attending other planning/program meetings
- Participating in other planning processes
- Monitoring community budget meetings for other community program opportunities

The successful implementation of the 2025 HMP update will require constant and vigilant review of existing plans and programs for coordination and multi-objective opportunities that promote a safe, sustainable community.

Mitigation is most successful when it is incorporated into the day-to-day functions and priorities of government and development. Implementation will be accomplished by adhering to the schedules identified for each action and through constant, pervasive, and energetic efforts to network win-win benefits to County programs. Simultaneously to these efforts, it is important to maintain a constant monitoring of funding opportunities that can be leveraged to implement some of the more costly recommended actions. When funding does become available, the County will be able to capitalize on the opportunity. Funding opportunities to be monitored include special pre- and post-disaster funds, state and federal earmarked funds, benefit assessments, and other grant programs, including those that can serve or support multi-objective applications.

The Anne Arundel County OEM is designated to lead plan maintenance processes of monitoring, evaluation and updating with support and representation from the Town of Highland Beach. OEM will coordinate maintenance efforts, but the input needed for effective periodic evaluations will come from County department leads, HMPC members, and other stakeholders that actively participated in the 2025 plan update, and the public. In addition, OEM will serve in an advisory capacity to the Anne Arundel County Council and other Departments within the County.

The Town of Highland Beach should designate a community representative (currently the Mayor) to monitor the implementation of the mitigation strategy and seek funding opportunities to address the hazards facing their community. This individual will be asked to work with OEM to provide updates on applicable mitigation actions and feedback on changing hazard vulnerabilities within their community. In addition, this individual will be responsible for reviewing the planning and land use regulatory element of the community's capability assessment to identify potential opportunities for incorporating appropriate elements of the 2025 HMP update into local planning mechanisms.

Similarly, the Anne Arundel County Office of Planning and Zoning will lead the effort to integrate mitigation goals, objectives, and actions into County comprehensive planning efforts. While the Comprehensive Plan will not include detailed information from the risk assessment and mitigation strategy, the 2025 HMP update will continue to be referenced to ensure this information is addressed in the comprehensive planning process. The Office of Planning and Zoning will report to the OEM the progress of these actions and will identify if there are changes that need to be made to the risk assessment or the mitigation strategy based on information developed during the comprehensive planning process.

The Resilience Authority of Annapolis and Anne Arundel County will undertake and support resilience infrastructure projects that mitigate the effects of climate change by offering a range of financing structures, forms, techniques and leverages public and private investment and stimulates demand for resilience infrastructure projects throughout Anne Arundel County. The Resilience Authority can work in partnership with OEM and the Office of Planning and Zoning to accelerate infrastructure financing, reduce the cost of implementation, and mitigate and manage the risks of climate change.

6.2 Method & Schedule

OEM will oversee the progress made on the implementation of action items identified and modify actions, as needed, to reflect changing conditions. OEM will meet annually to evaluate the plan and discuss specific coordination efforts that may be needed with the Town of Highland Beach and other stakeholders. Annual evaluations of the 2025 HMP update will include an investigation of whether mitigation actions were completed, and an assessment of how effective those actions were in mitigating potential losses. The review will include a qualitative and quantitative analysis of benefits (or avoided losses) and a determination of whether on-going mitigation actions should be discontinued or modified in any way. Progress will be documented by the HMPC and submitted to OEM for future updates. As part of the commitment to maintain the 2025 HMP update the OEM will be responsible for the following:

- Monitor and track the implementation of High, Medium, and Low Priority Mitigation Actions and projects identified in Section 5, and the County's progress towards incorporating the hazard mitigation goals and strategies into local building and construction codes, the General Development Plan, and the Floodplain Management program.
- Evaluate the HMP on an annual basis to ensure its continued effectiveness in achieving the stated purpose, goals, mitigation strategies and actions that best addresses the needs of the community.
- Undertake a full review and update of the HMP once every 5 years to ensure the County follows FEMA requirements, the 2021 Maryland Hazard Mitigation Plan and other federal, state, and local planning mechanisms. These efforts will ensure the County maintains eligibility for federal disaster assistance funding and hazard mitigation grants. Following the approval of the 2025 HMP update, OEM will be responsible for completing the following activities for future HMP updates:
- Initiating and undertaking a public information, outreach, and stakeholder campaign to engage partners, stakeholders, and citizens in the planning and update process of the HMP and ensure the final 2025 HMP update represents the needs of the community.
- Managing and coordinating a series of public meetings to include a public comment period and maintenance of all public records, documents and comments related to public meetings, and the public information, outreach, and stakeholder campaign; providing access to current and proposed 2025 HMP update documents at local libraries and on the OEM website; and ensuring sufficient opportunity is provided to receive public input and participation in the planning, update, and maintenance of the 2025 HMP update.
- Utilizing information technology, information systems and social media to disseminate, collect and assess public input and comments.
- Announcing public meetings, work sessions, and public hearings using electronic and print media to engage the media and broader participation by the public and ensure the update of the HMP represents the needs of the community.
- Reviewing and updating the 2025 HMP update should the County be impacted by a

disaster for which there is a Presidential Disaster Declaration to capture any "lessons learned" and to ensure the evolution of the document continues to meet the needs of the community.
- Assess what mitigation actions and projects should be considered by the County to reduce or prevent future losses and damage to property, infrastructure, critical facilities, and other vulnerable structures that were experienced in the community during the disaster event.
- Based on the results of damage assessments, submit recommendations on future mitigation strategies, actions, and projects to include in the next HMP update.

This Plan will be updated, as required by the Disaster Mitigation Act of 2000, or following a disaster event. Future updates will account for any new hazard vulnerabilities, special circumstances, or new information that becomes available. During the five-year review process, the following questions will be considered for assessing the effectiveness of the Plan.

- Has the nature or magnitude of hazards affecting the County changed?
- Are there new hazards that have the potential to impact the County?
- Do the identified goals and actions address current and expected conditions?
- Have mitigation actions been implemented or completed?
- Has the implementation of identified mitigation actions resulted in expected outcomes?
- Are current resources adequate to implement the plan?
- Should additional local resources be committed to address identified hazards?

6.3 Plan Amendment Process

Any necessary revisions to the 2025 HMP update elements will follow the plan amendment process outlined in State and FEMA guidance. For changes and updates to the Town of Highland Beach portions of the 2025 HMP update, local designees will assign responsible agents for completing each task.

Administrative changes may be made at any time by the Anne Arundel County OEM, HMP Coordinator, or his/her designee and documented in the Record of Changes. Mitigation Actions may be changed, updated, removed, or added, as long as the change or addition is approved by the HMPC.

Changes to the 2025 HMP update for Implementation and Integration, other than administrative changes, e.g., agency name changes or corrections that do not change the hazard risks, vulnerabilities, or intent of the mitigation strategy—will necessitate the approval and adoption of the changes by County Council and appropriate department leads and recorded by Anne Arundel County OEM. The changes will also be submitted to MDEM and FEMA for approval and record keeping.

OEM will forward information on any proposed changes to all interested parties including, but not limited to, all impacted departments, individuals, and businesses. When proposed amendments directly impact Sections of the Plan or specific mitigation projects the County will:

- Follow County, State, or Federal requirements on publishing public announcements or undertaking direct mailings.
- Submit any proposed plan amendments to MDEM and FEMA for approval.
- Seek public input on the proposed amendments for public review and comment.

- At the end of the public review and comment period, forward the proposed amendment(s) and all public comments to the HMPC for final consideration.

The HMPC will review the proposed amendments with the public comments received and submit recommendation to approve, adopt or deny the changes to the Plan within 60 days. In evaluating an amendment request, the following factors will be considered by the HMPC:

- New issues or needs have been identified that are not adequately addressed in the Plan
- There has been a change in information, data, or assumptions from those on which the Plan is based.
- There has been a change in capabilities to implement proposed hazard mitigation activities.

Upon receiving the recommendation from the HMPC and prior to the adoption of the amended Plan, OEM will seek a resolution to adopt the Plan amendment and any suggested modifications or revisions from the Anne Arundel County Council. Once adopted, OEM will provide the resolution to MDEM and FEMA. To establish a more clearly defined system of plan maintenance that will continue in future planning cycles, the roles and responsibilities and the monitoring procedure and schedule, including the step-by-step actions and specific tasks associated with each action to maintain the plan, are defined below.

6.4 Monitoring the 2025 Plan Update

Table 6.1-1: Hazard Mitigation Plan Monitoring Roles and Responsibilities

Stakeholder	Roles and Responsibilities
Anne Arundel OEM HMP Coordinator/Designee	• Coordinate and facilitate the monitoring process. • Initiate and maintain a schedule of monitoring activities. • Collect data and disseminate Mitigation Action reports. • Maintain records and documentation of all monitoring activities.
HMPC/Town of Highland Beach Representative	• Participate in the monitoring process as requested by the OEM HMP Coordinator. • Assist in collecting annual updates and maintaining reports. • Disseminating reports to stakeholders and the public. • Maintain records and documentation of all monitoring activities. • Promote the mitigation planning process with the public and solicit public input.

The following steps will be taken to monitor the progress of mitigation projects and plan implementation on an annual basis and following a Federally Declared Disaster event.

Step 1: Initiate Monitoring Process

- The Anne Arundel OEM HMP Coordinator/Designee will notify the HMPC and the Town of Highland Beach representatives to facilitate an annual or post-disaster review that undertakes the following:

- Disseminate the Mitigation Action Form for mitigation action updates to the HMPC/Town of Highland Beach representatives, along with the current list of mitigation actions in the Plan.

Step 2: Collect and assess the status of current actions and identify new actions

- Anne Arundel OEM HMP Coordinator/Designee and HMPC/Town of Highland Beach Representatives will assess progress for current actions, including implemented and funded actions and any new opportunities for mitigation actions.
  - Have any mitigation actions been completed?
  - Are different or additional resources now available?
  - Are mitigation actions being implemented and monitored?

Step 3: Assess new opportunities for mitigation

- The Anne Arundel OEM HMP Coordinator/Designee and HMPC/Town of Highland Beach Representatives will assess new opportunities for mitigation based on the following:
  - Has a major disaster occurred that presents opportunities for mitigation?
  - Is there a new initiative, agency priority, existing planning mechanism, or information that is not represented in current actions?

Step 4: Review the current actions and opportunities provided

- Anne Arundel OEM HMP Coordinator/Designee will review the current actions and opportunities provided and determine whether an amendment to the Plan is needed based on:
  - Any new issues or needs that are not adequately addressed in the Plan.
  - There has been a change in current information, data, or assumptions represented in the Plan.
  - There has been a change in capabilities that affect the implementation of the Plan or hazard mitigation activities.

6.5 Evaluating the 2025 Plan Update

This plan evaluation step assesses the plan's effectiveness in achieving its stated purpose and goals.

Table 6.1-2: Hazard Mitigation Plan Evaluation Roles and Responsibilities

Stakeholder	Roles and Responsibilities
Anne Arundel OEM HMP Coordinator/Designee	● Coordinate and facilitate the evaluation process. ● Maintain a schedule of evaluation activities. ● Collect data and disseminate Mitigation Action forms. ● Maintain records and documentation of all evaluation activities.
HMPC/Town of Highland Beach Representative	● Participate in the evaluation process. ● Assist in collecting and analyzing information. ● Assist in disseminating reports to stakeholders and the public. ● Maintain records and documentation of evaluation activities. ● Promote the mitigation planning process with the public and solicit public input.

The following process describes how the HMPC and the Town of Highland Beach will evaluate the effectiveness of the 2025 HMP update annually and/or following a Federally Declared Disaster or significant hazard event.

Table 6.1-3: Hazard Mitigation Plan Evaluation Procedure and Schedule

Action	Responsible Party	Task	Deliverable/Outcome
Initiate Annual Review	Anne Arundel OEM HMP Coordinator/Designee	Notify HMPC and Town of Highland Beach Representative to facilitate annual review.	Work plan, schedule, and assigned resources to implement the plan review process.
Invite HMPC, Town of Highland Beach Representative & Stakeholders	Anne Arundel OEM HMP Coordinator/Designee	Invite HMPC, the Town of Highland Beach Representative, key stakeholders, and others to participate in the plan evaluation process.	Invitation to participate, list of invites, existing and new stakeholders, and other key planning partners and public notice of annual evaluation.
Review Policies, Regulations, & Studies	Anne Arundel OEM HMP Coordinator/Designee & HMPC	Research new or updated laws, policies, regulations, initiatives, and studies that contribute to the hazard risk assessment or identified mitigation actions.	Status update for existing and new policies, regulations, initiatives, and/or studies.
Review Funding Programs and Planning Mechanisms	Anne Arundel OEM HMP Coordinator/Designee & HMPC	Assess changes in local, state, and federal agencies and their funding procedures, new grant programs or areas of focus and their potential integration into existing planning mechanisms.	Status update on existing and new funding procedures, grant programs, new areas of focus, and progress on integration into planning mechanisms.
Review Hazard Information	Anne Arundel OEM HMP Coordinator/Designee & HMPC	Research new or updated data and information that can contribute to risk assessments, loss estimates, or vulnerabilities to assets.	Status update on recent disasters, hazard impacts and losses, lessons learned, and status of facilities and infrastructure. Annual update of the 2025 HMP update to reflect new risk assessment and capability data gathered from review of hazard events and impacts.
Review Mitigation Actions	Anne Arundel OEM HMP Coordinator/Designee & HMPC	Assess progress in previously implemented actions that reduce vulnerability and losses and any new opportunities for mitigation actions.	Status update on completed actions, pending actions, and implementation status of actions collected through monitoring procedure.
Review Outcomes	Anne Arundel OEM HMP Coordinator/Designee	Maintain and complete documentation of the HMP review process, including any needed Plan updates, and prepare summary report.	Summary report of Mitigation Strategy Annual Update, including results of annual monitoring and evaluation process.

6.6 Updating the 2025 Plan Update

This plan maintenance step reviews and revises the Plan on an established schedule to reflect changes in hazard risk, priorities, and development, as well as progress in local mitigation efforts.

The Plan review and revision process are ongoing throughout the five-year life cycle of the Plan. The monitoring and evaluation activities that are conducted, at a minimum, annually and following a major disaster, will assist in maintaining the currency of multiple components of the plan, such as the hazard identification and risk assessment and mitigation actions and priorities.

The end date for the completion of the Plan update will be five years from the date the FEMA approvable pending adoption Plan is adopted, as confirmed by FEMA by letter. It is anticipated that the adoption will occur in 2025, which would set a tentative date for Plan expiration in 2030.

Table 6.1-4: Hazard Mitigation Plan Update Roles and Responsibilities

Stakeholder	Roles and Responsibilities
Anne Arundel OEM HMP Coordinator/Designee	• Coordinate and facilitate the Plan review, revision, and update process. • Maintain schedule of all Plan update activities. • Collect data and disseminate reports. • Maintain records and documentation of all monitoring, evaluation, and update activities. • Identify and implement opportunities for public participation and input in the planning process, including review of the revised draft plan.
HMPC/Town of Highland Beach Representative	• Participate in the planning cycle, including Plan review, revision, and update process. • Collect and report data to the OEM HMP Coordinator. • Maintain records and documentation of all Plan review and revision activities. • Promote the mitigation planning process with stakeholders and the public and solicit public input.

Following the five-year review, any necessary revisions will be implemented according to the reporting procedures and Plan amendment process outlined by state and FEMA guidance. Upon completion of the review and update/amendment process, the 2025 HMP update will be submitted to the State Hazard Mitigation Officer for review and forwarded by MDEM to FEMA for approval.

The Plan update process and schedule are designed to focus on various components of the Plan throughout the five-year cycle. Based on the schedule described, all parts of the Plan will have been reviewed at the end of the five-year cycle, potentially reducing the time and resource burden in the final planning year.

Table 6.1-5: Hazard Mitigation Plan Five-Year Update Process and Schedule

Stakeholder	Roles and Responsibilities
Monitoring and Evaluation Activities – Ongoing throughout the five-year period planning cycle	• Monitoring and evaluation results, meeting documentation, and other pertinent documents will be collected throughout the five-year life cycle of the Plan and used in the next HMP update. • Multiple meetings with elected officials, HMPC, the Town of Highland Beach Representatives, State and Federal agencies, and interested parties will be conducted. • Activities, meetings, and interactions will be tracked and documented throughout the planning cycle.
Updating the Risk Assessment – Conducted in the 1st quarter of the fifth year of the planning cycle	• OEM HMP Coordinator, HMPC/Town of Highland Beach representatives will identify key stakeholders to invite to participate and contribute to the updated risk assessment. • Monitoring and evaluation results will be incorporated. • Changes since the previous Plan approval will be identified. • Each hazard will be assessed and updated to include new data since the date of plan approval and adoption and subsequent updates. • New hazard occurrences and potential changes in low-ranked hazards will be identified and assessed.

Table 6.1-5: Hazard Mitigation Plan Five-Year Update Process and Schedule

Stakeholder	Roles and Responsibilities
	• Any significant changes in risk assessments will be noted during Plan review and integrated into the updated HMP.
Reviewing and Updating the Goals and Objectives – Conducted in the 2nd quarter of the fifth year of the planning cycle	• OEM HMP Coordinator will coordinate with HMPC/Town of Highland Beach representatives and stakeholders to assess the status of current mitigation goals and objectives for potential revision. • Status of integration of mitigation goals and objectives with existing planning mechanisms will be assessed. • Any significant changes in mitigation goals, especially those that are inconsistent with the current Plan goals, will be assessed and incorporated as appropriate in the updated HMP. • Monitoring and evaluation results will be utilized to modify the goals and objectives and describe achievements.
Reviewing and Updating Mitigation Actions – Conducted in the 3rd quarter of the fifth year of the planning cycle	• OEM HMP Coordinator will coordinate with HMPC/Town of Highland Beach representatives and stakeholders to obtain an • update on the status of actions. • Monitoring and evaluation results will be utilized to assess the status and effectiveness of mitigation actions in meeting the goals and reducing risks. • Plan maintenance data from the implemented activities will be used to describe progress in the previous five years.
Compiling and Reviewing Information – Conducted in the 3rd quarter of the fifth year of the planning cycle	• OEM HMP Coordinator, HMPC, and Town of Highland Beach representatives will compile data and develop the updated HMP. • Draft will be made available for stakeholder review and input. • Draft will be made available for public review and comment. • All comments and suggestions will be incorporated, and the final draft completed.
FEMA Review – Conducted in the 4th quarter of the fifth year of the planning cycle	• FEMA review of draft 2025 HMP update.
Plan Adoption	• Updated HMP will be adopted

Adherence to the monitoring, evaluation, and update process schedule will ensure the Plan is kept current throughout its five-year cycle.

6.7 Continued Public Involvement

Continued public involvement is imperative to the overall success of the plan's implementation. The update process provides an opportunity to solicit participation from new and existing stakeholders and to publicize success stories from the plan implementation and seek additional public comment. The plan maintenance and update process will include continued public and stakeholder involvement and input through attendance at designated committee meetings, web postings, press releases to local media, and through public hearings.

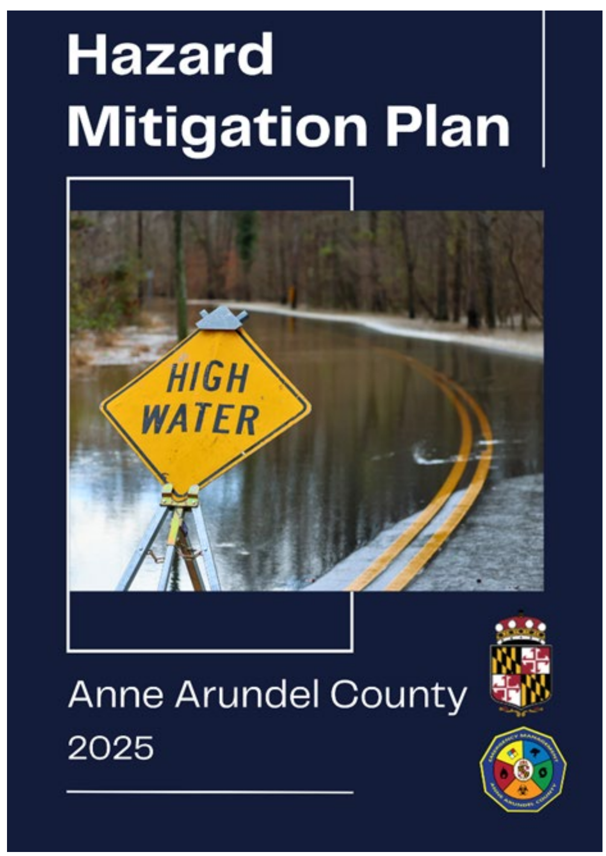
As described above, the County will undertake an annual HMP review process to ensure the document reflects the most current understanding of natural / non-natural hazard risks, and the County's priorities in addressing them. The annual HMP update process will incorporate an inclusive and open process in which public participation is solicited and encouraged. This will be initiated by the County posting notice describing the review process, and how the public may be involved. The notice will be published in the local newspapers, circulated on County social media sites, and posted on the County's website. It will include a detailed description of the 2025 HMP update and its purpose, how it was developed, the update process, and the ways in which the public may participate. The notice will include a link to the existing mitigation plan, and a means by which the public may review a paper version. The notice will also include an explanation of how the public can ask questions and comment on the document, changes that are proposed, and how to provide additional input for consideration in the update. The County will encourage telephone calls, emails, and written comments, and will provide all necessary contact information. There will be at least one public presentation and meeting regarding the plan update, and the public will be advised of this via notice in the local newspaper, and on the County website.

The County will compile input from the public responding to the notice of the annual review and will include this in materials provided to the HMPC as it undertakes the review and update process. Although not all the input will necessarily make it into the HMP, the County will summarize it in the plan, and retain it for future reference, as appropriate.

If changes are made to the 2025 HMP update (other than as a result of the annual review process described above), OEM will post the changes in a location where the public can easily access the information, provide feedback and make comments. The public will be provided with a 30-day comment period before any proposed changes become final. Before comments are incorporated in the 2025 HMP update, OEM will review and provide recommendations to the HMPC on the number and type of public comments received.

A copy of the most recently approved HMP will stay posted on the County's website until a new update occurs or changes are made. A copy of the document will also stay on file with OEM and be accessible to the public by calling or emailing OEM and requesting to review it. The County will continue to monitor opportunities for the public to become involved in hazard mitigation planning through attendance at region area planning meetings, and through targeted public outreach. Comments received by OEM will be documented and retained as an official record until final approval of the HMP update is granted by FEMA.

Plan Adoption



7.0 Plan Adoption

A hazard mitigation plan must document that it has been formally adopted by the governing bodies of the jurisdictions requesting federal approval of the plan. Adoption of the plan demonstrates the commitment of Anne Arundel County and the Town of Highland Beach to fulfill the mitigation goals and strategies outlined in the plan. Adoption legitimizes the HMP and authorizes responsible departments and agencies to execute their responsibilities.

F2. For multi-jurisdictional plans, has the governing body of each jurisdiction officially adopted the plan to be eligible for certain FEMA assistance? **(Requirement 44 CFR § 201.6(c)(5))**

Adopted plans demonstrate the County's recognition of the current planning process, acknowledge changes from the previous five years, and validate the priorities for hazard mitigation actions. Without adoption, the County and the Town of Highland Beach have not completed the mitigation planning process and will not be eligible for certain FEMA assistance, such as Hazard Mitigation Assistance (HMA) or High Hazard Potential Dam (HHPD) grant program funding for mitigation actions.

This plan will be submitted for a pre-adoption review to MDEM and FEMA. Once FEMA provides conditional approval of this HMP update, known as Approval Pending Adoption (APA), the County and the Town of Highland Beach will proceed with formal adoption proceedings. The adoption of this HMP completes the last step of the planning process: *Adopt the Plan, in accordance with the requirements of the Disaster Mitigation Act (DMA) of 2000.*

Following adoption or formal action on the plan, the Town of Highland Beach must submit a copy of the resolution or other legal instrument showing formal adoption (acceptance) of the plan to the Anne Arundel County OEM. Anne Arundel County will forward the executed resolutions to MDEM after which they will be forwarded to FEMA for record. The Town of Highland Beach understands that FEMA will transmit acknowledgement of verification of formal plan adoption and the official approval of the plan to the Anne Arundel County OEM. The resolutions issued by Anne Arundel County and the Town of Highland Beach to support adoption of the plan will be included in Appendix K.

In addition to being required by DMA 2000, adoption of the Hazard Mitigation Plan is necessary because:

- It lends authority to the plan to serve as a guiding document for all local and state government officials.
- It gives legal status to the plan in the event it is challenged in court.
- It certifies the program and grant administrators that the plan's recommendations have been considered and approved by the governing authority and jurisdictions.
- It helps to ensure the continuity of mitigation programs and policies over time because elected officials, staff, and other community decision-makers can refer to the official document when making decisions about the community's future.

Source: FEMA. 2003. "How to Series"-Bringing the Plan to Life (FEMA 386-4).